Office of Technology & Innovation

OFFICE OF TECHNOLOGY AND INNOVATION TESTIMONY BEFORE THE NEW YORK CITY COUNCIL COMMITTEE ON TECHNOLOGY

Oversight - LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.

June 7, 2023

Good afternoon, Chair Gutiérrez and members of the City Council Committee on Technology. My name is Brett Sikoff, Executive Director of Franchise Administration at the Office of Technology and Innovation (OTI). I am joined by Chantal Senatus, Deputy Commissioner for Legal Matters and Ryan Birchmeier, Deputy Commissioner for Public Information. Thank you for the opportunity to provide an update on LinkNYC, our citywide program bringing 5G connectivity and free services including high-speed Wi-Fi, free calling, mobile device charging, and access to 911 and 311 -- all at no cost to taxpayers. We have made significant progress over the last year, and I'm pleased to share the status of the rollout.

The LinkNYC program remains a crucial component of the Adams administration's goal to expand broadband access to historically underserved communities across the city. It is important to acknowledge that large segments of our city's population do not have reliable or affordable internet access. These New Yorkers deserve to feel connected and safe, regardless of where they live, work, or visit in the city.

5G, or the fifth-generation wireless network, will become the prevalent means of connecting to cellular data for mobile phone customers. With more and more New Yorkers relying on their mobile devices for day-to-day tasks, and for many as their only means to connect to the internet while at home, we must keep up with current and future demand for this service.

The new Link5G program delivers this in a novel way. The City has a franchise agreement that enables CityBridge to build kiosks that house 5G equipment along the City's rights-of-way (streets and sidewalks). In exchange, the City benefits by enabling the expansion of 5G connectivity, free public Wi-Fi, and a wide range of other community benefits available to New Yorkers and visitors, all while generating revenue from the program.

LinkNYC does not, and has never, cost the City money. In fact, it has generated over $115 million to the City over the course of the franchise, and continues to be a steady source of revenue.

Over the past 7 years, LinkNYC has become an invaluable resource to New York City residents and visitors alike. The program currently supports:

- Over 13 million Wi-Fi subscribers;
- Over 5 million phone calls a year;
- 30,000 yearly connections to social services; and
- 2,200 community organizations receiving free or discounted advertisements.

Beyond these widely utilized benefits, the LinkNYC network has also established a Gigabit Center in every borough to provide high-speed internet and support digital literacy training for underserved communities. This spring, we opened our most recent Center at La Colmena, which supports immigrant populations in Staten Island.

Link5G has continuously gone through a robust public review process. The Link5G design, for example, was approved by the Public Design Commission after an 18-month process that included several opportunities for public comment. As of last fall, OTI has expanded its engagement for proposed locations by notifying relevant stakeholders and holding 60-day public comment periods. Over the past several months, OTI and CityBridge have proposed 198 new sites in 36 Community Districts, attended approximately 20 community meetings, and discussed sites with dozens of elected officials and local stakeholders.

In addition to ensuring that every new proposed kiosk meets dozens of siting criteria, OTI carefully considers public feedback received during the comment period ahead of implementation. Link5G kiosks are also subject to additional local, state and federal governmental reviews before they can move forward.

We are looking forward to continuing to work with Council on this roll-out. As new sites are proposed, we are doubling down on our efforts to expand outreach and engagement. For example, OTI will be creating a new Link5G landing page that makes information more accessible. We will also endeavor to present more sites at once to smaller groups of Community Districts to make a more efficient and robust discussion around these critical investments.

With that, I will now take Council Members' questions.

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JUMAANE D. WILLIAMS

TESTIMONY OF PUBLIC ADVOCATE JUMAANE D. WILLIAMS
TO THE NEW YORK CITY COUNCIL COMMITTEE ON TECHNOLOGY
JUNE 7TH, 2023

Good afternoon,

My name is Jumaane D. Williams, and I am the Public Advocate for the City of New York. I would like to thank Chair Gutiérrez, and the Committee members for holding this hearing. CityBridge's Link5G towers are part of former Mayor DeBlasio and Mayor Adams' plans to expand internet access for all, a laudable and necessary goal. New Yorkers who do not have access to the internet cannot survive in the 21st century. Yet, far too many New Yorkers live without a reliable internet connection in their homes. Link5G offers free internet and enables those who are nearby to connect with the outside tower. This will benefit on-the-go and low income New Yorkers. However, there are still outstanding concerns on Link5G towers that must be addressed.

These concerns are:

1. **Overheating Concerns -** It is unclear if the FDNY has approved of Link5G design permits, or were involved in the Link5G placement process.

2. **Civil Rights Concerns -** Link5G have active cameras and it is unclear when cameras on the Link5G towers are activated and when the cameras are off. OTI staff stated that the cameras on Link5G towers are not on and are activated during crime. The Transparency Report does not explain this or specify cameras are always off. Furthermore, how does the tower know when a crime is in progress to then automatically turn on to capture the footage.

3. **Public Information Sharing** - To ensure transparency for New Yorkers, OTI should post on its website the Link5G's FCC RF Compliance Assessment and Report, Structural Analysis Report, and Construction Drawings. Several municipalities share critical information about the cell towers in commercial areas. In Takoma Park, Maryland, a municipality with a much smaller budget than New York City's government, the local government shares critical documents such as FCC RF Compliance Assessment and Report, Structural Analysis Report, and Construction Drawings[1].

[1] https://takomaparkmd.gov/initiatives/project-directory/small-cell-antennas-in-the-citys-rights-of-way/

4. **Expanding Public Internet-** Link5G towers have several slots, some of which will be used by commercial internet carriers. Do any Link5G towers have a chamber that is available for use by a nonprofit organization? Public internet nonprofits have expressed interest in using available Link5G tower slots.

5. **Link 5G towers falling** - The Link5G towers are being built too close to homes. Utility poles are not built right on top of apartment buildings/houses, so the same standards should be applied to Link5G towers. Link5G towers are bulkier than a typical utility pole, so special considerations should apply.

I would like the Committee on Technology to examine these concerns and continue to work with the OTI and CityBridge.. Thank you.

LinkNYC - Margaux Knee Testimony June 7 (3 MINUTES)

Thank you, Chair Gutiérrez and members of the Committee on Technology.

My name is Margaux Knee, and I serve as Chief Administrative Officer for LinkNYC. I appreciate the opportunity to update you on the program and its efforts to expand digital connectivity through the new Link5G kiosk.

We launched LinkNYC in 2015 with the firm belief that digital connectivity is a fundamental human right — absolutely necessary to fully participate and access opportunity in today's modern society. Since then, I'm proud to say we've facilitated over **3 billion** free Wi-Fi sessions for more than **13 million** subscribers in all five boroughs. It is also an engine of economic development, responsible for **$560 million** in labor income and **$1.1 Billion** in economic activity in the City since the program began.

This critical program functions as a digital safety net for our communities - during the pandemic **30%** of our free Wi-Fi users reported having no other means of accessing broadband; the tablet facilitates more than **5 million** free phone calls per year, most often to the EBT (food stamp) support line; and hundreds of thousands connect to government services and social support programs through partnerships with organizations like helpNYC.

Since we last met, the Link5G design received final approval from the Public Design Commission in Commercial and Manufacturing zones, and deployment has begun, starting first in equity areas in the Bronx, Queens, and Brooklyn.

Furthermore, LinkNYC has completed all five Gigabit Centers in each of the five boroughs. Gigabit Centers bring our digital safety net indoors to support community use, digital literacy training, and other programs based on the mission of each Gigabit Center partner. For example, Digital Girl in Brooklyn prepares **young women for careers in STEM** related fields; La Colmena in Staten Island supports **workforce development** and services for the **immigrant community**, and The Allen Senior Center in Queens, focusing on **digital literacy for older adults**.

Demand for mobile communications has exploded over the last 20 years, and this rapid growth is projected to continue unabated. As it builds the infrastructure to support this growth, New York City has an opportunity to lead the way by building a network that equitably supports all New Yorkers wherever they live, work, learn, and play throughout the entire city.

In our always-on world, we all expect and are expected to stay connected as we travel throughout our day. This is true for CEOs, deliveristas, parents, and young adults alike. But not all New Yorkers have the means to pay for unlimited wireless data, and preserve their mobile plans by leaning on open and free Wi-Fi networks like LinkNYC. Next generation, 5G network infrastructure will be built throughout the City, but only Link5G will provide this digital safety net to ensure that New Yorkers of any means have equal access to mobility. This is why it is so important to preserve the right to thoughtfully and strategically deploy Link5G in all parts of our City.

We share a vision of a New York that guarantees equitable access to the opportunities available in our digital economy. Mobile digital connectivity is a requirement to enable this, and we value the City and the Council's partnership in making this vision a reality.

Thank you for the opportunity to be here today. I am happy to take any questions you may have.

Testimony of Hon. Carolyn B. Maloney
Before the City Council Committee on Technology
June 7, 2023

My name is Carolyn Maloney and I am the former member of Congress for the 12th Congressional District. I am here to express my concerns about the 5G Towers that are being proposed for my neighborhood and many other communities in the city.

If the goal is to bring the internet to underserved populations, the 5G Towers are the wrong solution. The towers provide mobile broadband for pedestrians and people in vehicles but only limited home broadband service. What's more, there's no assurance that the towers are being placed where service would otherwise be lacking. It makes no sense to put these big obtrusive towers on the street when other solutions are available – small cells on existing street furniture, antennas on rooftops – which is exactly what the cell phone companies are already doing.

At a recent Community Board 7 Land Use Meeting, OTI said that the range of the towers is just 500 feet, that you must have a direct line of site to the antenna to use the towers and that the 5G signal will not penetrate walls. Only those who happen to have windows in a direct line of sight of the antenna can receive service, and then they would likely need another device to boost the signal so that it can be used at home.

We know from the Office of Technology and Innovation that as many as 36% of New Yorkers lack home broadband or mobile broadband or both. Unfortunately, after the cancellation of the Internet Master Plan, the city has no comprehensive plan to ensure that all New Yorkers have home and mobile broadband. Not having broadband at home is particularly problematic. Children cannot do homework or learn to code on a phone.

Big Apple Connect, which is only available to public housing residents, is funded for just 3 years, and fails to reach a huge segment of the underserved population.

When kids are sitting next to towers to do their homework, that's evidence that we need a better plan. The towers aren't a reasonable solution particularly in bad weather or at night. New York City needs a plan to make sure that anyone who wants broadband at home can get it, that both service and equipment are affordable and that people who need training can get it.

VERIZON TESTIMONY

OVERSIGHT HEARING ON

"LinkNYC: Deployment of 5G Infrastructure and Wi-fi Connectivity across the City"

HELD BY THE

COMMITTEE ON TECHNOLOGY

OF THE

COUNCIL OF THE CITY OF NEW YORK

ON

JUNE 7, 2023

Verizon appreciates the opportunity to submit testimony to the Council's Committee on Technology in regards to 5G deployment in NYC.

Verizon has deep-rooted connections with New York City, and for over a hundred years has played a substantial role in the life of the City. With the help of the many thousands of New Yorkers who work for the company, we have built and maintained the best-in-class wireline and wireless networks that are the backbone of the 21st century economy. We work on an ongoing basis, day after day, to maintain and upgrade those networks in order to meet the ever-increasing communication needs of the city and its people and businesses.

We understand the role that technology serves for the continued economic development in New York City and are committed to making sure the city is a national leader in technological advancements. To this end, Verizon has upgraded its wireline network to fiber optics and is moving into the next advancement in wireless innovation with 5G technology.

Over the past 30 years, our mobile device experience has expanded from phone calls to text messages to streaming high-definition movies. The evolution to 5G and its potential for blazing fast speeds and low latency is expected not just to let us do more on our phones, it could bring positive changes to society as a whole. 5G will usher in more informed and efficient businesses, safer and smarter communities, more connected everyday living, and ways to bring broadband connectivity to more people.

Furthermore, be assured that Verizon's telecommunications equipment and networks comply with Federal Communications Commission (FCC) radiofrequency (RF) safety standards. This includes ensuring that equipment is placed a safe distance from individuals, homes, and other areas to which the general public has access, and confirming that the total level of RF emissions from licensed telecommunications equipment identified nearby falls within FCC limits.

The City of New York must focus on policies that enhance and advance the ability of providers to deliver quality services across New York City. Currently, with respect to 5G, the city has a process in place that enables providers to access city infrastructure to help deliver crucial services. Further ensuring that the industry has access to public and private infrastructure, streamlining approvals, and ensuring timely issuance of permits are key areas that should remain the focus on fostering an environment that spurs 5G deployment. The city should resist the temptation to put in place any prohibitions or requirements that will only deter investment in and the deployment of advanced network facilities.

It is important to note that build plans are developed with an eye towards addressing today's current user capacity demands and anticipating tomorrow's growth and consumption. Being prepared allows for proper build execution and a seamless experience for city residents and businesses. Public safety, remote learning, hybrid work, telehealth, augmented & virtual reality applications will all rely 5G. Any temptation to prohibit or limit a provider's ability to build should be avoided at all costs.

Respectfully, we ask that the Council to support efforts to facilitate 5G rollout and carefully consider any actions that may delay providers' ability to complete 5G deployment, a delay which ultimately could jeopardize New York City's competitive position as a leader in technology.

Thank you for the opportunity to share this information and we are more than happy to meet with you to discuss the importance of ensuring that New York City supports service providers ability to upgrade and maintain the wireless networks depended on by the people of New York City.

Jeannine Kiely, *Chair*
Susan Kent, *First Vice Chair*
Valerie De La Rosa, *Second Vice Chair*
Mark Diller, *District Manager*

Antony Wong, *Treasurer*
Amy Brenna, *Secretary*
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February 1, 2023

Matthew C. Fraser
Chief Technology Officer & Commissioner
375 Pearl Street, 16th Floor
New York, NY 10038

Gregory Cala
Community and Intergovernmental Affairs Associate
1 Centre St., 9th Floor
New York, NY 10007

Dear Matthew C. Fraser and Gregory Cala:

At its Full Board meeting January 19, 2023, Community Board #2, adopted the following resolution:

1. Resolution highlighting community concerns around the construction of Link5G towers and calling for a moratorium on the construction of such towers in Community District 2.

Link5G Background

1. **Whereas,** New York City, through its Office of Technology and Innovation ("OTI"), has contracted with CityBridge to install and operate a citywide wireless communications network, subject to a Public Communications Structure Francise Agreement ("Franchise Agreement"); and

2. **Whereas**, under the Franchise Agreement, CityBridge is seeking to install up to 2,000 "Link5G" towers, along sidewalks throughout NYC, with these 32-foot-tall towers providing free Wi-Fi to surrounding areas, containing space that can be rented to wireless carriers that can enhance their 5G networks, and with some of these towers containing advertising space analogous to the advertising space on existing LinkNYC terminals; and

3. **Whereas,** CityBridge has already commenced installing Link5G towers in Industrial and Commercial districts, and is now looking to expand the rollout to include Residential districts and Landmarked Historic districts; and

4. **Whereas**, CityBridge is required to site 90% or more of new Link5G terminals outside of Manhattan below 96th Street in order to fulfill its mandate of providing broadband equity and closing the digital divide, with additional requirements to site a certain number of terminals in identified "equity community districts"; and

5. **Whereas**, the remaining 5G terminals outside of this equity mandate, which include those terminals proposed for Community District 2 ("CD2"), are, according to CityBridge, sited subject to various other criteria including where 5G service carriers have indicated the need for additional capacity, and the ability to generate advertising revenue; and

6. **Whereas**, potential siting locations are subject to a range of siting criteria, with additional criteria applying to those being sited within landmarked historic districts; and

7. **Whereas**, Link5G only represents one component of NYC's investment in 5G technology, with additional pole-top and roof-top 5G units under separate programs having already been rolled out and continuing to be rolled out extensively across the city; and

Initial Proposed Link5G Sites in CD2

8. **Whereas**, Representatives from OTI and CityBridge presented to Community Board 2's Quality of Life committee on Tuesday, January 17th, 2023, to share the plan for the initial siting of Link5G kiosks in CD2 and to hear questions and concerns from the community; and

9. **Whereas**, there are currently nine initial sites provided by CityBridge / OTI that will be part of the initial rollout of Link5G in CD2; and

10. **Whereas,** five of the proposed nine locations are located within landmarked historic districts within CD2, with two locations (820 Greenwich St. and 771 Greenwich St.) located within the Greenwich Village Historic District, two locations (568 Broadway and 110 Prince St.) located within the SoHo-Cast Iron Historic District, and one location (113 Horatio St.) located within the Gansevoort Market Historic District; and

11. **Whereas**, the other four locations, while not located within a landmarked historic district, are in close proximity to such districts may be located in close proximity to individual landmarks as well; and

12. **Whereas**, these nine sites only represent the initial round of proposed sites within CD2, and other sites are likely to be proposed by CityBridge in the future; and

13. **Whereas,** it does not appear that CityBridge / OTI are complying with the established siting criteria set forth in the Franchise Agreement for several of the locations, and specifically there appear to be no certifications that installation of the Link5G towers will in no way damage existing vault structures, which are widely prevalent in the proposed areas for such towers and where specific adjacent property owners have expressed concerns; and

Significant and Wide-Ranging Community Concerns

14. **Whereas**, numerous residents of CD2 and elsewhere attended CB2 meetings and/or submitted written testimony to CB2 to express opposition and concern regarding the installation of Link5G towers within CD2, with virtually no community members expressing support for the installation of these towers; and

15. **Whereas**, the specific points of concern and opposition expressed by the community were wide-ranging, touching on areas including design & aesthetics (including specifically in relation to towers in landmarked districts and in proximity to individual landmarks), safety, privacy, maintenance, equity, and economics; and

16. **Whereas**, from a design & aesthetics perspective, community and board members felt that the towers were out-of-scale with the streetscape in CD2, and particularly out-of-character with the landmarked historic districts within CD2, and there was a general consensus that if the Link5G towers could not be prevented from being sited with CD2, that they should at the very least be re-designed; and

17. **Whereas**, with particular regard to towers sited in landmarked historic districts or in proximity to individual landmarks, there was uncertainty and concern amongst board and community members as to the exact LPC approval process and the amount of oversight that LPC and other agencies would have over the placement of Link5G towers and if there would be consideration of other alternative infrastructure that might better suit and be less obtrusive within landmarked historic districts which could also meet the established objectives; and

18. **Whereas,** from a safety perspective, there was community concern around the potential health impacts of electromagnetic radiation emitted by 5G towers, particularly within residential and mixed use districts, and that relying solely on FCC regulations without additional state or local oversight was not adequate; and

19. **Whereas**, from a privacy perspective, despite CityBridge being subject to a privacy policy under the Franchise Agreement, there was community concern that this was not an adequate protection, and that the Link5G system may be vulnerable to cyber threats; and

20. **Whereas,** from an engineering design perspective, concerns were raised regarding engineering challenges, both for design and structural placement of the Link5G towers, it being apparent that many variable subsurface conditions exist throughout the older historic portions of the city, particularly in areas that precede the historic city grid system with extensive vaults underneath many of CD2s Sidewalks; and

21. **Whereas**, there was community concern regarding the future maintenance of these towers, and that despite CityBridge's obligation to maintain them, that they might fall into future disrepair; and

22. **Whereas**¸ there was confusion and concern expressed by community members regarding the stated equity goals of the Link5G program, that the towers being proposed for siting

in CD2 did nothing to advance these goals, as CD2 already has an extremely high level of broadband access, and that resources would be better spent siting Link5G terminals in areas where they would be more impactful; and

23. **Whereas**, there was opposition voiced regarding economic aspects of the Link5G program, which, while purportedly being installed at no cost to the taxpayer, would allow private entities to profit off of public space with the city receiving, according to some publications, minimal shared profits; and

24. **Whereas**, while CB2 appreciates that OTI and CityBridge have been conducting significant public outreach regarding the Link5G program, there clearly remain a large number of unanswered questions that span these various areas of concern; and

25. **Whereas**, seeing no immediate need for the installation of Link5G towers within CD2 given existing levels of cell carrier coverage and broadband access, CB2 members agreed that in the light of extensive community concerns and unresolved questions around the Link5G program, there is no reason to continue with installation of the proposed towers in CD2 at this time; now

Therefore Be It Resolved that CB2 Manhattan calls for a moratorium on installation of Link5G towers in Community District 2 within all residential districts and mixed use districts which contain residential zoning, as well as within all landmarked historic districts and areas in close proximity to individual landmarks.

Therefore Be It Further Resolved that should the city elect to proceed with installation of Link5G towers in CD2, CB2 Manhattan calls for a robust engagement with community stakeholders and significantly more extensive public education, public input and community review process to address the community's substantial range of questions and concerns.

Vote: Passed, 44 Board Members in favor, 1 against (C. Dignes)

Please advise us of any decision or action taken in response to this resolution.

Sincerely,

Jeannine Kiely, Chair
Community Board #2, Manhattan

William Benesh, Chair
Quality of Life Committee
Community Board #2, Manhattan

JK/em

cc: Hon. Jerrold Nadler, Congressman

Hon. Daniel Goldman, Congressman
Hon. Brad Hoylman-Sigal, State Senator
Brian Kavanaugh, State Senator
Hon. Deborah Glick, Assembly Member
Hon. Mark Levine, Man. Borough President
Hon. Erik Bottcher, City Council Member
Hon. Christopher Marte, City Council Member
Hon. Carlina Rivera, City Council Member
Brett Skioff, OTI
Robert Sokota, CityBridge
Margaux Knee, CityBridge

CityBridge

For the New York City Council Committee on Technology
LinkNYC 5G Safety Research

News Articles

AAP Factcheck (February 28, 2023): 5G microwave claim is well and truly cooked
"A Facebook video with more than half a million views claims that people are exposed to more radiation from standing near a 5G tower than if they were inside a microwave. The claim is false with experts telling AAP FactCheck the levels of radiation inside a microwave are around 150,000 times greater."

Forbes Health (January 19, 2023): Is 5G Making You Sick? Here's What Experts Say
"Claims state 5G weakens the immune system, making it easier to contract COVID-19, or that it directly causes the virus. Simply put, research emphasizes that the belief that 5G causes or can spread COVID-19 isn't true."

Good Rx Health (September 19, 2022): Health Debunked: Is 5G Bad for Your Health?
"Expert organizations find no evidence that 5G is harmful to human health."

ABC (Australian Broadcasting Corporation) News (August 26, 2022): Does 5G pose a health risk? ARPANSA scientists say Melbourne study suggests the answer is no
"A team of Melbourne scientists measuring the electromagnetic output from phone towers across the city are confident controversial cellular upgrades do not pose a risk to health. Experts from the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) hope to counter misinformation about the continued rollout of 5G."

PC Magazine (May 16, 2022): Is 5G Safe?
"Power levels are extremely important. Bluetooth and microwave ovens run on the same frequency, at 2.4GHz. The reason your microwave oven can cook food and your Bluetooth headset can't is that your Bluetooth headset is many thousands of times weaker. A firefly isn't a blowtorch. 5G systems are more on the firefly end of things.

Studies of mmWave have shown that it doesn't penetrate human skin well and that its strongest effect, at levels of power higher than any 5G network uses, is that it makes things slightly warmer. At the levels 5G networks use, there's no perceptible effect on people."

USA Today (January 30, 2022): Fact check: No evidence 5G networks have 'enormous impact' on immune system
"'I am unaware of any evidence that exposure to 5G emissions has any adverse effects on the immune system,' Richard Tell, chair of the Committee on Man and Radiation at the Institute of Electrical and Electronics Engineers, said in an email."

"The claim that 'EMF radiation from 5G has & will have an enormous impact on your immune system' is inaccurate and uncalled for," Dr. Marvin Ziskin, emeritus professor of radiology and medical physics at the Temple University Medical School, said in an email. Ziskin added that the claim was "without any scientific justification."

"'The science is really straightforward — there's simply no solid evidence that anything other than a small amount of body heating may result from exposure to 5G radiofrequency fields,'" he says.

How to Geek (March 31, 2020): How Worried Should You Be About the Health Risks of 5G?
"With the onset of the Coronavirus pandemic, a number of viral social media conspiracy theories have speculated that 5G is the cause of the world's current problems. Simply put, these claims are factually false. 5G does not cause Coronavirus."

"Dr. Steve Novella, an assistant professor of neurology at Yale and the editor of Science-Based Medicine, understands that people generally get concerned about radiation. 'Using the term radiation is misleading because people think of nuclear weapons—they think of ionizing radiation that absolutely can cause damage. It can kill cells. It can cause DNA mutations.' But since non-ionizing radiation doesn't cause DNA damage or tissue damage, Novella says that most concern about cell phone RFR is misplaced. 'There's no known mechanism for most forms of non-ionizing radiation to even have a biological effect,' he says."

Reuters (March 16, 2020): False claim: 5G networks are making people sick, not Coronavirus
"According to the ICNIRP, 'Another general characteristic of RF EMFs is that the higher the frequency, the lower the depth of penetration of the EMFs into the body. As 5G technologies can utilize higher EMF frequencies (>24 GHz) in addition to those currently used (<4 GHz), power from those higher frequencies will be primarily absorbed more superficially than that from previous mobile telecommunications technologies [...] Accordingly, 5G exposures will not cause any harm providing that they adhere to the ICNIRP (2020) guidelines'"

The Guardian (March 12, 2020): 5G confirmed safe by radiation watchdog
"5G is safe, according to the international body in charge of setting limits on exposure to radiation, which has updated its advisory guidelines for the first time in more than 20 years."

Fox Business (February 12, 2020): Cellphones don't cause cancer, FDA says
"Over the decades since cellphones were introduced, dubious health claims have followed them. Local planning board meetings and Facebook groups across the country have heard from people convinced that cell towers and mobile phones will cause cancer. But is it actually true?
The answer is a scientifically cautious 'no,' probably not, according to a new report from the U.S. Food and Drug Administration. The agency reviewed 125 studies published over the past decade and found that none of them showed that localized radio frequency radiation exposure could lead to adverse effects."

MIT Technology Review (February 11, 2020): No, there's no evidence that cell phones give you cancer
"The report reviewed 125 experiments carried out on animals and 75 on humans between 2008 and August 2019. In summary, the FDA said that there's 'no consistent pattern' to link radiofrequency radiation, or RFR, to tumors or cancer."

The Wall Street Journal (December 5, 2019): FCC Says 5G Doesn't Pose New Cellphone-Radiation Threats
The FCC said it found no basis for changing current exposure limits and took to heart the Food and Drug Administration's comments that the weight of scientific evidence hadn't linked cellphones to health problems."

"A new comment piece, appearing in the New Zealand Medical Journal on Friday, agrees the topic is complex but says any potentially harmful biological effects are more commonly seen in low-quality scientific studies."

"'Many of the studies showing a potential detrimental health effect are of low quality, but get published because they are interesting,' Elwood said. 'The word 'potential' is important. Most of the studies investigate some physiological or molecular change which could possibly be related to a health effect, but usually direct evidence of a health detriment is lacking.'"

The New York Times (July 16, 2019): The 5G Health Hazard That Isn't
"According to experts on the biological effects of electromagnetic radiation, radio waves become safer at higher frequencies, not more dangerous. (Extremely high-frequency energies, such as X-rays, behave differently and do pose a health risk.)"

"Dr. Marvin C. Ziskin, an emeritus professor of medical physics at Temple University School of Medicine, agreed. For decades, Dr. Ziskin explored whether such high frequencies could sow illness. Many experiments, he said, support the safety of high-frequency waves."

Memorial Sloan Kettering Cancer Center (May 20, 2019): Do Cell Phones Cause Cancer?
"Any individual study might find something unusual,' Dr. Dauer says. 'But what's most important to consider is the weight of evidence across all of them.' And that, he says, does not show any clear link between cell phones and cancer… The argument that cell phones cause cancer lacks biological plausibility because the energy contained in the waves is too low to cause damage."

The New York Times (May 12, 2019): Your 5G Phone Won't Hurt You. But Russia Wants You to Think Otherwise.
"The Russian network RT America aired the segment, titled 'A Dangerous 'Experiment on Humanity,' in covering what its guest experts call 5G's dire health threats. U.S. intelligence agencies identified the network as a principal meddler in the 2016 presidential election. Now, it is linking 5G signals to brain cancer, infertility, autism, heart tumors and Alzheimer's disease — claims that lack scientific support."

"'It's economic warfare,' Ryan Fox, chief operating officer of New Knowledge, a technology firm that tracks disinformation, said in an interview. 'Russia doesn't have a good 5G play, so it tries to undermine and discredit ours.'"

"The Kremlin 'would really enjoy getting democratic governments tied up in fights over 5G's environmental and health hazards,' said Molly McKew, head of Fianna Strategies, a consulting firm in Washington, D.C., that seeks to counter Russian disinformation."

CNBC (March 27, 2019): Some say 5G will cause cancer, but here's why scientists say we do not need to worry
"At the levels that are used for example in wireless communications or that are used for transmitting AM, FM radio, of 5G technology, the amount of RF energy that's being transmitted is very, very low and would need to be thousands of times greater to even be felt by the body as a heat source, much less cause any particular harm."

Los Angeles Times (February 2, 2018): Radiation from cellphones is not hazardous to your health, government scientists say

CityBridge

Conclusions: The results of this investigation, the first nationwide cancer incidence study of cellular phone users, do not support the hypothesis of an association between use of these telephones and tumors of the brain or salivary gland, leukemia, or other cancers.

5G Health Facts/CTIA (2021): Dr. Eric Swanson, Ph.D. | Testimony Before the South Carolina Senate Judiciary Subcommittee

"What about non-ionizing radiation? That's the radiation we're talking about. In 5G, the predominant health effect is a thermal effect. It's a heating effect on tissue. The FCC regulated this stringently, I've looked at the regulations, they are incredibly conservative…Your head because it is warm emits thermal radiation and if the FCC chose to regulate it, it would be illegal by a factor of ten…The sun, by the way, if the FCC chose to regulate it, it would also be illegal. It emits far higher radiation than is permissible by FCC standards."

Exponent (April 2020): Wireless 5G Radiofrequency Technology

"Fixed small cell wireless communication installations—such as small cell antennas—that operate in compliance with the regulations of the FCC will produce RF exposures well within the recommended exposure limits of the FCC, ICNIRP, and IEEE. Research to date does not provide a reliable scientific basis to conclude that the operation of these facilities will cause or contribute to adverse health effects in the population. Research on RF will continue as is often done with new technologies, but not because public health authorities have established that the use of RF communications technologies today causes adverse health effects or is unsafe."

Journal of the National Cancer Institute (July 27, 2001): Cellular telephones and cancer--a nationwide cohort study in Denmark

Background: It has been hypothesized that children and adolescents might be more vulnerable to possible health effects from mobile phone exposure than adults. We investigated whether mobile phone use is associated with brain tumor risk among children and adolescents.

Methods: CEFALO is a multicenter case-control study conducted in Denmark, Sweden, Norway, and Switzerland that includes all children and adolescents aged 7-19 years who were diagnosed with a brain tumor between 2004 and 2008. We conducted interviews, in person, with 352 case patients (participation rate: 83%) and 646 control subjects (participation rate: 71%) and their parents. Control subjects were randomly selected from population registries and matched by age, sex, and geographical region. We asked about mobile phone use and included mobile phone operator records when available. Odds ratios (ORs) for brain tumor risk and 95% confidence intervals (CIs) were calculated using conditional logistic regression models.

Results: Regular users of mobile phones were not statistically significantly more likely to have been diagnosed with brain tumors compared with nonusers (OR = 1.36; 95% CI = 0.92 to 2.02). Children who started to use mobile phones at least 5 years ago were not at increased risk compared with those who had never regularly used mobile phones (OR = 1.26, 95% CI = 0.70 to 2.28). In a subset of study participants for whom operator recorded data were available, brain tumor risk was related to the time elapsed since the mobile phone subscription was started but not to amount of use. No increased risk of brain tumors was observed for brain areas receiving the highest amount of exposure.

Conclusion: The absence of an exposure-response relationship either in terms of the amount of mobile phone use or by localization of the brain tumor argues against a causal association.

CityBridge

National Cancer Institute (March 10, 2022): RF Safety FAQ: ARE WIRELESS CELLULAR AND PCS TOWERS AND ANTENNAS SAFE?
"…radiofrequency emissions from antennas used for cellular and PCS transmissions result in exposure levels on the ground that are typically thousands of times below safety limits. These safety limits were adopted by the FCC based on the recommendations of expert organizations and endorsed by agencies of the Federal Government responsible for health and safety. Therefore, there is no reason to believe that such towers could constitute a potential health hazard to nearby residents or students."

National Cancer Institute (March 10, 2022): Cell Phones and Cancer Risk
"These frequencies all fall in the nonionizing range of the spectrum, which is low frequency and low energy. The energy is too low to damage DNA."

"The human body does absorb energy from devices that emit radiofrequency radiation. The only consistently recognized biological effect of radiofrequency radiation absorption in humans that the general public might encounter is heating to the area of the body where a cell phone is held (e.g., the ear and head). However, that heating is not sufficient to measurably increase core body temperature. There are no other clearly established dangerous health effects on the human body from radiofrequency radiation."

"… although many studies have examined the potential health effects of non-ionizing radiation from radar, microwave ovens, cell phones, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans."

World Health Organization (WHO) (February 27, 2020): Radiation: 5G mobile networks and health
To date, and after much research performed, no adverse health effect has been causally linked with exposure to wireless technologies.

U.S. Food and Drug Administration (FDA) (February 10, 2020): Scientific Evidence for Cell Phone Safety
"As part of ongoing monitoring activities, the FDA analyzes published epidemiological studies for specific outcomes including brain and other tumors as well as for any evidence of other adverse events. No clear and consistent pattern has emerged from epidemiological studies. Based on the evaluation of the currently available information, the FDA believes that the weight of the scientific evidence does not support an increase in health risks from radio frequency exposure from cell phone use at or below the radio frequency exposure limits set by the FCC."

"The FDA also monitors the Surveillance, Epidemiology, and End Results (SEER) database maintained by the National Cancer Institute (NCI) at the National Institutes for Health (NIH). The SEER data show that brain cancer rates are not increasing in the United States despite the significant increase in the number of cell phone users."

"The NCI data clearly demonstrate no widespread rise in brain and other nervous system cancers in the last (nearly) three decades despite the enormous increase in cell phone use during this period. The Pew Research Center estimates that from 2002 to 2019, the percentage of the population owning a cell phone or smartphone has risen from 62 percent to 96 percent, and yet there is a small decrease in brain and other nervous tissue cancer rates."

"Published in vivo studies have yielded no clear evidence that radio frequency energy exposure at levels experienced by the public from cell phone use leads to tumorigenesis."

CityBridge

"Although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumours in adults."



LinkNYC

a collaboration between New York City government and CityBridge

NYC Council Committee on Technology Oversight Hearing - LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.

Wednesday, June 7, 2023

**This presentation has been prepared by CityBridge, LLC and not by the Office of Technology and Innovation.*

The LinkNYC Program was developed to enhance access to New Yorkers and visitors

- High-speed, free public Wi-Fi throughout NYC
- Free nationwide digital calling
  - 911 / 311 access (911 dialed 28,000 times/year)
  - Access to all social services hotlines
  - Video-relay service for deaf and hard of hearing community
- Access to FindHelp government and social services websites
- USB port for free charging of mobile devices
- Advertising space for the City, community information, and local businesses



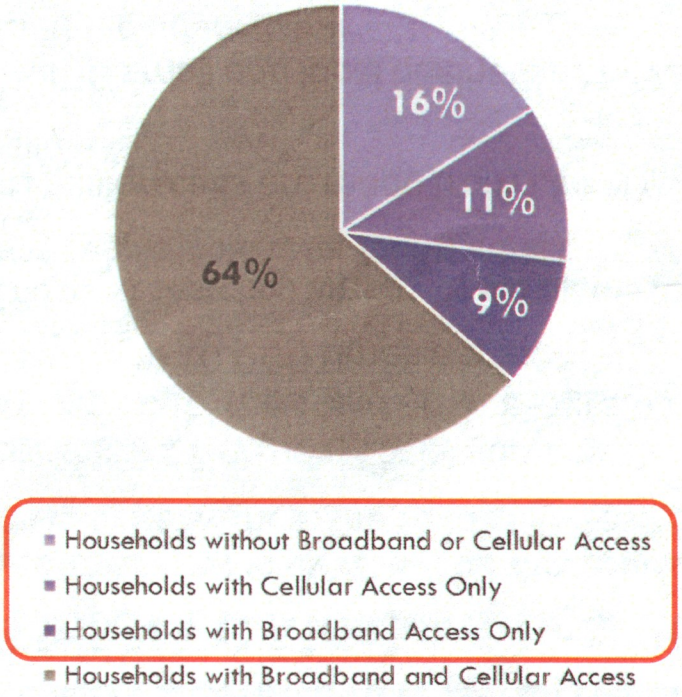
More than 13 million people have used LinkNYC kiosks since 2014

- Once completed, LinkNYC will be the largest free public Wi-Fi network in the United States.
- Mid-pandemic, FindHelp social services directory for jobs, housing, food, and other programs was accessed over 10,000 times *per month*.
    - The most searched for service during the pandemic was people looking for food pantries.
- Over 5 million calls are made from LinkNYC kiosks annually.
- Over 1,300 small and local businesses have been provided fee advertising.
- 250,000 people accessed IRS COVID Stimulus check information
- Link5G kiosks will dramatically improve New York City's 5G coverage through the deployment of thousands of new small cells sites, each of which can support multiple wireless carriers.

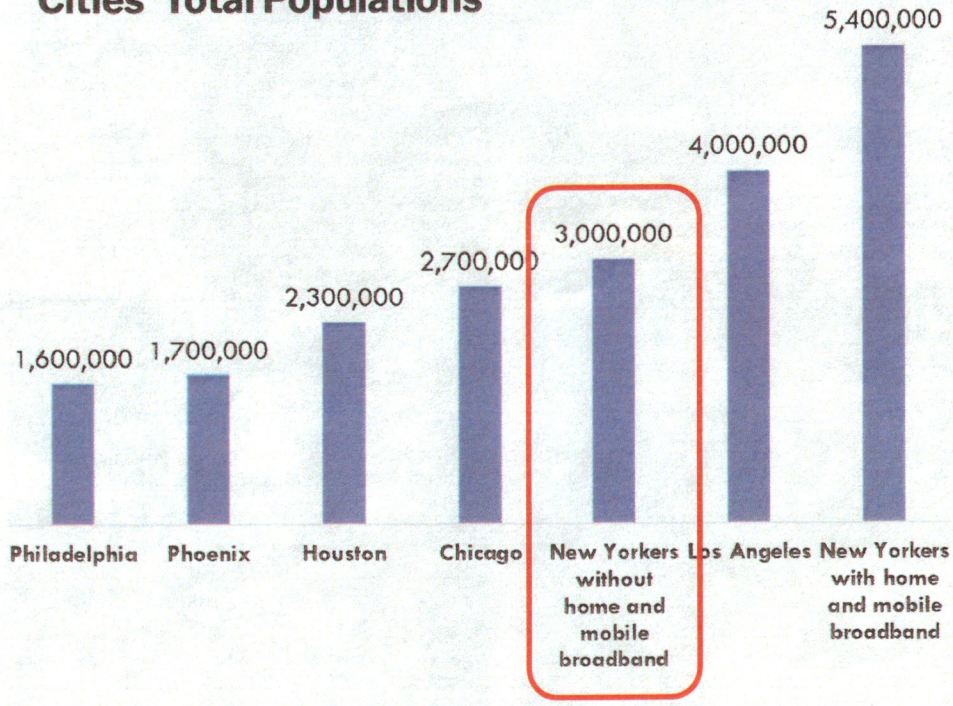


The Digital Divide in New York City

Households in New York City with Home Broadband or Mobile Broadband



New York City's Digital Divide Relative to Other Cities' Total Populations

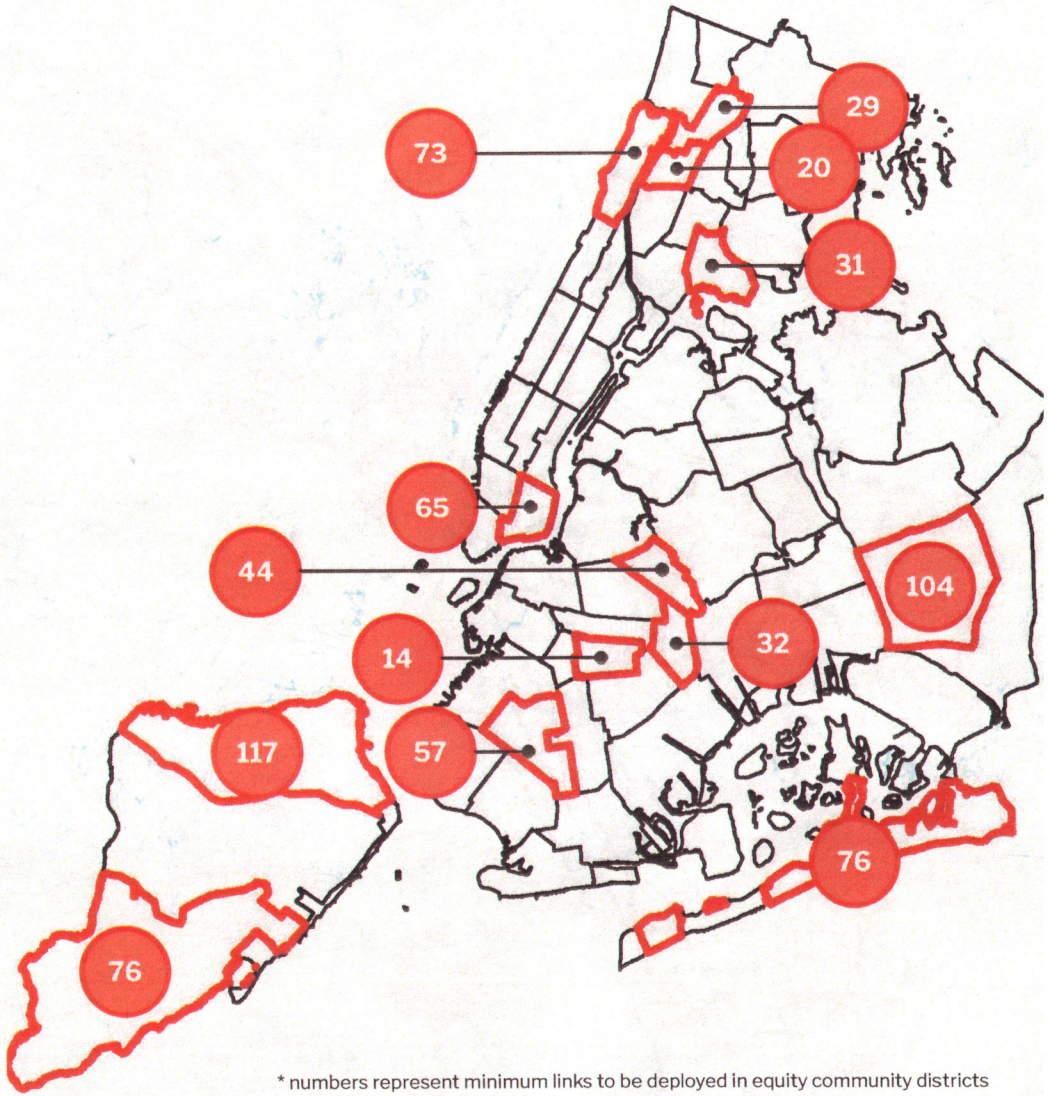


Source: American Community Survey 5-Year Estimates (2016-2020) (most recent data available)

Through equitable deployment, LinkNYC will benefit New York City's underserved and unserved

- CityBridge will deploy approximately 2,600 Link5G sites (in addition to the 1,800 Link kiosks already deployed), of which at least 739 will be deployed in 13 equity community districts (outlined in red on the map) chosen by New York City based on:
  - Lack of broadband options
  - Lower median annual income
  - Lack of Links
  - High levels of pedestrian / street traffic

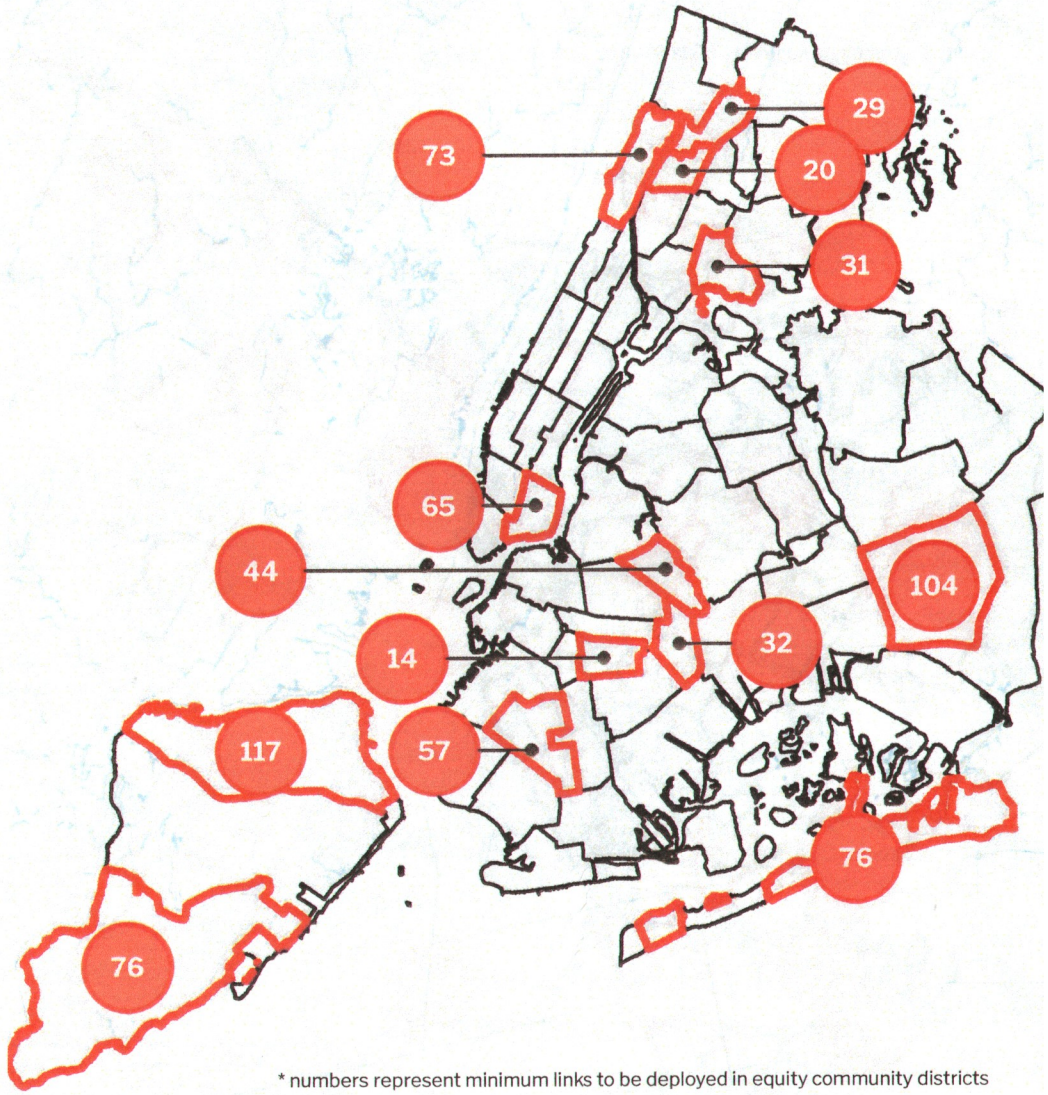
- 96 of the 107 Link5Gs deployed to date are located in the outer boroughs or above 96th Street in Manhattan, and the 11 Link5Gs deployed below 96th Street were deployed in MN03 on the Lower East Side, an equity community district.



* numbers represent minimum links to be deployed in equity community districts

Equitable Deployment Mandate

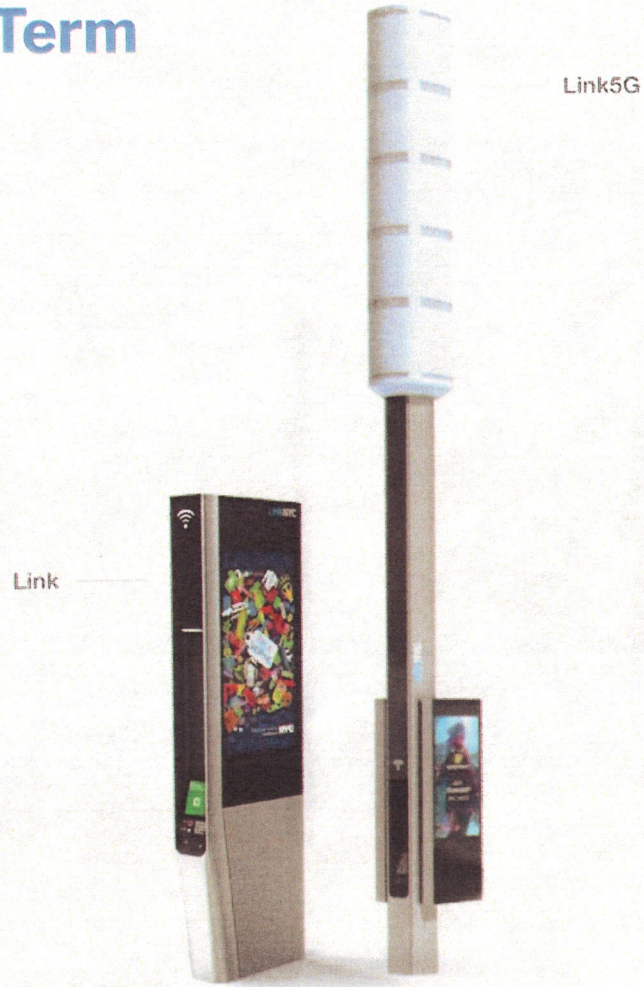
Borough	Community District	Number of CD Structures
Bronx Total: 80	2	31
	5	20
	7	29
Brooklyn Total: 147	4	44
	9	14
	12	57
	16	32
Manhattan Total: 138	3	65
	12	73
Queens Total: 180	12	104
	14	76
Staten Island Total: 194	1	117
	3	77
Total		**739**



* numbers represent minimum links to be deployed in equity community districts

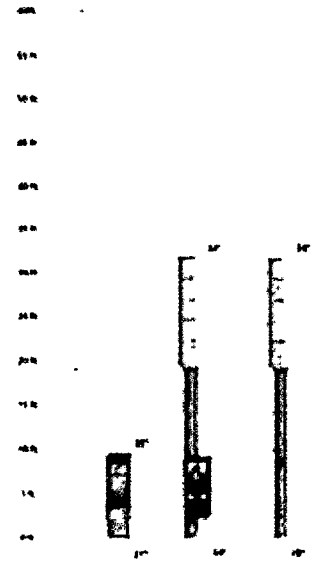
LinkNYC Is Revamping to Facilitate Long-Term Financial Viability and Mission Success

- From 2014-2019, CityBridge deployed 1,800x 9' "Link" kiosks with unlicensed Wi-Fi primarily in Manhattan. By 2019, the LinkNYC program was in financial distress and new deployments ceased.
- In 2021, New York City and CityBridge revamped the program by switching to 32' "Link5G" kiosks.
    - This added space for small cells. The carrier leasing fees, along with kiosk advertising, aim to support the program.
- CityBridge deployed 107 Link5G sites since 2022, but temporarily stopped all deployments to implement CIPD's guidance regarding CIPD's interpretation of the NEPA/NHPA rules.
    - CityBridge currently is working with the NY SHPO to complete Section 106 review of previously deployed Link5G sites and will complete NEPA/NHPA review of all sites prior to deployment.



Link5G versus Other Multi-Tenant 5G Street Furniture

Link5G vs. Other 5G Street Furniture





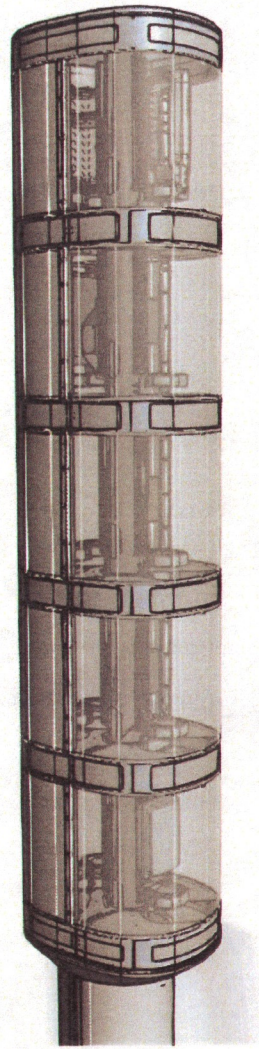


Location	Link NYC / Link 5G New York City	New Jersey***	Las Vegas
Maximum No. of Carriers W/ 5G	4 Carriers	3 Carriers	1 Carrier
Other Tech Features	Free Wi-Fi, National Calling, etc.	Nothing	Nothing

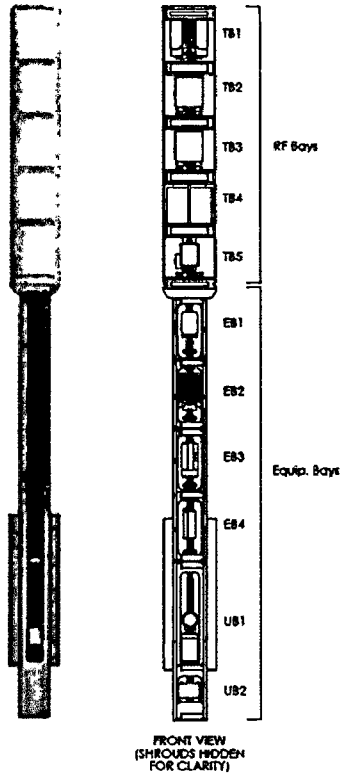
Link5G Design Expands All Carrier Network Coverage & Public Wi-Fi

- With 5 bays in full use, CityBridge has calculated the following:
- Transmission bays start at 19.5'
- 29" separation between transmission bays
- 5" for ventilation
- 5 bays required for free Wi-Fi and sufficient space for 5G transmitters

19.5' + (29" x 5) + 5" = 32' total height



Link5G Design Expands Broadband Infrastructure

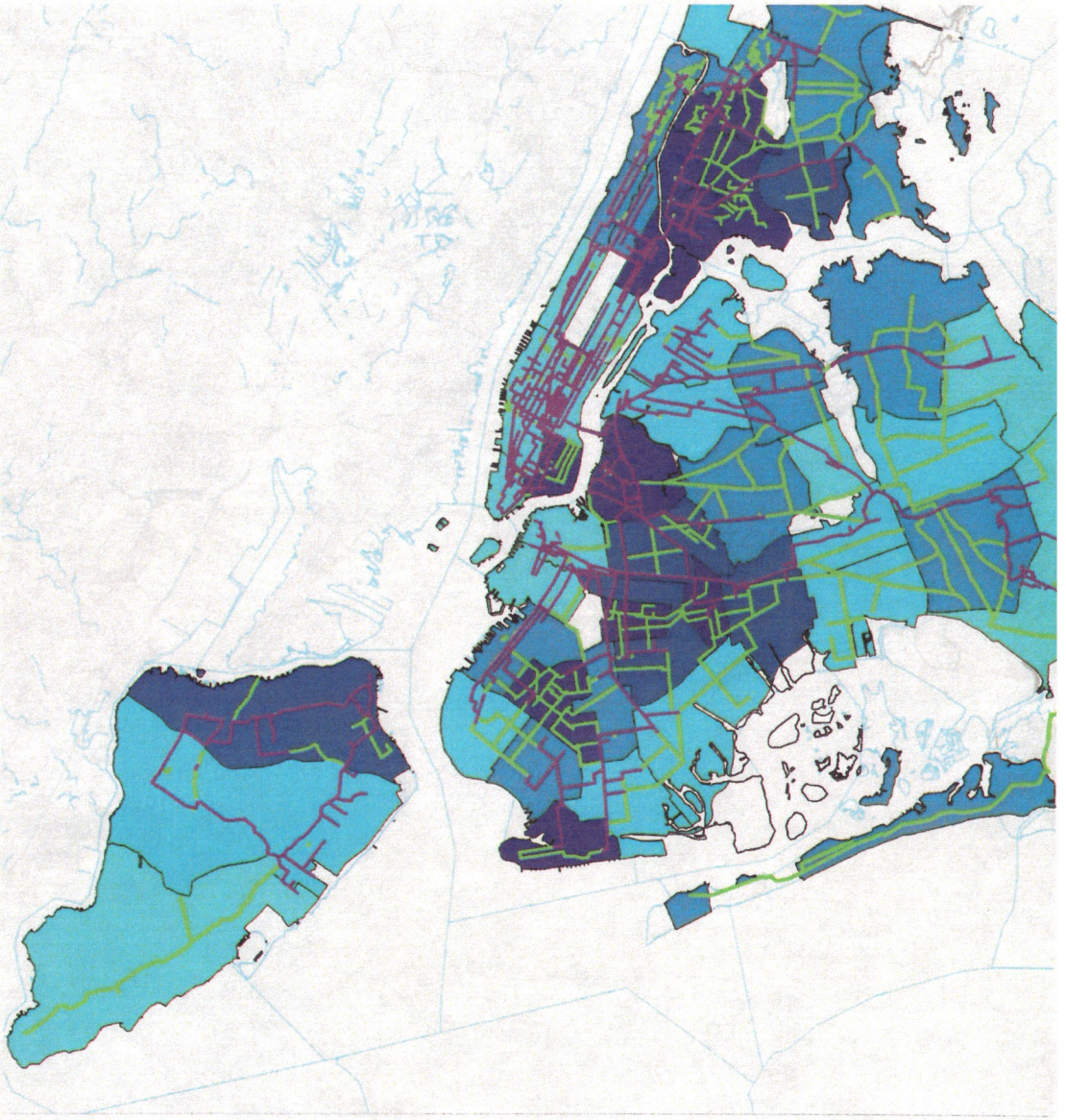


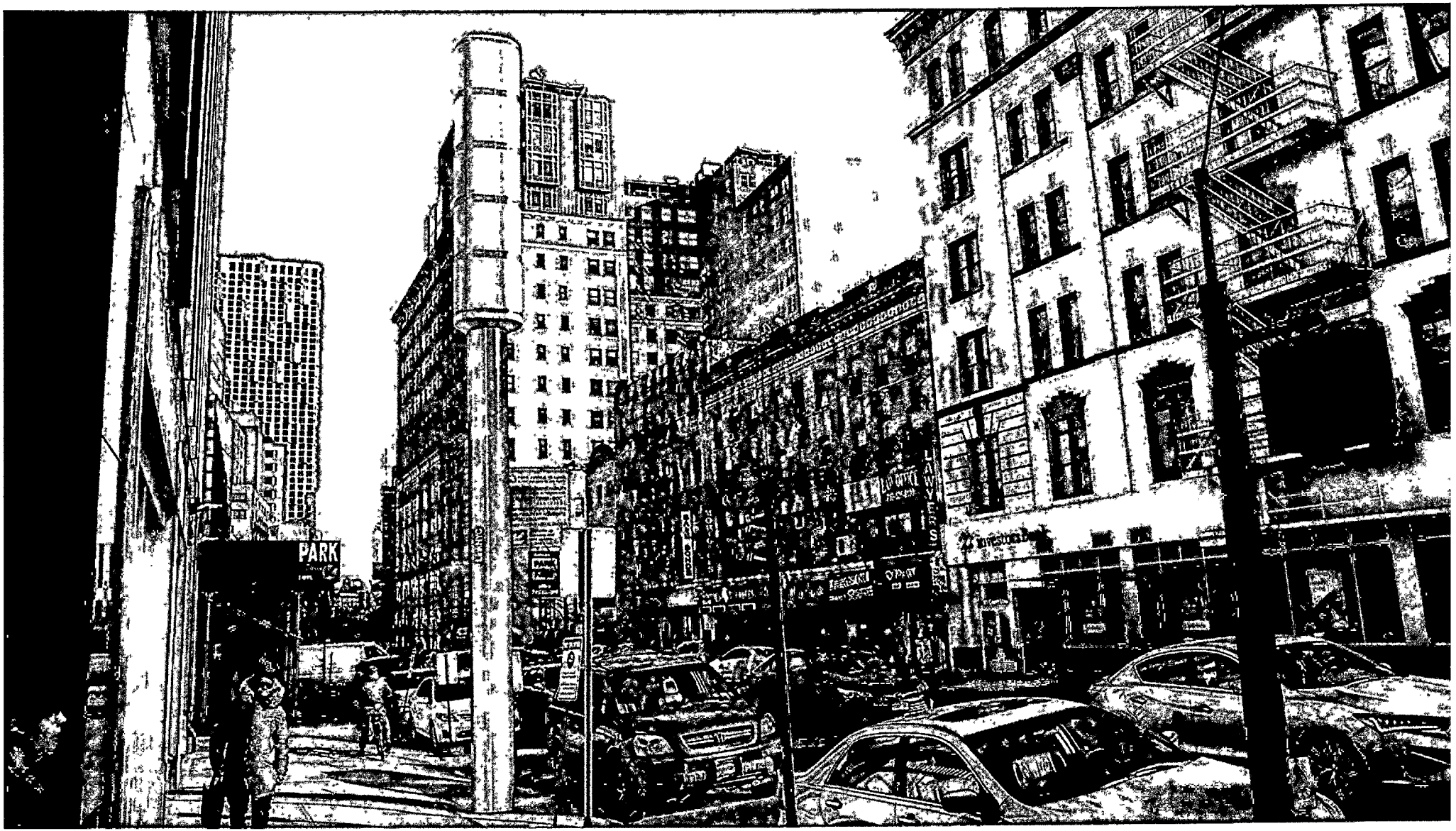
TB1	Millimeter Wave Bay for Operator 1 Ultra-Fast 5G Service	Ultra-Fast 5G Services from multiple providers, giving NYers freedom of choice and the fastest possible wireless services
TB2	Millimeter Wave Bay for Operator 2 Ultra-Fast 5G Service	
TB3 + TB4	Millimeter Wave Bay or Sub 6 GHz Shared Bay for 4G LTE + 5G for additional coverage and capacity for CBRS and/or IOT to support neutral host providers and technologies	Coverage and capacity at Sub 6GHz bands, while alternative technology offerings increase competitive landscape and open doors to alternative wireless providers for NYers
TB5	Optimized Wi-Fi structure and siting locations improve coverage and performance of free public gigabit Wi-Fi	Improved free public Wi-Fi Service
EB1 to EB4	Operator Equipment	Safe, secure, efficient use of space to house required radio equipment concealed from view
UB1 + UB2	LinkNYC Wireless Services Equipment, Pole controls and connection to fiber and power	Provides critical public City services

Below ground fiber infrastructure that can be used by other carriers to deliver connectivity throughout NYC

Where Link5G Goes, Fiber Follows

- **Robust fiber infrastructure** deployed across NYC neighborhoods.
- Fiber provides platform for **additional alternative service providers** (wired and wireless) to deliver competitive internet offerings (like Spot On and Skywire).
- Expansion of **free Wi-Fi network.**
- Expansion of **upgraded 5G infrastructure.**




PARK
LAWYERS


YMD
PHARM
We Accept All Insu
911
Emergency
Services
911
AUDIO
USB POWER

Testimony of the New York Electrical Contractors Association

New York City Council
Committee on Technology

LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City

June 7, 2023

Good afternoon members of the New York City Council,

I'm proud to testify today on behalf of the New York Electrical Contractors Association, the leading association of union electrical contractors in New York City and Westchester, about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal Wi-Fi program in the U.S., and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free Wi-Fi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

Members of the NYECA are running new fiber infrastructure through manholes across the city every single day to support LinkNYC, because the more fiber a neighborhood has, the more options community members have to select different internet service providers. In other words, the LinkNYC program provides a means to improve access to broadband service options and make these options more affordable for New Yorkers in all communities, especially those in the outer boroughs.

We're excited for the next phase— Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

NYECA is the leading trade association of electrical contractors in New York City and Westchester. We help build New York City, serve our communities in times of crisis, provide opportunities for minority and women-owned businesses, and promote the highest standards of worker safety in the industry.

Thank you for the opportunity to present this testimony.

06/07/23

NYC Council - Committee on Technology
City Hall
New York, NY 10007

Dear Council and Committee Members:

The New York State Wireless Association would like to express our support for the Department of Information Technology and Telecommunications' submission of the LINK5G facilities in NYC neighborhoods.

We support the DoITT proposal for several reasons, which I'd like to outline for you.

First and foremost, the Link 5G kiosk as revised will stimulate and support the City's goal of bridging the digital divide by providing high speed free public wi-fi throughout the City including underserved areas. High speed broadband must be deployed widely to all neighborhoods, as the pandemic made clear how important remote learning and working now are.

Second, the Link 5G kiosk as revised will improve wireless connectivity and coverage by collocating multi-tenant wireless facilities in the kiosks. These facilities will allow small cell deployments on the public right of way which are critical if cities and citizens are to leverage the benefits of the new 5G/broadband applications and beyond. Even without the new 5G/broadband applications and services, the public safety benefits of improved cellular connectivity and coverage are obvious.

Third, the design of the wireless equipment bays is modular and open to each of the wireless carrier's radios. This will allow multiple technologies to use the same Link5G kiosk, including state of the art open technologies such as CBRS and/or Private LTE.

Finally, while not necessarily our area of expertise, the Link 5G kiosks, as revised, will make the LinkNYC project sustainable so its other benefits of disseminating community and government information, providing digital calling (5m calls since 2020), charging mobile devices and accessing web sites will continue to be provided for NYC's residents, businesses and visitors.

We assume the Link 5G kiosks will be made available to all users on a competitive, nondiscriminatory basis based on fair and reasonable compensation consistent with law.

Thank you for the consideration of our written testimony and the opportunity to provide our support to DoITT's initiatives to deploy wireless technology and make it more accessible, affordable and available to the great City of New York. We would be pleased to answer any additional questions you may have. You may contact us at the email below or through CityBridge.

Sincerely,

Thomas Marciano

Thomas Marciano
Board Member
New York State Wireless Association
president@nyswa.org or info@nyswa.org

THE NEW YORK LANDMARKS CONSERVANCY

June 7, 2023

STATEMENT OF THE NEW YORK LANDMARKS CONSERVANCY BEFORE THE NEW YORK CITY COUNCIL COMMITTEE ON TECHNOLOGY REGARDING LINKNYC: DEPLOYMENT OF 5G INFRASTRUCTURE AND WI-FI CONNECTIVITY ACROSS THE CITY

The New York Landmarks Conservancy is a 50-year old organization dedicated to preserving, revitalizing, and reusing New York's historic buildings and neighborhoods. We thank the Council for taking its rightful leadership role and holding this important hearing.

We have significant questions about installation of new 32-foot tall LinkNYC towers and kiosks across the City, and about the chaotic public review process for their approval. We've heard from constituents in neighborhoods across the City and we are sure you and your colleagues have as well.

We wrote to City Hall looking for an explanation. The response was a list of OTI talking points. (Both letters are attached.) We ask for a pause on any future installations until we all get answers. This is a time-sensitive request. We have received notification of several new installations entering a State preservation review process just last week. The foundations and fiber connections are already in place.

As a preservation organization, we believe that the designs are ungainly and will detract from historic districts and individual landmarks. The towers are inappropriate and out-of-scale for residential areas and for commercial areas in many historic districts, where narrow sidewalks and lower-scale buildings are prevalent.

But the concerns go beyond the relationship to historic resources. We think the large towers will have a detrimental impact throughout the entire City. We support the goal of expanding digital equity, but have questions about how the currently proposed locations serve that objective. We are sympathetic to the need to provide improved wireless and cellular technology, especially in "digital deserts" but are unclear about why neighborhoods such as the Upper East Side and SoHo have been selected for the initial roll-out of the new towers.

One Whitehall Street, New York, NY 10004
tel 212.995.5260 | fax 212.995.5268 | nylandmarks.org

THE NEW YORK LANDMARKS CONSERVANCY

There are additional questions about the financing of the towers, about which will have advertising screens, where the new towers will be distributed across the entire city. New Yorkers deserve clarity about the churn of technology and the older, 4G kiosks which seem to function mostly as advertising posts, but take up limited sidewalk real estate. Will they be removed? What will happen when technology upgrades make 5G obsolete?

Some of the proposed sites are in uneven clusters, close to each other, and even on the same block. The vendor has indicated that the sites were chosen based on gaps in carrier coverage. The City should explain how this siting will close those gaps.

The review process for just the initial installations has been piecemeal and confusing, leading to uneven community engagement, and a lack of clarity on the full effects of 5G towers across the City.

We understand that the Landmarks Preservation Commission has the opportunity to review proposed sitings in historic districts but as of now, there is no date for that hearing. Given the impact of these behemoth towers, the LPC should also have an opportunity to comment on installations adjacent to individual landmarks, and on the appearance of towers that will be located in historic districts and adjacent to individual landmarks, even in an advisory capacity. A review for the impacts on historic resources listed on the State and National Registers of Historic Places is forthcoming, but the City's landmarks agency should also be playing a role.

The Public Design Commission has binding jurisdiction on the design, but even they have open questions about it. In September, PDC Commissioners asked whether the visual impact could be reduced. They pressed the Office of Technology and Information and vendor CityBridge to return to the PDC with a global design comparison, but that has not occurred.

New York's historic buildings and neighborhoods are beloved by residents and visitors. Their unique appeal will be an integral part of the City's recovery, but we fear that these towers will have severe, negative, and permanent impacts on those resources. We believe digital equity is an important objective, but City agencies and the private vendor have not shown how this roll-out addresses that goal.

Thank you for the opportunity to express the Conservancy's views.

One Whitehall Street, New York, NY 10004
tel 212.995.5260 | fax 212.995.5268 | nylandmarks.org

















January 12, 2023

First Deputy Mayor Sheena Wright
Deputy Mayor Maria Torres-Springer
City Hall
New York, NY 10007

Dear Deputy Mayors Wright and Torres-Springer,

The undersigned groups request information regarding the installation of new 32-foot tall Link5G towers across the City. We have heard from many constituents raising numerous concerns about these installations and about the chaotic and opaque review process for their approval.

The City's Office of Technology & Innovation (OTI) should provide a public update on the project, including (1) clarification of the process for identifying and approving locations for Link5G towers, including reviews by City agencies and how the borough presidents are informing residents of the installations and the community feedback process; (2) a detailed list of the siting limitations and requirements, with representative illustrations; (3) A list of Link5G installations to date, with equity districts noted; and (4) maps showing all installations to date at the borough, neighborhood and street scale.

The LinkNYC structures are poorly designed, massive, and will clutter the city's streetscapes, detracting from historic districts and individual landmarks. The towers are inappropriate and out-of-scale for residential areas and for commercial areas in many historic districts, where narrow sidewalks and lower-scale buildings are prevalent.

The Public Design Commission (PDC) has binding jurisdiction on the design, but even they have open questions about it. The PDC approved the installations in limited districts (commercial, commercial overlay, and manufacturing) with strict siting requirements. While reviewing the expansion of the program to residential and historic districts in September, PDC Commissioners asked whether the visual impact could be reduced. They pressed OTI and vendor CityBridge to return to the PDC with a global design comparison, but that has not occurred.

According to the City's presentations to the PDC, Link5G installations in historic areas require review and approval of the Landmarks Preservation Commission (LPC) and installations adjacent to public parks require review and approval of the Department of Parks & Recreation (DPR). The DPR approval process is opaque and, as of now, the LPC has not held a public hearing to review these installations. Given the impact of these behemoth towers, the LPC should comment on installations adjacent to individual landmarks, and on the appearance of towers proposed in historic districts and adjacent to individual landmarks, even in an advisory capacity.

The concerns about the towers extend beyond their relationship to historic resources. Overall, the review process for just the initial installations has been piecemeal and confusing, leading to uneven community engagement, and a lack of clarity on the full effects of 5G towers across the City.

We support the goal of bridging the digital divide and providing wireless and cellular services to underserved communities. However, we are concerned that the currently proposed locations do not serve that objective. The public presentation to the PDC were clear in their aim to target underserved communities beyond Manhattan's core and in the outer boroughs. However, neighborhoods such as the Upper East Side and SoHo have been selected for the initial roll-out of the new towers.

In seeking PDC's approval, the City promised that no more than one structure would be installed on any given block and the towers would not be installed closer than 200 feet from each other. And yet some of the proposed sites are in uneven clusters, close to each other, and even on the same block. The vendor has indicated that the sites were chosen based on gaps in carrier coverage. The City should explain how this siting will close those gaps.

There are additional questions about the financing of the towers, which ones will have advertising screens, which ones will replace the older, obsolete kiosks, and where the new towers will be distributed across the entire city.

New York's historic buildings and neighborhoods are beloved by residents and visitors. Their unique appeal will be an integral part of the City's recovery, but we fear that these towers will have severe, negative, and permanent impacts on those resources. We believe digital equity is an important objective, but City agencies and the private vendor have not shown how this roll-out addresses that goal.

We request that you ensure that the policies and processes that have been put in place to implement the installation of new 5G be effectively and consistently enforced. We look forward to further information about this program as soon as possible. Thank you.

Sincerely,

Frampton Tolbert, Executive Director
Historic Districts Council

Elizabeth Goldstein, President
Municipal Art Society

Peg Breen, President
The New York Landmarks Conservancy

Rachel Levy, Executive Director
Friends of the Upper East Side Historic Districts

Sean Khorsandi, Executive Director
Landmark West!

Andrew Berman, Executive Director
Village Preservation

Lo Van Der Valk, President
Carnegie Hill Neighbors

Sharon Pope-Marshal, Executive Director
CIVITAS NYC

Cc:
Sreoshy Banerjea
Executive Director
Public Design Commission
City Hall, Third Floor
New York, NY 10007

Matthew Fraser, Chief Technology Officer
Office of Technology and Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Sarah Carroll, Chair
Landmarks Preservation Commission
1 Centre Street, 9th floor
New York, NY 10007

OFFICE OF THE MAYOR
THE CITY OF NEW YORK

MATTHEW C. FRASER
CHIEF TECHNOLOGY OFFICER

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President Peg Breen
The New York Landmarks Conservancy
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Executive Director Rachel Levy
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Executive Director Sean Khorsandi
Landmark West!
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New York, NY 10023

Executive Director Andrew Berman
Village Preservation
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New York, NY 10003

President Lo Van Der Valk
Carnegie Hill Neighbors
1326 Madison Ave
New York, NY 10128

Executive Director Sharon Pope-Marshal
CIVITAS NYC
1457 Lexington Ave
New York, NY 10128

January 31, 2023

To the Representatives of the above Organizations:

Thank you for your engagement on this matter.

We appreciate your stated interest in bridging the digital divide and providing wireless and cellular services to underserved communities. We share in this interest and believe that New York City deserves to be the most technologically advanced and equitable city in the world and that no neighborhood is left behind. Link5G kiosks, which provide 5G infrastructure, free Wi-Fi and nation-wide calling, connection to 911 and 311, and other digital amenities, are critical to ensuring that New Yorkers and visitors always feel connected and safe, wherever they are in the city. The LinkNYC program has already proven to be a valuable resource in this respect with over 12.6 million free Wi-Fi subscribers and more than 425,000 phone calls made every month from LinkNYC kiosks. During the pandemic, 30% of LinkNYC users said these kiosks were their primary connection to broadband internet.

Wireless networks in New York City – like in most cities around the country – are supported by a combination of antennas on building rooftops and street furniture. With more and more New Yorkers relying on cell phones as their

primary means of connecting to the internet, there is a pressing need to ensure that networks are as robust and resilient as possible.

To select potential locations for Link5G kiosks, our franchisee, CityBridge, works with wireless carriers to identify areas with a need for additional connectivity. Locations are chosen based on existing 5G network coverage and capacity deficiencies as well as an area's ability to broaden the range of LinkNYC's free Wi-Fi network. Proposed sites in residential zoning districts, as well as in historic districts, must have at least one wireless carrier committed to them, thereby ensuring that a wireless network coverage and/or capacity need within the immediate area is being addressed. Once sites are identified, the City conducts an extensive review to ensure that each location meets established siting criteria and is as minimally invasive as possible on the surrounding community. Examples of such criteria include minimum distances from parking meters and subway entrances, and sidewalk clearance requirements, among dozens of others. Siting criteria and other franchise documents are available on OTI's website. As soon as the City ensures that sites meet these requirements, proposed locations are released for public comment. This cadence is intended to engage community stakeholders as early in the process as possible.

You can find lists and maps of current and proposed LinkNYC locations on the City's Open Data portal.

As you note, any proposed sites in historic districts are subject to further review and approval by the Landmarks Preservation Commission (LPC). The Office of Technology and Innovation (OTI) is currently in conversations with LPC, the Public Design Commission (PDC), and other City agencies about additional public review processes. We will share information regarding the timing of further public reviews as soon as it is available.

The City is committed to providing New Yorkers and visitors with the digital tools necessary to succeed in the 21st century. While LinkNYC kiosks will be installed in every community district in the city, the vast majority —more than 90%— will be deployed above 96th Street in Manhattan and in the outer boroughs to help bridge the digital divide.

The team at OTI is more than happy to provide further information regarding the LinkNYC program and the public review processes. If you have additional questions, please feel free to reach out to my colleague, Stacy Gardener (sgardener@oti.nyc.gov), Senior Director of External Affairs.

Thank you,

Matthew C. Fraser
Chief Technology Officer
City of New York

OFFICE OF THE MAYOR
THE CITY OF NEW YORK

Cc:

First Deputy Mayor Sheena Wright
Deputy Mayor Maria Torres-Springer
City Hall
New York, NY 10007

Executive Director Sreoshy Banerjea
Public Design Commission
City Hall, Third Floor
New York, NY 10007

Chair Sarah Carroll
Landmarks Preservation Commission
1 Centre Street, 9th floor
New York, NY 10007

SURVEILLANCE TECHNOLOGY OVERSIGHT PROJECT

40 Rector Street, 9th Floor
New York, New York 10006
www.StopSpying.org | (212) 518-7573

STATEMENT OF
SHRUTHI SRIRAM, ADVOCACY INTERN
SURVEILLANCE TECHNOLOGY OVERSIGHT PROJECT ("S.T.O.P.")

BEFORE THE COMMITTEE ON TECHNOLOGY,
NEW YORK CITY COUNCIL

FOR AN OVERSIGHT HEARING ON LINKNYC AND THE DEPLOYMENT OF 5G INFRASTRUCTURE AND WI-FI CONNECTIVITY IN NEW YORK CITY

PRESENTED
JUNE 7th, 2023

Good afternoon, Chair Gutiérrez and members of the Committee on Technology. The Surveillance Technology Oversight Project ("S.T.O.P.") is a New York-based civil rights and anti-surveillance group. S.T.O.P. advocates and litigates against discriminatory surveillance. Thank you for organizing this important hearing. We appreciate the opportunity to testify today on our concerns about LinkNYC's impact on New Yorkers' privacy.

Low-cost, reliable, broadband connectivity is not a luxury, and is increasingly indispensable to modern life. Bandwidth-intensive applications are ever more central to how New Yorkers work, learn, and live their lives. LinkNYC was created with the promise of fulfilling this vital public need, but recent revelations raise real concerns about its ability to serve the people of New York. While we believe that it is crucial for New York City to continue to prioritize the deployment of wireless connectivity, both through 5G cellphone service and Wi-Fi network access, additional scrutiny is needed to ensure that LinkNYC is truly able to deliver a network that lives up to our city's needs.

One of the most immediate concerns is LinkNYC's privacy track record. We have been glad to see CityBridge officials repeatedly reaffirm their company's commitment to keep New Yorkers data secure. Unfortunately, the company's privacy policy and terms of service continue to fall far short of meeting the standard that the company has described to this council and to the public. LinkNYC continues to reserve the right to track huge volumes of users' data, monetizing our movements, and providing our data to law enforcement even when not required by law. CityBridge has been quick to claim that it doesn't engage in many of the practices that its terms of service enable. And while that may be true, there is a world of difference between promising privacy and ensuring it as a legal right.

These concerns were only amplified by recent findings from privacy and transparency audits. According to the 2022 reports, CityBridge unlawfully collected MAC addresses, IP data, subscriber data, and other identifying information from LinkNYC kiosks. Such practices not only were a security and privacy risk to New Yorkers, but in direct violation of its amended Privacy Policy and Franchise Agreement. Additionally, auditors found that CityBridge gave incomplete Terms of Use, and incorrect privacy policies to LinkNYC users.

These privacy failures are not momentous on their own, and we recognize that any technology provider will occasionally have technical lapses. However, we believe that these failures demonstrate a basis for heightened concern and oversight of LinkNYC operations, ensuring that these violations are not emblematic of more sustained or systemic shortcomings. Both the Council and the Administration must actively audit LinkNYC's operations going forward, ensuring that these failings are not repeated or expanded.

The consequences couldn't be higher. LinkNYC's franchise agreement entrusts it to collect some of the most intimate information New Yorkers have. LinkNYC kiosks could easily be used to track political protesters, those seeking abortion care, or houses of worship. Their cell towers and Wi-Fi hotspots have the capability to not only track where we go, but who we speak with, and nearly everything we do online. CityBridge continues to emphasize that they do not engage in these sorts of practices, but press releases are not enough to provide New Yorkers with true peace of mind.

Since the 2022 audit, CityBridge issued a remediation report stating that it deployed MAC address anonymization and now ensures that users are provided with accurate Terms of Use and privacy information. While these are important steps forward, far more is needed to protect New Yorkers' data.

We commend the committee for holding this hearing and urge it to maintain its aggressiveness in its oversight of LinkNYC and CityBridge. This company repeatedly failed to meet its commitments to the city and people of New York. It has not only failed to provide New Yorkers with the economic returns they were promised (falling $60 million short of its projected ad revenue in 2019) but has also breached users' privacy rights.

CityBridge has been given millions of dollars in-kind support from our city, including real-estate, infrastructure, debt forgiveness, the waiver of installation goals, and other support. So far, this has been a one-sided deal, where CityBridge has frequently fallen short of its contractual obligations, and rarely (if ever) exceeded them. Such a troubled history necessitates unflinching scrutiny of every aspect of the firms' business practices.

Additionally, CityBridge provides the public peace of mind with an updated privacy policy and terms of service that make all of their past privacy promises binding. Our challenge for company leaders is this: for every reassurance you've provided today, for every promise you've made for the future, are those binding obligations, or just empty words? As long as those commitments clash with the company's, we have no choice but to assume those promises are more about PR than privacy.

LANDMARK WEST!

THE COMMITTEE TO PRESERVE THE UPPER WEST SIDE

Testimony of LANDMARK WEST!
Certificate of Appropriateness Committee
Before the New York City Council Committee on Technology
Deployment of 5G Infrastructure across the city
June 7, 2023

LANDMARK WEST! is a not-for-profit community organization committed to the preservation of the architectural heritage of the Upper West Side.

The LANDMARK WEST! Certificate of Appropriateness Committee shares concern with Upper West Side neighbors, the wider community and advocacy groups that the design and installation of these proposed 5G towers will have an adverse impact on our Historic Districts and streetscapes. Wifi towers have widened and more than doubled in height in just a few short years. The proposed design is wholly inappropriate not only for its size but for its disproportionate and frankly poor design. These towers are entirely out of scale for residential areas and most commercial areas in Historic Districts, where the streets are often narrow and buildings are lower in scale. They can serve only to clutter the city's streets and Historic Districts.

The lack of clarity regarding the approval and review process of 5G towers has led to a lack of trust from the community. The ostensibly random clusters of approved sites for installation with no official review process undertaken for towers installed in Historic Districts demonstrates a lack of transparency surrounding this important issue. We believe that no concern has been given to the sensitivity of placing these huge towers in Historic Districts or near Individual Landmarks and Scenic Landmarks, simply for City Bridge's own goal of coverage and profit.

The proposal of 5G towers offers to bring equity and access to all with the aim of targeting underserved areas, yet approved installations appear in SoHo and the Upper East Side. Nevertheless, the opaque approval process does not speak to the equity this city hopes to achieve. The public deserves to be fully informed about the seemingly unstoppable approach of 5G towers with a list of proposed and approved locations made available.

The LANDMARK WEST! Certificate of Appropriateness Committee recommends a redesign of the visible 5G infrastructure that applies sensitivity to the city's streetscapes. Alternate designs are possible without compromising the integrity of our city's historic neighborhoods. Our Committee seeks clarification on the process of identifying and approving locations, especially in Historic Districts and near Individual Landmarks and Scenic Landmarks. We want a clear and transparent review process that effectively includes public opinion, including how the public will be informed of proposed sites and how forums for discussion and feedback will be organized. We also seek a list of installations to date with specific locations and an up to date map showing installations to date and proposed locations.

Thank you.

PARTNERSHIP for New York City

Testimony of the Partnership for New York City

New York City Council
Committee on Technology

LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City

June 7, 2023

Thank you, Chair Gutiérrez and members of the committee for the opportunity to testify in support of LinkNYC. The Partnership for New York City represents private sector employers of more than one million New Yorkers. We work together with government, labor and the nonprofit sector to maintain the city's position as the preeminent global center of commerce, innovation and economic opportunity.

LinkNYC is the largest and fastest free municipal WiFi network in the United States. The kiosks supply vital services for our city's residents, businesses, and tourists including free WiFi, internet, phone calls and access to emergency services. The screens provide important information local events, artists, and small businesses.

The COVID-19 pandemic reinforced the importance of access to high-speed internet for all New Yorkers. The Link program is critical to achieving universal internet access in the city and accelerating the roll out of 5G technology. The city has lagged behind many other cities in the development of the infrastructure to increase 5G service. The expansion of 5G's faster cellular service and data speeds is necessary to maintain New York City's global competitiveness, attract businesses to the city, and enable our small businesses to participate in the digital economy. The innovative design for the new Link5G will enable the rapid implementation of 5G technology across the city by allowing maximum access for many cellular carriers while also maintaining a clean and consistent design.

We fully support the continued expansion of LinkNYC.

Thank you.

THE NEW YORK LANDMARKS CONSERVANCY

June 7, 2023

STATEMENT OF THE NEW YORK LANDMARKS CONSERVANCY BEFORE THE NEW YORK CITY COUNCIL COMMITTEE ON TECHNOLOGY REGARDING LINKNYC: DEPLOYMENT OF 5G INFRASTRUCTURE AND WI-FI CONNECTIVITY ACROSS THE CITY

The New York Landmarks Conservancy is a 50-year old organization dedicated to preserving, revitalizing, and reusing New York's historic buildings and neighborhoods. We thank the Council for taking its rightful leadership role and holding this important hearing.

We have significant questions about installation of new 32-foot tall LinkNYC towers and kiosks across the City, and about the chaotic public review process for their approval. We've heard from constituents in neighborhoods across the City and we are sure you and your colleagues have as well.

We wrote to City Hall looking for an explanation. The response was a list of OTI talking points. (Both letters are attached.) We ask for a pause on any future installations until we all get answers. This is a time-sensitive request. We have received notification of several new installations entering a State preservation review process just last week. The foundations and fiber connections are already in place.

As a preservation organization, we believe that the designs are ungainly and will detract from historic districts and individual landmarks. The towers are inappropriate and out-of-scale for residential areas and for commercial areas in many historic districts, where narrow sidewalks and lower-scale buildings are prevalent.

But the concerns go beyond the relationship to historic resources. We think the large towers will have a detrimental impact throughout the entire City. We support the goal of expanding digital equity, but have questions about how the currently proposed locations serve that objective. We are sympathetic to the need to provide improved wireless and cellular technology, especially in "digital deserts" but are unclear about why neighborhoods such as the Upper East Side and SoHo have been selected for the initial roll-out of the new towers.

One Whitehall Street, New York, NY 10004
tel 212.995.5260 | fax 212.995.5268 | nylandmarks.org

THE NEW YORK LANDMARKS CONSERVANCY

There are additional questions about the financing of the towers, about which will have advertising screens, where the new towers will be distributed across the entire city. New Yorkers deserve clarity about the churn of technology and the older, 4G kiosks which seem to function mostly as advertising posts, but take up limited sidewalk real estate. Will they be removed? What will happen when technology upgrades make 5G obsolete?

Some of the proposed sites are in uneven clusters, close to each other, and even on the same block. The vendor has indicated that the sites were chosen based on gaps in carrier coverage. The City should explain how this siting will close those gaps.

The review process for just the initial installations has been piecemeal and confusing, leading to uneven community engagement, and a lack of clarity on the full effects of 5G towers across the City.

We understand that the Landmarks Preservation Commission has the opportunity to review proposed sitings in historic districts but as of now, there is no date for that hearing. Given the impact of these behemoth towers, the LPC should also have an opportunity to comment on installations adjacent to individual landmarks, and on the appearance of towers that will be located in historic districts and adjacent to individual landmarks, even in an advisory capacity. A review for the impacts on historic resources listed on the State and National Registers of Historic Places is forthcoming, but the City's landmarks agency should also be playing a role.

The Public Design Commission has binding jurisdiction on the design, but even they have open questions about it. In September, PDC Commissioners asked whether the visual impact could be reduced. They pressed the Office of Technology and Information and vendor CityBridge to return to the PDC with a global design comparison, but that has not occurred.

New York's historic buildings and neighborhoods are beloved by residents and visitors. Their unique appeal will be an integral part of the City's recovery, but we fear that these towers will have severe, negative, and permanent impacts on those resources. We believe digital equity is an important objective, but City agencies and the private vendor have not shown how this roll-out addresses that goal.

Thank you for the opportunity to express the Conservancy's views.

One Whitehall Street, New York, NY 10004
tel 212.995.5260 | fax 212.995.5268 | nylandmarks.org

















January 12, 2023

First Deputy Mayor Sheena Wright
Deputy Mayor Maria Torres-Springer
City Hall
New York, NY 10007

Dear Deputy Mayors Wright and Torres-Springer,

The undersigned groups request information regarding the installation of new 32-foot tall Link5G towers across the City. We have heard from many constituents raising numerous concerns about these installations and about the chaotic and opaque review process for their approval.

The City's Office of Technology & Innovation (OTI) should provide a public update on the project, including (1) clarification of the process for identifying and approving locations for Link5G towers, including reviews by City agencies and how the borough presidents are informing residents of the installations and the community feedback process; (2) a detailed list of the siting limitations and requirements, with representative illustrations; (3) A list of Link5G installations to date, with equity districts noted; and (4) maps showing all installations to date at the borough, neighborhood and street scale.

The LinkNYC structures are poorly designed, massive, and will clutter the city's streetscapes, detracting from historic districts and individual landmarks. The towers are inappropriate and out-of-scale for residential areas and for commercial areas in many historic districts, where narrow sidewalks and lower-scale buildings are prevalent.

The Public Design Commission (PDC) has binding jurisdiction on the design, but even they have open questions about it. The PDC approved the installations in limited districts (commercial, commercial overlay, and manufacturing) with strict siting requirements. While reviewing the expansion of the program to residential and historic districts in September, PDC Commissioners asked whether the visual impact could be reduced. They pressed OTI and vendor CityBridge to return to the PDC with a global design comparison, but that has not occurred.

According to the City's presentations to the PDC, Link5G installations in historic areas require review and approval of the Landmarks Preservation Commission (LPC) and installations adjacent to public parks require review and approval of the Department of Parks & Recreation (DPR). The DPR approval process is opaque and, as of now, the LPC has not held a public hearing to review these installations. Given the impact of these behemoth towers, the LPC should comment on installations adjacent to individual landmarks, and on the appearance of towers proposed in historic districts and adjacent to individual landmarks, even in an advisory capacity.

The concerns about the towers extend beyond their relationship to historic resources. Overall, the review process for just the initial installations has been piecemeal and confusing, leading to uneven community engagement, and a lack of clarity on the full effects of 5G towers across the City.

We support the goal of bridging the digital divide and providing wireless and cellular services to underserved communities. However, we are concerned that the currently proposed locations do not serve that objective. The public presentation to the PDC were clear in their aim to target underserved communities beyond Manhattan's core and in the outer boroughs. However, neighborhoods such as the Upper East Side and SoHo have been selected for the initial roll-out of the new towers.

In seeking PDC's approval, the City promised that no more than one structure would be installed on any given block and the towers would not be installed closer than 200 feet from each other. And yet some of the proposed sites are in uneven clusters, close to each other, and even on the same block. The vendor has indicated that the sites were chosen based on gaps in carrier coverage. The City should explain how this siting will close those gaps.

There are additional questions about the financing of the towers, which ones will have advertising screens, which ones will replace the older, obsolete kiosks, and where the new towers will be distributed across the entire city.

New York's historic buildings and neighborhoods are beloved by residents and visitors. Their unique appeal will be an integral part of the City's recovery, but we fear that these towers will have severe, negative, and permanent impacts on those resources. We believe digital equity is an important objective, but City agencies and the private vendor have not shown how this roll-out addresses that goal.

We request that you ensure that the policies and processes that have been put in place to implement the installation of new 5G be effectively and consistently enforced. We look forward to further information about this program as soon as possible. Thank you.

Sincerely,

Frampton Tolbert, Executive Director
Historic Districts Council

Elizabeth Goldstein, President
Municipal Art Society

Peg Breen, President
The New York Landmarks Conservancy

Rachel Levy, Executive Director
Friends of the Upper East Side Historic Districts

Sean Khorsandi, Executive Director
Landmark West!

Andrew Berman, Executive Director
Village Preservation

Lo Van Der Valk, President
Carnegie Hill Neighbors

Sharon Pope-Marshal, Executive Director
CIVITAS NYC

Cc:
Sreoshy Banerjea
Executive Director
Public Design Commission
City Hall, Third Floor
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Matthew Fraser, Chief Technology Officer
Office of Technology and Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Sarah Carroll, Chair
Landmarks Preservation Commission
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OFFICE OF THE MAYOR
THE CITY OF NEW YORK

MATTHEW C. FRASER
CHIEF TECHNOLOGY OFFICER

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President Lo Van Der Valk
Carnegie Hill Neighbors
1326 Madison Ave
New York, NY 10128

Executive Director Sharon Pope-Marshal
CIVITAS NYC
1457 Lexington Ave
New York, NY 10128

January 31, 2023

To the Representatives of the above Organizations:

Thank you for your engagement on this matter.

We appreciate your stated interest in bridging the digital divide and providing wireless and cellular services to underserved communities. We share in this interest and believe that New York City deserves to be the most technologically advanced and equitable city in the world and that no neighborhood is left behind. Link5G kiosks, which provide 5G infrastructure, free Wi-Fi and nation-wide calling, connection to 911 and 311, and other digital amenities, are critical to ensuring that New Yorkers and visitors always feel connected and safe, wherever they are in the city. The LinkNYC program has already proven to be a valuable resource in this respect with over 12.6 million free Wi-Fi subscribers and more than 425,000 phone calls made every month from LinkNYC kiosks. During the pandemic, 30% of LinkNYC users said these kiosks were their primary connection to broadband internet.

Wireless networks in New York City – like in most cities around the country – are supported by a combination of antennas on building rooftops and street furniture. With more and more New Yorkers relying on cell phones as their

primary means of connecting to the internet, there is a pressing need to ensure that networks are as robust and resilient as possible.

To select potential locations for Link5G kiosks, our franchisee, CityBridge, works with wireless carriers to identify areas with a need for additional connectivity. Locations are chosen based on existing 5G network coverage and capacity deficiencies as well as an area's ability to broaden the range of LinkNYC's free Wi-Fi network. Proposed sites in residential zoning districts, as well as in historic districts, must have at least one wireless carrier committed to them, thereby ensuring that a wireless network coverage and/or capacity need within the immediate area is being addressed. Once sites are identified, the City conducts an extensive review to ensure that each location meets established siting criteria and is as minimally invasive as possible on the surrounding community. Examples of such criteria include minimum distances from parking meters and subway entrances, and sidewalk clearance requirements, among dozens of others. Siting criteria and other franchise documents are available on OTI's website. As soon as the City ensures that sites meet these requirements, proposed locations are released for public comment. This cadence is intended to engage community stakeholders as early in the process as possible.

You can find lists and maps of current and proposed LinkNYC locations on the City's Open Data portal.

As you note, any proposed sites in historic districts are subject to further review and approval by the Landmarks Preservation Commission (LPC). The Office of Technology and Innovation (OTI) is currently in conversations with LPC, the Public Design Commission (PDC), and other City agencies about additional public review processes. We will share information regarding the timing of further public reviews as soon as it is available.

The City is committed to providing New Yorkers and visitors with the digital tools necessary to succeed in the 21st century. While LinkNYC kiosks will be installed in every community district in the city, the vast majority —more than 90%— will be deployed above 96th Street in Manhattan and in the outer boroughs to help bridge the digital divide.

The team at OTI is more than happy to provide further information regarding the LinkNYC program and the public review processes. If you have additional questions, please feel free to reach out to my colleague, Stacy Gardener (sgardener@oti.nyc.gov), Senior Director of External Affairs.

Thank you,

Matthew C. Fraser
Chief Technology Officer
City of New York

OFFICE OF THE MAYOR
THE CITY OF NEW YORK

Cc:

First Deputy Mayor Sheena Wright
Deputy Mayor Maria Torres-Springer
City Hall
New York, NY 10007

Executive Director Sreoshy Banerjea
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Americans for Responsible Technology
184 Main Street • Port Washington • New York • 516.883.0887 • www.AmericansForResponsibleTech.org

June 7, 2023

New York City Council
Committee on Technology
City Hall
New York, NY

RE: Comments regarding Cell Towers and Schools

Dear Chair Gutiérrez and Members of the Committee,

Our non-profit organization represents more than 150 grassroots organizations across the country using the latest science to support the deployment of safe, economical and future-proof wired technology. Thank for the opportunity to submit these comments regarding children and the proposal to expose them to chronic radiofrequency radiation from cell towers.

As the World Health Organization and the American Academy of Pediatrics have both made clear on repeated occasions, children are not just little adults. Their rapidly developing physiology makes them prime targets for environmental threats that can interfere with normal development and cause life-long behavioral problems and learning deficits.

Our science-based organization first became aware of the potential harm that RF radiation poses for children with the publication of a study performed in 2012 at Yale University, where the offspring of laboratory mice who were exposed to cell phone radiation during pregnancy exhibited odd behavioral patterns that mimic every symptom of ADHD. An examination of the brains of the exposed animals revealed abnormal brain development, while the unexposed control group were completely normal in every way.

What parent wants to take the chance that their child will not develop normally because of an unnecessary and involuntary exposure to a cell phone tower? Are we adults so desperate to be able to connect our wireless devices to everything, everywhere, all the time, that we are willing to take chances with our children's health and well being?

Last week our organization filed a formal Citizens Petition with the FDA, accusing the agency of violating its own law - a law which requires the FDA to take every possible step to minimize the public's exposure to RF radiation. Because the FDA has failed to obey the law, you have never

been warned that RF radiation can be harmful. You have never been told that the potential harm from cell towers should be balanced with the needs of the community.

No one needs a cell tower in front of or even near a school. One day soon, the FDA will probably tell you that.

Sincerely,



Doug Wood
Founder and National Director

Read some of the independent science linking exposure to radiofrequency radiation with biological harm at https://www.techsafeschools.org/science.

Good morning members of the New York City Council,

I'm proud to testify today on behalf of ARTHOUSE.NYC about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal WiFi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free wifi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

We are ARTHOUSE.NYC is a digital art gallery and international art collective, devoted to all things artistic, colorful and larger than life in one of the greatest cities in the world. ARTHOUSE.NYC is dedicated to supporting emerging artists by creating colorful events in NYC and across the US to inspire and heal. ARTHOUSE.NYC produced The Hero Art Project, portraits honoring healthcare heroes which was exhibited on LinkNYC in April 2021. This exhibition helped us to connect to the Brave of Heart Fund, which resulted in an exhibition of The Hero Art Project on the National Mall in November 2022.

The Link ad screens have become iconic for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to community board meetings.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

Good morning members of the New York City Council,

I'm proud to testify today on behalf of BlackFacts.com about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal WiFi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free wifi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

LinkNYC has leveraged their screens to share the importance of Black History and Cultural Achievements within the communities they serve as part of a Black History Month campaign – leveraging curated content from BlackFacts.com. They are also doing a special run about the History of Juneteenth this month. These are just a few of the examples of how LinkNYC is leveraging their platform to Inspire our communities and engage our young people but share stories they may never have heard about. It is only through technology that we can achieve the educational goals for our communities and LinkNYC is using their technology to uplift the race. We are so pleased and have worked with them and to continue our partnership.

The Link ad screens have become iconic for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to community board meetings.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

Sincerely,

Dale Dowdie

Co-Founder/CEO

BlackFacts.com

Good morning members of the New York City Council,

I'm proud to testify today on behalf of Bridge Street Development Corporation about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

Bridge Street Development Corporation is a 501c(3) non-profit organization with a mission to provide civic and economic opportunities to the residents of Central Brooklyn with an emphasis on low-to-moderate income residents. We do this by building partnerships with businesses, government, and other community stakeholders and partners. As a partner Link NYC, has allowed us to share information about our services and offerings in a way we would be unable to otherwise.

LinkNYC is already the largest free municipal WiFi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free wifi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

The Link ad screens have become iconic for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to community board meetings.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

June 7, 2023

Re: 5G

To the City Council,

As a decades long resident of SoHo, member of the Broadway Residents Coalition and concerned New York City voter, I urge the City Council to stop or, at minimum, pause the installation of 5G towers in New York City. My reasons for asking this are:

- Currently, the city has no clear process in place by which to effectively and appropriately place the towers so that they serve the areas in which they are most needed and do not unnecessarily blight neighborhoods where they are not.

- The siting guidelines which were established by the NYC Office of Technology and innovation are routinely ignored. This has led to the placement of 5G towers in inappropriate and disruptive locations.

- OTI has failed to respond in any meaningful way to the resolution that Community Board 2 passed describing in detail the reasons it is asking for a moratorium on construction of LinkNYC 5G towers in our area.

- OTI has likewise failed to respond in any meaningful way to the letters sent by all of our local elected officials that describe in detail the reasons they are asking for a moratorium on the construction of these towers in our area.

- The current placement of these towers does not help bridge the digital equity gap that the city claims is the main goal of the project.

Sincerely,
Renée Monrose
Broadway Residents Coalition
542 Broadway
New York, NY 10012

April 21, 2023

Matthew C. Fraser
Chief Technology Officer
Office of Technology & Innovation
The NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Proposed LinkNYC 5G Tower to be Located at 1190 Madison Avenue (87th/Madison Avenue), Manhattan

Dear Chief Technology Officer Fraser,

We represent the residents and businesses that will be most impacted by the proposed tower installation at 1190 Madison Avenue, and we are united in our opposition against it.

While we understand the need to expand 5G infrastructure across New York City to help bridge the digital divide, this effort should be focused on neighborhoods lacking essential digital infrastructure and connectivity. Our neighborhood (Carnegie Hill) is over 100% Wi-Fi and broadband saturated, with underground, street level, and rooftop cell sites. Telecom experts have concluded the proposed towers are redundant and unnecessary.

In addition, we are concerned that these structures will create considerable bulk on our sidewalks and will negatively impact the visual appeal and historic character of our neighborhood.

Finally, at 1190 Madison Avenue specifically, we have worked hard both pre- and post-pandemic to accommodate the needs of our Madison Avenue-facing retail tenants. All seven of those businesses are signatories to this letter in opposition to the installation of the proposed tower at 87th/Madison Avenue.

In conclusion, we respectfully seek your commitment to removing the tower proposed at 1190 Madison Avenue (Site ID: MN-08-119916) from the CD-108 Plan.

Sincerely,

C Scalera (Apr 23, 2023 10:20 EDT)

Board President
11 East 87th Street

Board President
20 East 87th Street

Board President
21 East 87th Street

Board President
47 East 87th Street

Board President
40 East 88th Street

Owner
Blue & Cream
1190 Madison Ave

Store Manager
Bluemercury
1190 Madison Ave

Store Manager
Brora
1190 Madison Ave

Owner
Gas Bijoux
1190 Madison Ave

Store Manger
Hanro
1190 Madison Ave

Store Manager
Pink Chicken
1190 Madison Ave

Store Manager
Unsubscribed
1190 Madison Ave

Cc:
Honorable Eric Adams, Mayor of the City of New York
Honorable Mark Levine, Manhattan Borough President
Honorable Keith Powers, NYC Council Member, 4th Council District
Honorable Julie Menin, NYC Council Member, 5th Council District
Honorable Sarah Carroll, Landmarks Preservation Commission
First Deputy Mayor Sheena Wright, City Hall
Deputy Mayor Maria Torres-Springer, City Hall
Sreoshy Banerjea, Public Design Commission
Honorable Erik Kulleseid, NYS Historic Preservation Office
Honorable Liz Krueger, NYS Senator, 28th Senatorial District
Honorable José M. Serrano, NYS Senator, 29th Senatorial District
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Honorable Edward Gibbs, NYS Assembly Member, 68th Assembly District
Honorable Alex Bores, NYS Assembly Member, 73rd Assembly District
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Joanna Cawley, Executive Director, Carnegie Hill Neighbors
Elizabeth Goldstein, President, Municipal Art Society
Russell Squire, Chair, Community Board 8
Craig Lader, Co-Chair, Community board 8, Transportation Committee
Charles Warren, Co-Chair, Community board 8, Transportation Committee

Board President
11 East 87th Street

Board President
12 East 87th Street

Board President
20 East 87th Street

Board President
21 East 87th Street

Board President
47 East 87th Street

Board President
40 East 88th Street

Owner
Blue & Cream
1190 Madison Ave

Store Manager
Bluemercury
1190 Madison Ave

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Craig Lader, Co-Chair, Community board 8, Transportation Committee
Charles Warren, Co-Chair, Community board 8, Transportation Committee

Sue B. Dorn
Sue B. Dorn (Apr 22, 2023 15:47 EDT)

Board President 11 East 87th Street	Board President 12 East 87th Street	Board President 20 East 87th Street	Board President 21 East 87th Street
Board President 47 East 87th Street	Board President 40 East 88th Street		
Owner Blue & Cream 1190 Madison Ave	Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Owner Gas Bijoux 1190 Madison Ave
Store Manger Hanro 1190 Madison Ave	Store Manager Pink Chicken 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave	

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Craig Lader, Co-Chair, Community board 8, Transportation Committee
Charles Warren, Co-Chair, Community board 8, Transportation Committee

Eric Chilton

Board President 11 East 87th Street	Board President 20 East 87th Street	Board President 21 East 87th Street	Board President 47 East 87th Street

Board President
40 East 88th Street

Owner Blue & Cream 1190 Madison Ave	Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Owner Gas Bijoux 1190 Madison Ave

Store Manger Hanro 1190 Madison Ave	Store Manager Pink Chicken 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave

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Joanna Cawley, Executive Director, Carnegie Hill Neighbors
Elizabeth Goldstein, President, Municipal Art Society
Russell Squire, Chair, Community Board 8
Craig Lader, Co-Chair, Community board 8, Transportation Committee

Anjali Bhandari (Apr 21, 2023 14:20 EDT)

Board President 11 East 87th Street	Board President 20 East 87th Street	Board President 21 East 87th Street	Board President 47 East 87th Street

Board President
40 East 88th Street

Owner Blue & Cream 1190 Madison Ave	Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Owner Gas Bijoux 1190 Madison Ave

Store Manger Hanro 1190 Madison Ave	Store Manager Pink Chicken 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave

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Charles Warren, Co-Chair, Community board 8, Transportation Committee

Board President 11 East 87th Street	Board President 20 East 87th Street	Board President 21 East 87th Street	Board President 47 East 87th Street

[redacted] Apr 22, 2023 13:19 CDT)
Board President
40 East 88th Street

Owner Blue & Cream 1190 Madison Ave	Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Owner Gas Bijoux 1190 Madison Ave

Store Manger Hanro 1190 Madison Ave	Store Manager Pink Chicken 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave

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Board President 19 East 88th Street	Board President 40 East 88th Street	Board President 47 East 88th Street	Executive Director Park Avenue Synagogue
Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Store Manager Gas Bijoux 1190 Madison Ave	Store Manager Hanro 1190 Madison Ave
Store Manager Pink Chicken 1190 Madison Ave	 Jeffrey Goldstein Store Manager Blue & Cream 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave	

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Board President 11 East 87th Street	Board President 20 East 87th Street	Board President 21 East 87th Street	Board President 47 East 87th Street

Board President
40 East 88th Street

Marina Wilson (Apr 23, 2023 10:38 EDT)

Owner Blue & Cream 1190 Madison Ave	Store Manager Bluemercury 1190 Madison Ave	Store Manager Brora 1190 Madison Ave	Owner Gas Bijoux 1190 Madison Ave

Store Manger Hanro 1190 Madison Ave	Store Manager Pink Chicken 1190 Madison Ave	Store Manager Unsubscribed 1190 Madison Ave

Cc:
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Honorable Sarah Carroll, Landmarks Preservation Commission
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Board President
11 East 87th Street

Board President
12 East 87th Street

Board President
20 East 87th Street

Board President
47 East 87th Street

Board President
19 East 88th Street

Board President
40 East 88th Street

Board President
47 East 88th Street

Executive Director
Park Avenue Synagogue

Store Manager
Bluemercury
1190 Madison Ave

Store Manager
Brora
1190 Madison Ave

Store Manager
Gas Bijoux
1190 Madison Ave

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Hanro
1190 Madison Ave

Store Manager
Pink Chicken
1190 Madison Ave

Store Manager
Blue & Cream
1190 Madison Ave

Store Manager
Unsubscribed
1190 Madison Ave

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Board President
11 East 87th Street

Board President
20 East 87th Street

Board President
21 East 87th Street

Board President
47 East 87th Street

Board President
40 East 88th Street

Owner
Blue & Cream
1190 Madison Ave

Store Manager
Bluemercury
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Russell Squire, Chair, Community Board 8
Craig Lader, Co-Chair, Community board 8, Transportation Committee
Charles Warren, Co-Chair, Community board 8, Transportation Committee

Digital Girl, Inc.
A STEM Program. Enriching girls from the root.

Good morning members of the New York City Council,

I'm proud to testify today on behalf of Digital Girl, Inc. about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal WiFi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free wifi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

At Digital Girl Inc. we provide STEM programming to the community through off site and on site programming. Even though we offer virtual programming, some participants must come into our site because of lack of wifi connection. There are schools that we work with who have no internet connection or very slow internet. This makes learning difficult for students who are already dealing with other challenges. Having free wifi options around the city would be a great advantage to students who are part of the digital divide.

The Link ad screens have become iconic for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to community board meetings. We have had an increase in registration for our programming because of the ads on the LinkNYC Kiosks.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

Sincerely,

Michelle Gall
Founder and Executive Director

1958 Fulton Street, Suite 310 Brooklyn, NY 11233 347.857.8647 mgall@digitalgirlinc.org

ERO HEALTH COMMUNICATIONS

Dear Officials of the City of New York,

I am writing to express my concern regarding the 18 sites proposed for the installation of 32-foot LinkNYC kiosks at 18 sites throughout the Upper East Side, including 13 in the neighborhood's Historic Districts.

I understand the City's goals to expand digital equity. However, the proposed sites do not serve that objective, and will further clutter the neighborhood's sidewalks. In addition, the 5G towers are wholly inappropriate within the Upper East Side, Metropolitan Museum, Carnegie Hill, and Park Avenue Historic Districts and out of keeping with the special character and aesthetic interest of these areas. We urge the City to seek to minimize the visual impacts throughout the neighborhood, and especially in Historic Districts.

I am concerned that the design of the towers, although they have been subject to the public design review process, could be refined and improved. Commissioners at the PDC's discussion last September continued to question whether the visual impact could be further reduced, pressing OTI and CityBridge to return to the PDC with a global design comparison. We understand that PDC has binding jurisdiction on the design of these installations, but we would urge the LPC to opine on the design for structures in historic districts in an advisory capacity. The LinkNYC kiosks were first reviewed at LPC years ago under a different iteration of the plan, and before the three-story 5G towers were incorporated into the design.

Current designs of both the tower version and the tower with advertising screens are not appropriate in appearance or scale for either the residential areas where they are proposed or in the commercial areas, especially the narrow sidewalks and lower scale buildings on Madison Avenue. Furthermore, the planned advertising screens go against LPC's masterplan for Madison Avenue storefronts, which prohibits the installation of flashing digital screens in shop windows.

Presentations made to the PDC clearly indicated that no advertising screens would be installed in residential zoning districts and historic districts. However, CityBridge presented a different vision at the hearings held by CB8, stating the intent to install ad kiosks in five sites within historic districts (46 East 91st Street, 1354 Madison Avenue, 24 East 63rd Street, 688 Madison Avenue, and 30 East 64th Street).

The towers without the advertising screens still pose significant concerns. It is hard to see how a 32-foot tower will fit into the existing context along Madison, Fifth, and Park Avenues and throughout Carnegie Hill, not to mention in front of individual landmarks and institutional sites including the Knickerbocker Club (Fifth Avenue and 62nd Street), the Metropolitan Museum (1000 Fifth Avenue), and the Carnegie Mansion (1095 Fifth Avenue). We are also concerned about the siting of 5G towers along the congested crosstown thoroughfares of 86th Street (1050 Fifth Avenue, 1040 Park Avenue) where bus stops and more already crowd the sidewalk.

While I am sympathetic to the need to provide improved wireless and cellular technology, especially in neighborhoods that are identified as "digital deserts" where residents have sparse and unreliable internet access, I don't understand why the Upper East Side has been

selected for the initial roll-out of the new 5G towers. When Mayor Adams unveiled the plan last year, his press release stated that most of the new kiosks "will be located in... areas that are affected by the digital divide." Indeed, the CityBridge franchise agreement is clear "at least 90% of new structures must be installed in Manhattan above 96th Street and in the Bronx, Brooklyn, Queens, and Staten Island."[1]

Among the 280 new sites currently in the permit process for the Link5G pilot, there are 31 sites in Manhattan south of 96th Street, and of those, 58% are located on the Upper East Side. There has been no convincing explanation about this uneven geographic focus. Upper East Side would hardly qualify as lacking in cell and wireless coverage. The clear cherry-picking of tower locations must be motivated more by revenue earned by selling advertising space and leasing out transmission facilities to carriers.

There has also been no real discussion of the uneven clustering of proposed sites. Why, for example, are five sites within a single block from each other in the East 60s necessary? Similarly, several of the Carnegie Hill sites are located on opposite ends of the very same block. The vendor indicated in discussions with CB8 that the sites were chosen based on gaps in carrier coverage. Can the City demonstrate data regarding those gaps in coverage?

In addition, when will sites be proposed for the rest of the Upper East Side, and the rest of the city, for that matter? Segmenting the review and approval process for various parts of the community does not facilitate a holistic study of the impact across the neighborhood, and unevenly privileges neighborhoods with the capacity to organize.

Once again, I believe digital equity is an important objective, but I fail to see how this initial roll-out serves that goal.

Sincerely,

Erica B. Bersin

Erica B. Bersin
President

311 EAST 71st STREET NEW YORK NEW YORK 10021 ERICABERSIN@EROHEALTHCOMMS.COM
erohealthcommunications.com

Findhelp
3429 Executive Center Dr
Austin, TX 78731
(512) 717-0518
company.findhelp.com

Good morning members of the New York City Council,

I'm proud to testify today on behalf of findhelp about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal WiFi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free wifi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

Findhelp powers findhelp.org, a leading referral platform for social services that is designed to connect people with local nonprofits offering social services, while supporting organizations with tools that help them provide the best service. In partnership with findhelp, LinkNYC launched a banner on its tablets providing access to local services using findhelp.org, which is free and anonymous for all users. There are currently more than 3,500 programs, such as temporary shelters and food pantries, that are accessible on LinkNYC. For the past three years, our campaign was accessed over 401,000 times, with over a third of all searches related to food or housing insecurity.

Unfortunately, many of the New Yorkers who could benefit the most from access to services through our platform live in residential areas that have not been approved for deployment by the PDC. As such, we sincerely hope that the PDC will act quickly to ensure that Link5G kiosks complete with our findhelp platform can be deployed in residential areas -- particularly in social equity districts – across New York City as soon as possible.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our City. We look forward to seeing the program's continued success.

Sincerely,

Katie Morgan

Katie Morgan
Senior Customer Success Manager
Findhelp, a Public Benefit Corporation
kmorgan@findhelp.com

FRIENDS
of the UPPER EAST SIDE
HISTORIC DISTRICTS

Board of Directors

Franny Eberhart
PRESIDENT

Rita C. Chu
Lionel Goldfrank III
David I. Karabell
Patricia F. Sullivan
Ronda Wist
VICE PRESIDENTS

Andrew P. Steffan
TREASURER

Alice McG. Concagh
SECRETARY

George Calderaro
Sarah Chu
Christopher Collins
Christina R. Davis
Alexandra C. Howard
Thomas Jayne
E. William Judson
Rev. John A. Kamas
Christian Keesee
Marjorie F. MacLachlan
Carol E.R. Miller
Genie Rice
Jeanne Sloane
Daniel B. Strickler, Jr.
Arete Warren
Margot Wellington

Board of Advisors

Kent L. Barwick
Andrew S. Dolkart
Hermes Mallea
Peter deF. Millard
Judith Price
Robert C. Quinlan
Timothy C. Quinlan
Jean Tatge
Anthony C. Wood

Anna Marcum
EXECUTIVE DIRECTOR

June 7, 2023

New York City Council
Committee on Technology

RE: Oversight - LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City

FRIENDS of the Upper East Side Historic Districts is an independent, not-for-profit membership organization, founded in 1982, dedicated to preserving and celebrating the architectural legacy, livability, and sense of place of the Upper East Side. Since the Link5G program began its surprisingly unfettered and aggressive rollout last fall, we have expressed broad concerns about the proposed installation of 32-foot Link5G towers throughout the Upper East Side and New York City.

While we wholeheartedly believe that equitable and reliable access to high-speed internet is essential, there is a myriad of issues with the Link5G project. One of the most puzzling is the opacity behind siting choices for the towers. OTI and the CityBridge team have offered inconsistent reasoning – all equally vague – for the tower siting, oscillating between a strategic placement to bridge the digital divide and placing towers at the behest of various commercial telecommunications companies to fortify their networks. The absurdity of the siting plan for the Link5G towers is clearly illustrated in the proposed locations for the towers on the Upper East Side. Nine of Link5Gs are proposed in our neighborhoods, seven of which are in historic districts. Inexplicably, six are located in a two-by-nine-block area in Carnegie Hill spanning from Fifth Avenue to Park Avenue and 86th Street to 95th Street. Each of these towers is less than three blocks away from the next closest Link5G tower. There are two towers, one at the southwest corner of Madison Avenue and 62nd Street and the other at the southwest corner of Park Avenue and 63rd Street, that are one block diagonally away from each other. While CityBridge and OTI claimed today that the siting for the towers was more thoughtful and spaced out than the initial LinkNYC rollout, it is important to remember that the Link5G towers are three times the height of the original LinkNYC kiosks and much more visually intrusive. The locations of Link5G towers seem to be selected with only the most commercially lucrative opportunities for telecommunications providers in mind. The clustering of these massive towers in our historic districts would irreparably alter the built environment and rhythm of the streetscape of some of our city's most precious architectural resources.

FRIENDS is also troubled by the design of the towers. While the design was approved by the Public Design Commission on September 12, 2022, OTI and CityBridge have failed to appropriately address two key contingencies of the approval: the Landmarks Preservation Commission's jurisdiction over the siting of the towers and the requirement that OTI and CityBridge research and develop a design more suitable to residential areas and historic districts. While historic preservation advocates have been assured by the LPC that proposed Link5G sites will be subject to a public hearing, specifics of the regulatory process have still not been outlined. Regarding the required research and proposal for a design more appropriate to residential areas and historic districts, there is no set timeline for the development and implementation of a new design in these areas. I asked OTI and CityBridge representatives about this requirement at a Community Board meeting earlier this year. The requirement was flippantly disregarded by both representatives and not acknowledged as a condition of the approval. No timeline was given for research and development of a better, more appropriate design. From a thoughtful redesign of the towers to cleverly blending the canisters housing 5G connectivity equipment with existing street architecture, there are surely more sensitive design solutions to this problem.

There are several serious issues surrounding the LinkNYC 5G tower program that extend well beyond the issues I've highlighted today including the rampant privatization of public space and the harmful impact

these towers will have on the ADA accessibility and congestion of New York City's sidewalks. FRIENDS of the Upper East Side Historic Districts strongly encourages the Committee to reconsider the implementation of the LinkNYC 5G tower program until clear processes for community engagement, approval, and transparency practices have been solidified.

CC:
Councilmember Keith Powers District 4
Councilmember Julie Menin District 5

New York City Council Committee on Technology
Councilmember Jennifer Gutiérrez District 34 (Chair, Committee on Technology)
Councilmember Shaun Abreu District 7
Councilmember Vickie Paladino District 19
Councilmember Julie Won District 26
Councilmember Robert F. Holden District 30
Councilmember Ari Kagan District 47

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New York City Council Oversight Hearing
Wednesday, June 7, 2023
1:00 p.m.

"Oversight – LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City."

The Garment District Alliance applauds the city's effort to assure wi-fi connectivity for all neighborhoods in the city, particularly those that have a dearth of access.

With seven years of experience with the Links system, we also appreciate the council holding this hearing to review the positive and negative impacts of the program. We believe it is important not only to look ahead at the next generation of the system, but to remedy the unintended consequences of the initial rollout.

Although the Links have benefits, the Garment District is an exception. Sidewalk space is in the District is extremely limited and the pedestrian volume unusually high resulting from the proximity to Times Square, Herald Square, the Empire State Building, Penn Station, Port Authority, the 42nd Street subway nexus, over 125,000 office workers and 54 hotels with 3 million visitors a year.

The sidewalks and pedestrian corridors are also compromised by food carts, legal and illegal vendors, newsstands, muni-meters, bus shelters, signage, fire hydrants, mailboxes, outdoor dining, bollards, planters and much more. Our public spaces are awkwardly congested and the addition of Links totems, while conferring one public benefit, also compromises public safety.

The Garment District is faced with an astonishing redundancy of totems which leads us to question the sincerity of the stated objectives of the program and the implementation plan. We understand that the Links are a franchise agreement with CityBridge, LLC, and that for the program to be profitable for both CityBridge and the city, advertising must be sold to underwrite the costs of the program.

Advertising value in Manhattan's central business district is greater than in most other neighborhoods. However, placing totems according to value rather than need has resulted in an excessive number of Links in the Garment District. If a totem's range is 500', we have redundancy throughout our area, which also has many establishments offering free wi-fi. There is no improved public benefit, only additional profit for CityBridge at the expense of pedestrian safety and mobility. As such, the Alliance requests that the Council mandate that DoITT eliminate redundancy in any future agreements.

Further, the Garment District suffers from the outsized presence of homeless, drug addicts, mentally ill and other socially challenged individuals living on our streets. These individuals tend to cluster around specific Links and monopolize them, streaming all day long in intimidating groups or passed out with the belongings around the totem.

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The Alliance has for years implored DoITT to eliminate specific problematic Links which markedly compromise public safety in our neighborhood. Despite these efforts, presenting photographic evidence and testimony from district stakeholders about the negative consequences on their employees and businesses, DoITT steadfastly refuses.

The Alliance urges the Council to require that in cases where a community demonstrates that a Link has become a detriment, not an asset, to a neighborhood, then the safety concerns of the community take precedence.

Thank you.

CITY COUNCIL DRAFT TESTIMONY

Good afternoon members of the New York City Council,

My name is Tearanny Street, I'm the Director of Communications and Marketing for Greenwich House, a 120-year-old settlement house serving 20,000 New Yorkers each year across a range of health and social services and thank you for the opportunity to share some thoughts on the city's expanding LinkNYC program.

Like most community-based, non-profit human services organizations in the city, Greenwich House does not have a robust marketing budget to help us promote the programs and services available to neighbors in our area – and to any New Yorker in need. This is particularly frustrating when so many of our services are funded and supported by government funding, and yet there are rarely any funds budgeted for advertising to reach New Yorkers who could use the services being purchased.

In the absence of many no-cost or low-cost alternatives, we've seen first-hand how the LinkNYC program greatly benefits organizations, workers, residents, and tourists alike to fill this promotion and local advertising gap.

In a time when human services organizations are facing devastating budget cuts, Link ad screens offer a free and affordable way to connect with New Yorkers about our free services and resources, such as congregate lunches, health and wellness programs, digital literacy classes, and workforce services.

While this public-private partnership provides benefits for us and those we serve, we also understand the frustrations that some of our neighbors have about the LinkNYC infrastructure. However, in our experience, the value of this partnership and the opportunities it provides far outweighs those frustrations and inconveniences.

While we believe it's important that LinkNYC ensures that paid advertisers underwrite this public infrastructure, and that this resource must continue to come at no cost to taxpayers, as the program expands, I would only hope that more time and space be available for human services organizations like ours to utilize these valuable local communications assets.

We're glad that the City and CityBridge continue figuring out innovative ways to add to and expand this critical program.

We look forward to seeing the program's continued success.

HISTORIC PARK AVENUE®
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TESTIMONY ON 5G NETWORK
THE NEW YORK CITY COUNCIL TECHNOLOGY COMMITTEE
JUNE 7, 2023

Chair Gutierrez and Members of the Committee, thank you for hearing my testimony in opposition to the installation of 5 G Network towers in New York City historic districts and in front of individual landmarks.

As a founder and President, from its inception, of Historic Park Avenue, a preservation organization formed for the stated purpose of including Park Avenue from the north side of 79th Street to the south side of 86th Street in an historic district, as were the streets on Park Avenue south of this location.

After nine years of very hard work, extensive community outreach and diligence, we filed the RFE with the Landmarks Preservation Commission, and the district was designated in 2014 along with its inclusion on the State and National Registers of Historic Places.

Preservation organizations and the appropriate committees of Community Boards spend endless hours scrutinizing even the most minute details of buildings and streets that come before them in-order-to determine the best and most appropriate course of action needed to preserve and respect the integrity of those entities. As a member of Community Board 8 Manhattan and its Landmarks Committee, I take part in this effort regularly, and as a member of the Zoning Committee, I am vigilant in my efforts to protect our neighborhoods and make decisions appropriate to maintaining the livability of our communities.

The installation of 32 foot tall 5 G Network towers and 5 G multiple modules placed on lampposts are the antithesis of respecting the aesthetic standards of our historic districts and violate, not only the city standards for historic districts, but the federal standards, as well.

The size of the towers, some of which include active advertising screens, overwhelm the streetscape, mask the view of trees and interfere with the uniformity and standard of the architecture in an historic district. Sitting close to the windows of residents, the towers block views and emit questionable levels of wireless radiation, and concern that requires much more discussion.

The contracts that were signed with the city were done so without input from communities and are in violation of the Federal standard for 5G installation in historic

districts. There is questionable need for the service at the sites proposed and a misrepresentation that these would only be installed in areas deficient in wireless service. In the historic district that I represent, residents affirm that they have no need for the service the towers provide, as their wireless service is more than adequate. They don't need the towers, and they don't want the towers.

Currently, there is 5G technology available from companies that are able to use the existing antennas that are on the Empire State Building and bounce signals off the existing infrastructure already put in place by companies such as Verizon and A T & T.

These tech companies will build and operate an innovative and interconnected broadcast platform to provide commercial services and solutions for national data distribution. The cost to the local provider and to the end consumer will be a fraction of what City Bridge is proposing and will not be in close proximity to any street, building or person, and therefore, will not be a visual blight or a health threat.

This technology already exists, so there is no need for the city to sell its streets to the highest bidder, to demean and damage its historic districts and individual landmarks or to risk the health and well-being of its citizens.

Please put a stop to this ill-thought out, potentially dangerous and potentially unnecessary program that takes advantage of the city coffers to line its own while providing no benefit to anyone.

Thank you for your consideration.

Sincerely,

Michele Birnbaum, President
HISTORIC PARK AVENUE®
(917)868-0748

June 7, 2023
To: The City Council Committee on Technology
From: Cynthia Penney, secretary, Jane Street Block Association

I am very concerned about the LinkNYC 5G initiative and ask that you pause it immediately until the following issues are addressed:

• There are no clear, consistent guidelines about where towers should be located.
• The siting guidelines established by NYC OTI are being routinely ignored .
• OTI has failed to respond in any meaningful way to the detailed concerns of Community Board 2 and many elected officials.
• The current placement of these towers does not help bridge the digital equity gap that the city claims is the main goal of the project.

For example: There is no need to install two towers close together on Washington Street (10014) two blocks from the Whitney Museum/Highline/Little Island/Hudson River Park. This is not a digital desert. Every one of these institutions has its own wi-fi in place. Furthermore: construction on Washington Street was begun (and then halted) before any of the above issues were addressed, especially guidelines as to location.
• I am especially concerned that there are no guidelines in place for a so-called "sensitive" design of towers in historic districts. As a resident of the historic district of the West Village, and secretary of the Jane Street Block Association, this issue is personally of paramount concern.



JaneStreetBlockAssn@gmail.com

Latino
Social
Work
Coalition
& Scholarship Fund

Testimony for The Latino Social Work Coalition and Scholarship fund before the New York City Council Committee on Technology

Wednesday, June 7, 2023

Good afternoon, Chair Gutierrez, and distinguished members of the New York City Council Committee on Technology, thank you for the opportunity to address you today. My name is Luisa Lopez, and I am honored to serve as the President of the Latino Social Work Coalition and Scholarship Fund. Today, I stand before you to testify about the tremendous impact of the LinkNYC program and the forthcoming LinkNYC 5G upgrade, particularly in the context of promoting culturally competent mental health support for all New Yorkers.

The LinkNYC program has been instrumental in enabling nonprofit organizations like ours to connect with the diverse population of this great city. By providing access to the hundreds of LinkNYC kiosks across the city, this program has facilitated our efforts to deliver culturally competent mental health support to the 8 million residents of New York. Without this generous program, reaching such a vast and diverse audience would have been an insurmountable challenge.

To honor Mental Health Awareness Month this year, the Coalition partnered with LinkNYC to showcase the importance of culturally competent social workers and mental health professionals to support the 1 in 5 New Yorkers that experience mental health challenges. Through the LinkNYC program, our organization has been able to leverage the kiosks to disseminate crucial information, provide internet access through its WIFI networks, and ensure that all New Yorkers, regardless of their income, have high-speed internet access in times of emergencies or when they need instant information at their fingertips. This program has been a powerful tool in bridging the digital divide for unhoused and under-resourced New Yorkers, particularly during the COVID-19 pandemic and its aftermath.

However, as technology evolves, it is imperative that the city continues to invest in making internet access universal. High-speed internet has become as vital in today's world as telephone access was in the 1970s and 1980s when public telephones dotted every corner of New York City. Internet access is no longer a luxury; it is an equity issue that directly impacts the lives of all New Yorkers, particularly those living in vulnerable communities.

While it is understandable that some may view the design of 5G kiosks as potential eyesores in certain historic neighborhoods, we must remember that similar concerns were raised in the past about public telephones, hotdog stands, and Citybike racks. Today, these fixtures have become iconic symbols of our city's landscape. We cannot envision New York City without them.

However, greater efforts must be made to ensure that we have transparency when it comes to sitting of the towers and more community input on the designs to ensure that they match the surrounding area. This is a creative opportunity by which we can showcase local artists by having them decorate the towers to add a bit of the local neighborhood "flavor" to these kiosks. Doing so will allow these LinkNYC 5G kiosks, with their innovative design, to become a part of our city's identity and contribute to its vibrant character.

As we advocate for the forthcoming LinkNYC 5G upgrade, it is crucial to emphasize the transformative impact it will have on the provision of mental health support. Culturally competent mental health services are vital for the well-being of our communities. By leveraging the LinkNYC kiosks, we can disseminate critical mental health resources, raise awareness, and foster an environment of understanding and support for all New Yorkers.

In conclusion, I urge you to recognize the significance of the LinkNYC program and the forthcoming LinkNYC 5G upgrade. These initiatives have not only bridged the digital divide for the most vulnerable but have also empowered organizations like ours to deliver culturally competent mental health support to all New Yorkers. Let us embrace the potential of technology to foster equitable access to high-speed internet, just as we did with public telephones in the past. Together, we can build a New York City that thrives on inclusivity, connectivity, and the well-being of its residents. Thank you.

ZenFi Testimony

My name is Robert Sokota. I am the President for Link Solutions for ZenFi Networks. ZenFi is a NYC homegrown entity started in 2014 to improve the wireless infrastructure in New York City. I also serve at the President for Wireless for CityBridge.

ZenFi has been involved in the LinkNYC program from the outset, providing the underlying fiber network connections to all the of the Link kiosks. In 2021 as part of the reset of the LinkNYC franchise, we also became an investor in CityBridge.

Part of the 2021 reset of the LinkNYC franchise was to expand the wireless services that can be provided by the kiosks. Key to that goal was the development and deployment of the new Link5G kiosk. The Link5G kiosk represents a world leading design for street furniture. It is capable of providing the same services as the original LinkNYC kiosk. But it is also purpose built for the siting of a wide range of wireless services equipment including the planned rollout of 5G services. Similar to the original kiosks, each Link5G will also be connected with fiber that we construct. This fiber is then available for additional uses, which is especially important in some outer borough neighborhoods which have suffered from a relative lack of telecom infrastructure investment compared to upper income areas in Manhattan.

Additional investment in wireless infrastructure in New York City is vital because the demand for mobile communications is continually increasing. If New York City fails to invest in the required underlying wireless infrastructure or fails to provide pathways for mobile service operators to deliver new services, it risks having New York City fall behind other cities on mobile services.

Link5G is the right solution for New York City in that it will enable New York City to be a leader in the rollout of new wireless technologies such as 5G and wireless broadband. Our mission is to bring as many carriers onto the structure as possible, which means the neighborhoods that receive Link5G should ultimately have the best service with the most choice for wireless communications.

Just as importantly, the Link5G deployment is planned all across New York City and will provide a digital safety net for New Yorkers.

The current LinkNYC network of 2,000 kiosks is the largest free outdoor public WiFi system in the country. Over the next few years we are going to double the number of kiosks from 2,000 to 4,000. Because we will be upgrading to the new Link5G and because we will optimize deployment for the wireless coverage, that doubling in the number of kiosks will lead to quadrupling or 4x increase of the area of New York City that will receive free WiFi coverage.

And we are currently working on new technologies to extend the signal indoors so that the Link5G deployment will also mean more WiFi availability for people who live or work close to the new Link5G kiosks.

5G and other new wireless technologies are necessary for the future of New York. Through the deployment of Link5G, New York has an opportunity to lead the way to building an equitable digital economy.

MADISON AVENUE
BUSINESS IMPROVEMENT DISTRICT

June 7, 2023

Good afternoon, Council Member Gutiérrez and members of the NYC Council Committee on Technology.

The Madison Avenue Business Improvement District strongly opposes the installation of a Link5G tower at the proposed location of 688 Madison Avenue, between East 61 and East 62 Streets. This location is within the boundaries of the NYC- and National Register of Historic Places Upper East Side Historic Districts, and the Special Madison Avenue Preservation District (NYC Zoning Resolution Section 99-00).

We very much believe that this tower will permanently damage the pedestrian scale and historic character of the Historic District's setting. These changes to the character of the district are contrary to NYC policy & law. As noted in Z.R. 99-00, the Special Madison Avenue Preservation District was enacted "to preserve and protect the unique character and architectural quality of Madison Avenue and its surrounding area."

Z.R. 99-00 also states that the Preservation District was enacted "to promote the most desirable use of land in this area and thus to conserve the value of land and buildings and thereby protect the City's tax revenues." We and our members contend that the installation of this Link5G towers will diminish the value of land and buildings, reduce sales at adjacent retail locations, and thus reduce the City's tax revenues.

We therefore respectfully request that OTI remove this location from their list of potential Link5G kiosk sites, and that OTI take into consideration the unique character of Madison Avenue prior to any future permanent street installations.

Thank you.

- Respectfully submitted by Matthew Bauer, President, Madison Avenue B.I.D.

Massachusetts for safe TECHNOLOGY

June 7, 2023

Testimony in Opposition:

Committee on Technology Oversight - LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity Across the City

By Cecelia Doucette, Director, Massachusetts for Safe Technology
Education Services Director, Wireless Education

Good Evening,

I'm Cecelia Doucette, Director of Massachusetts for Safe Technology. I helped my schools become the first in the nation to adopt Best Practices for Mobile Devices. I also helped New Hampshire become the first state in the nation to pass a law to investigate the health and environmental impact of 5G. Their groundbreaking commission report documents conflicts of interest with the wireless industry, the FCC and FDA.

New Hampshire also documents serious biological harm from wireless technology and makes 15 recommendations to transition away from toxic wireless emissions and instead invest in fiber-optics to and through the premises. Retired President of Microsoft Canada Frank Clegg testified that wireless is no longer advanced technology. Fiber optics directly to and through the premises is.

The earth pulses healthy electron energy at 7. 83 times per second. Wireless technology pulses man-made microwave radiofrequency energy in the Megahertz and Gigahertz range. That's one million and one billion times per second, respectively.

Quite simply, wireless radiation overpowers our biological cells.

This radiofrequency radiation detection meter let's us see this invisible energy (Safe & Sound Pro II RF Meter).

Science indicates we should be at 10 microwatts per square meter or less indoors which is where my home is because I choose hard-wired technology. When I take my phone out of airplane mode, we see the radiation levels go from green to highly toxic red with a reading over 500,000.

I can limit my use of this, but when we permit cell towers close to homes, schools and other sensitive areas, we condemn the inhabitants to 24x7 toxic levels of radiation.

Please, do not install close-range cell towers of any kind. There are many experts at the ready to help you deploy technology responsibly.

I invite you all to join me for a free public education webinar at Massachusetts for Safe Technology where you will learn the facts on science, risk, public policy and legal actions.

Thank you, and I'd be honored to answer any questions.

--

I will also upload my current educational slides for the public record, so you can quickly access the science, legal actions and current public policy.

I will also upload a quick reference sheet, EMF Points of Confusion vs. Fact which may help to sift through industry disinformation.

The following links provide facts for you to learn from and share with your own loved ones as well as your colleagues:

- **Introduction**
- **The Science**
- **Military Experts**
- **Doubts**

- **Cancers**
- **Infertility**
- **Impact on Children**
- **Wi-Fi in Schools**
- **Electromagnetic Sensitivity (EMS)**
- **Utility "Smart" Meters**
- **Cell Towers**
- **5G & IoT**
- **Planetary Impact**
- **Legal Issues**
- **MA EMF Bills**
- **Bills in Other States**
- **Manufacturers**
- **Media Limitations**
- **World Response**
- **Solutions**
- **For Schools & Families**
- **For Workplace Training**
- **For Health Care Providers**
- **For Engineers & Physicists**
- **For Municipal Leaders**
- **For Legislators**
- **For Lawyers**
- **Expert Video Clips**
- **Books**
- **Documentaries**

Massachusetts for safe TECHNOLOGY

EMF Points of Confusion vs. Fact

Many are surprised to learn the **electromagnetic fields (EMFs)** emitted by wireless technology are biologically hazardous, and one often gets push-back when they open the conversation. This fact sheet provides information to help sort fact from disinformation and identifies solutions for safer technology use. For those reading this in print format, please see https://sites.google.com/site/understandingemfs/massachusetts-emf-bills-2023-24?authuser=0 for an electronic copy to investigate the links below.

Point of Confusion	**FACT**
The FCC says wi-fi is fine.	The Federal Communication Commission's 1996 guidelines are outdated. The FCC ignored 11,000 pages of scientific evidence of harm and was sued for not protecting the public. FCC is a captured agency and has yet to respond to the court order. See Harvard's *Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates*. See also the Mobile Communications and Health study by T-Mobil showing the industry knew early on of the serious harm. New Hampshire is the only U.S. government to do an independent investigation, see their final commission report documenting conflicts of interest, science, harm and 15 recommendations for responsibly deploying technology.
The manufacturers make it look like all wi-fi all the time is the way to go.	Most consumers, and even many who work in the industry, are unaware of the manufacturers' fine print that comes with each device indicating one should never keep an active device on one's body or radiation exposure may exceed even the FCC's outdated non-protective guidelines. Additionally, science indicates we should have invoked the Precautionary Principle decades ago when evidence of harm was first found, and not exposed the public until proven safe. We have not done this in the U.S. but other countries have. Physicians for Safe Technology illustrate the disparity in allowable public radiation exposure levels.
There are studies showing no evidence of harm.	No evidence of harm is not the same as safe. This technology was brought to market with no safety testing and a safe level of microwave radiation has never been identified. The telecommunications industry produces its own scientific studies designed to show no evidence of harm. This creates doubt among consumers so they will continue to purchase wireless products. Dr. Henry Lai provides insights here. In 2018 the U.S. National Institutes of Health found clear evidence of cancer, as did a large Italian study at the Ramazzini Institute. Pittsfield, MA Board of Health documented their findings of harm too.
There are not many studies done on wi-fi.	There didn't used to be, but there are now. See this 2018 meta-study on Wi-Fi by Dr. Martin Pall. Cell phones came first so that is why the majority of studies, which can take years to complete, use cell phones. However, all wireless operates in the biologically hazardous microwave segment of the electromagnetic radiation spectrum. So, what cell phone studies reveal holds true for 2G, 3G, 4G, 5G, wi-Fi and the Internet of Things too. We have thousands of studies showing man-made EMFs are hazardous to all biological species– humans, plants, animals, and insects -- including the pollinators needed to grow our food.

Point of Confusion	FACT
Surely we would know if this were an issue.	Advertising dollars influence media content, and telecommunications, energy and technology companies are among the top advertisers. Media executives will not allow true investigative journalism into this issue or their revenues will drop so we rarely hear of wi-fi harm in mainstream media. When there is coverage, they typically say more research is needed, which appeases industry advertisers and keeps consumers buying their toxic products. Industry influence on public servants can also be a factor. In 2017, it took a lawsuit for the California Department of Public Health to finally release a long-suppressed fact sheet on cell phone radiation.
Our education agencies do not see this as an issue.	Few agencies have investigated because the industry has been so effective at suppressing evidence of harm while offering financial incentives to adopt EMF products and infrastructure. In our top-down education system, local schools often do not feel empowered to act. However, legal precedents are being set that leave schools, public agencies and companies at risk. The insurance industry has identified EMFs as one of the top emerging hazards. Lloyds of London and other insurers do not cover EMF damages so schools and businesses can be held directly responsible for harm. Workers compensation cases have also been awarded for EMF damages in the workplace, and teachers unions are beginning to request hard-wired work environments. Click here for additional information. Ashland Public Schools, MA has become the first in the nation to adopt Best Practices for Mobile Devices and Maryland is the first state to recommend hard-wiring in schools with wi-fi off and offer Guidelines to Reduce Electromagnetic Field Radiation.
We need wireless for the 21st century classroom.	The industry identified children as an untapped market and began their 21st Century Classroom campaign to put a wireless device in the hands of every child. In addition to biological harm from wi-fi, studies show excessive screen time is harming brain development causing impaired social and emotional skills, digital addiction and poorer educational outcomes. Silicon Valley executives send their children to schools with NO tech. TechSafe Schools will send information to your schools with health, legal and remediation information.
Some say electrosensitivity doesn't exist.	The United States Access Board's IEQ Indoor Environmental Quality Project indicates electromagnetic sensitivities may be considered disabilities under the ADA and recommends accommodations. Just as Lyme Disease was dismissed by medical practitioners before it was widely understood, today's doctors, nurses, psychologists and social workers in many countries have yet to be trained. They can now attend the EMF Medical Conference on-line. School nursing records often indicate an increase in one or more common symptoms among students and staff following the installation of wireless systems: headaches, tachycardia, bloody noses, ear bleeds, skin rashes, nausea, tinnitus (loud ringing in the ears), vertigo, inability to concentrate, depression, anxiety, insomnia. See also the *EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses*.

Point of Confusion	FACT
The radiation drops off with distance.	This is true, in physics the inverse-square law states the intensity is inversely proportional to the square of the distance from the source of that physical quantity. However, it is the pulsed, spiked, erratic signal that causes biological damage. Many routers and cell antennas send and receive data at long distances, and those erratic pulses, though spread out with distance, hit our bodies as they go through buildings, walls, ceilings, etc. Further, if not stopped through protective town zoning code, the industry is installing cell antennas right in our neighborhoods every 2-12 houses for 5G and the Internet of Things. These pulse close range toxic radiation at our families 24x7.
Respected engineers, physicists, medical professionals and technologists in our community want our children to have wi-fi in schools.	Most professionals were taught in school and in their work that there must be enough heat from a wireless device to raise the temperature of skin tissue in order to cause harm. Non-industry funded science has now proven this thermal effect premise is false. Thousands of studies show biological effects at the non-thermal, non-ionizing level; the U.S. National Toxicology Program study found DNA damage as well as brain and heart tumors. Professionals in all sectors will benefit from updated education on EMFs.
There is nothing we can do, wi-fi is everywhere.	Leading non-industry funded EMF scientists from around the world have already sent a formal appeal to the World Health Organization and United Nations to address this "emerging public health crisis". They succinctly outline specific measures to solve this problem, the first of which is to protect children and pregnant women. The retired President of Microsoft Canada indicates wireless is no longer advanced technology: fiber-optics is. Until public policy catches up with science and biologically safe technology is brought to market: • Use hard-wired connections with antennas turned off (cell, data, Bluetooth, wi-fi, hotspot) to access the internet safely and avoid legal exposure. Hard-wired is not only safer, it is faster, more reliable and more secure than wireless. Use Ethernet cables and adapters to hard-wire routers, laptops, tablets, etc. Clear sleeping areas of EMFs, and never give to or use an active device near a child. • Choose corded baby monitors, gaming devices, entertainment systems; turn off any wi-fi antennas. • Use corded landline phones, they are safer and more reliable, especially during power outages. Avoid DECT cordless phones, they have high EMF emissions. Cell phones can be forwarded to landlines. • Keep analog utility meters, they do not emit the electromagnetic radiation that "smart" meters do. • Work with public servants to keep wireless infrastructure away from where we live, work, learn, play. The U.S. Collaborative for High Performance Schools provides Low-EMF Best Practices to establish a hard-wired school environment and prohibit use of personal wi-fi devices in school, except during emergencies. See WirelessEducation.org, a non-profit charity that distills the science and medical recommendations into easy-to-learn concepts in an affordable 30-minute e-learning course for families, schools, and workplaces.

Not Sleeping? Anxious? Depressed? Headaches? Heart Issues?



Who knew -- it could be the radiation from your wireless devices…

*ALL ARE WELCOME TO JOIN US FOR A **FREE EDUCATIONAL WEBINAR**:*

WIRELESS TECHNOLOGY RISKS & SAFER SOLUTIONS

JUNE 6, 12 NOON ET & JUNE 28, 6 P.M. ET
JULY 11, 12 NOON ET & JULY 27, 6 P.M. ET

CO-HOSTED BY NEW HAMPSHIRE FOR SAFE TECHNOLOGY AND
CECE DOUCETTE, DIRECTOR OF MASSACHUSETTS FOR SAFE TECHNOLOGY
& THE NON-PROFIT WIRELESS EDUCATION

TO REGISTER: MA4SAFETECH.ORG/EVENTS OR EMAIL
NEWHAMPSHIREFORSAFETECHNOLOGY@GMAIL.COM
CAN'T ATTEND? REGISTER AND WE WILL SEND YOU THE VIDEO RECORDING

Did you know New Hampshire is the first government in the U.S. to conduct a formal investigation of wireless risks and issue a groundbreaking report of harm along with safer ways to use today's technology?

They discovered **thousands** of peer-reviewed, published studies that link wireless radiation to our growing rates of **insomnia**, headaches, fatigue, anxiety, depression and more. In the long-term, the U.S. National Toxicology Program has found cell phone radiation causes cancer and DNA damage. It is also a leading cause of our disappearing pollinators.

This invisible radiation is constantly pulsed from all things wireless, unless we learn to use technology responsibly. Let's learn together how to stay connected and protected.

Please join us to discuss this timely issue with technology safety educator Cece Doucette. She introduced similar legislation in Massachusetts and helped her schools become the first in the nation to begin safeguarding students and staff from wireless radiation. She is also an invited lecturer at the EMF Medical Conference.

Cece will walk us through the issue, answer questions, and demonstrate radiation emissions from wireless technology. You'll learn simple strategies you and your loved ones can use TODAY to access technology much more safely. Feel free to invite others.

If this is new to you, consider watching the award-winning film Generation Zapped in advance (Amazon Prime, library subscriptions to Kanopy or Hoopla, or download for a small fee).

IF YOU ARE UNABLE TO ATTEND BUT WOULD LIKE TO JOIN ANOTHER CONVERSATION, OR PERHAPS HOST ONE OF YOUR OWN, PLEASE CONTACT **MA4SAFETECH@GMAIL.COM**. *THANK YOU!*

Massachusetts for safe TECHNOLOGY

Wireless Technology Risks & Safer Solutions

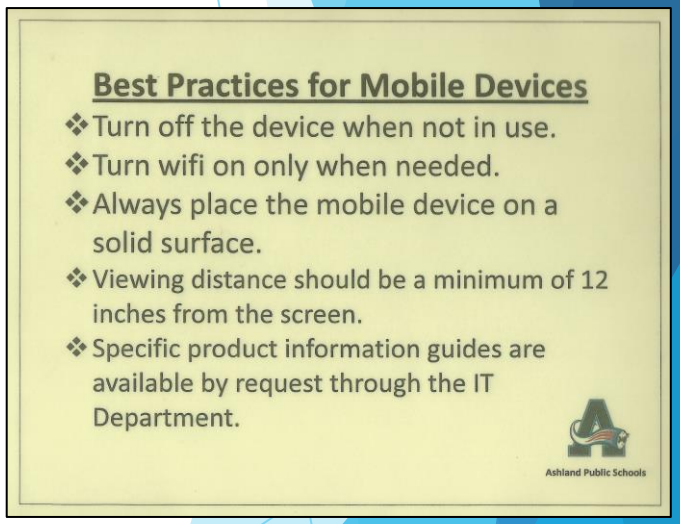
Lori Schreier, Deb Hodgdon, Jennifer White, New Hampshire for Safe Technology
Cece Doucette, Massachusetts for Safe Technology

June 6, 2023

Cece Doucette, MTPW

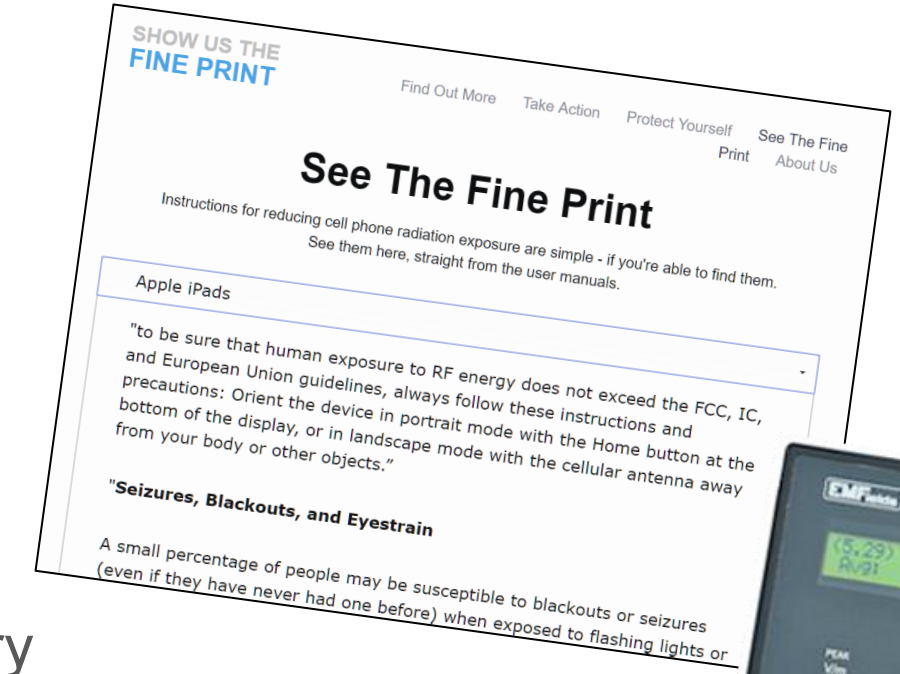


- Helped Ashland, MA become first-in-nation with Best Practices for Mobile Devices, 2014
- Introduced legislation in MA & testified in NH
- Co-founder, Wireless Education, educational non-profit
- Co-founder, Massachusetts for Safe Technology
- Co-Chair, Technology Panel, Health in Buildings Roundtable Conference @ NIH
- Speaker: EMF Medical Conference 2021



The Legal Fine Print

- See the Fine Print
  - Settings
    - General
      - (About)
        - Legal & Regulatory
          - RF Exposure

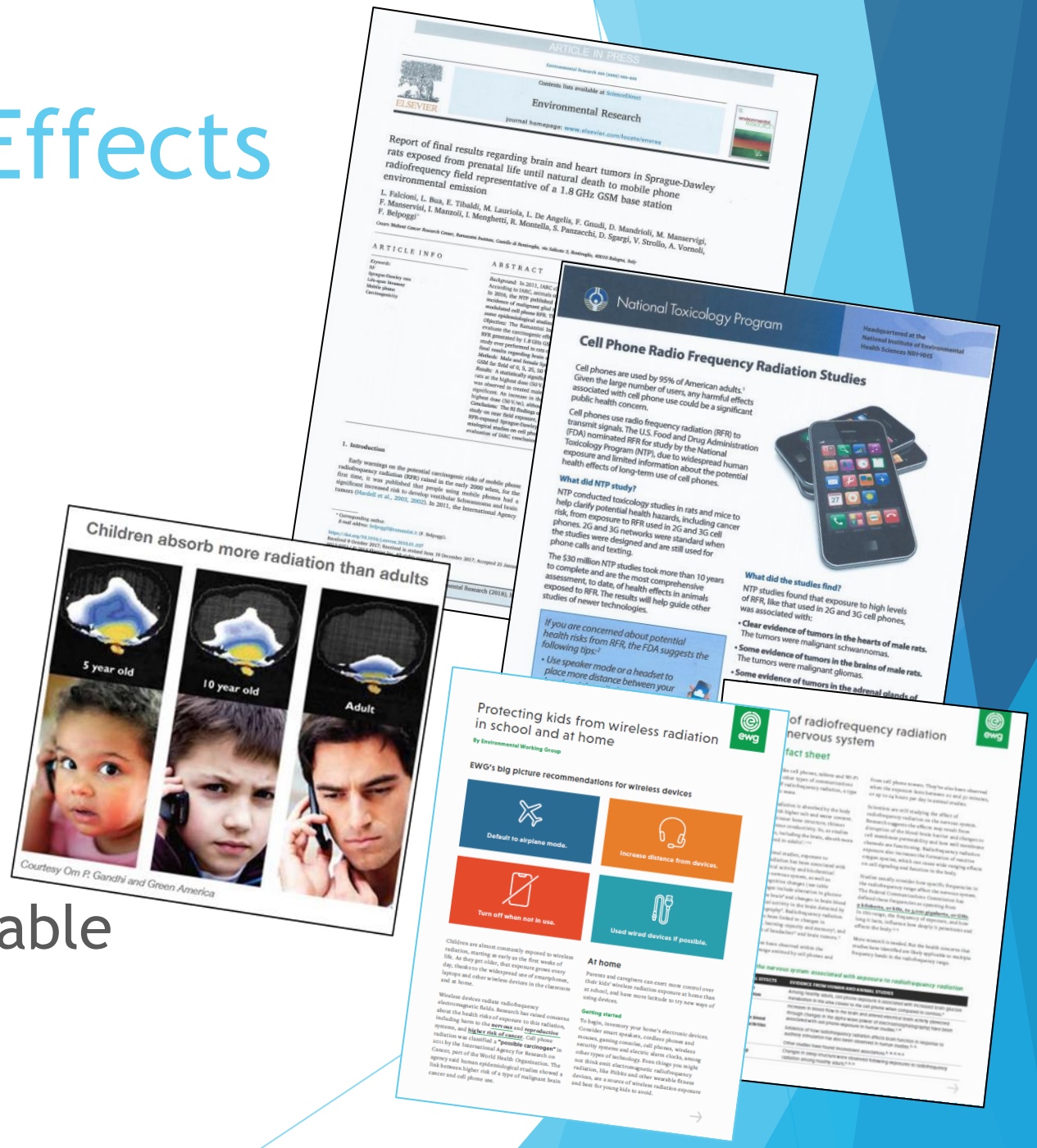




- Ashland & Newton library Acoustimeter Pittsfield Safe & Sound Pro II
- WACA 23-min. PSA, WCCA Tech Safe series

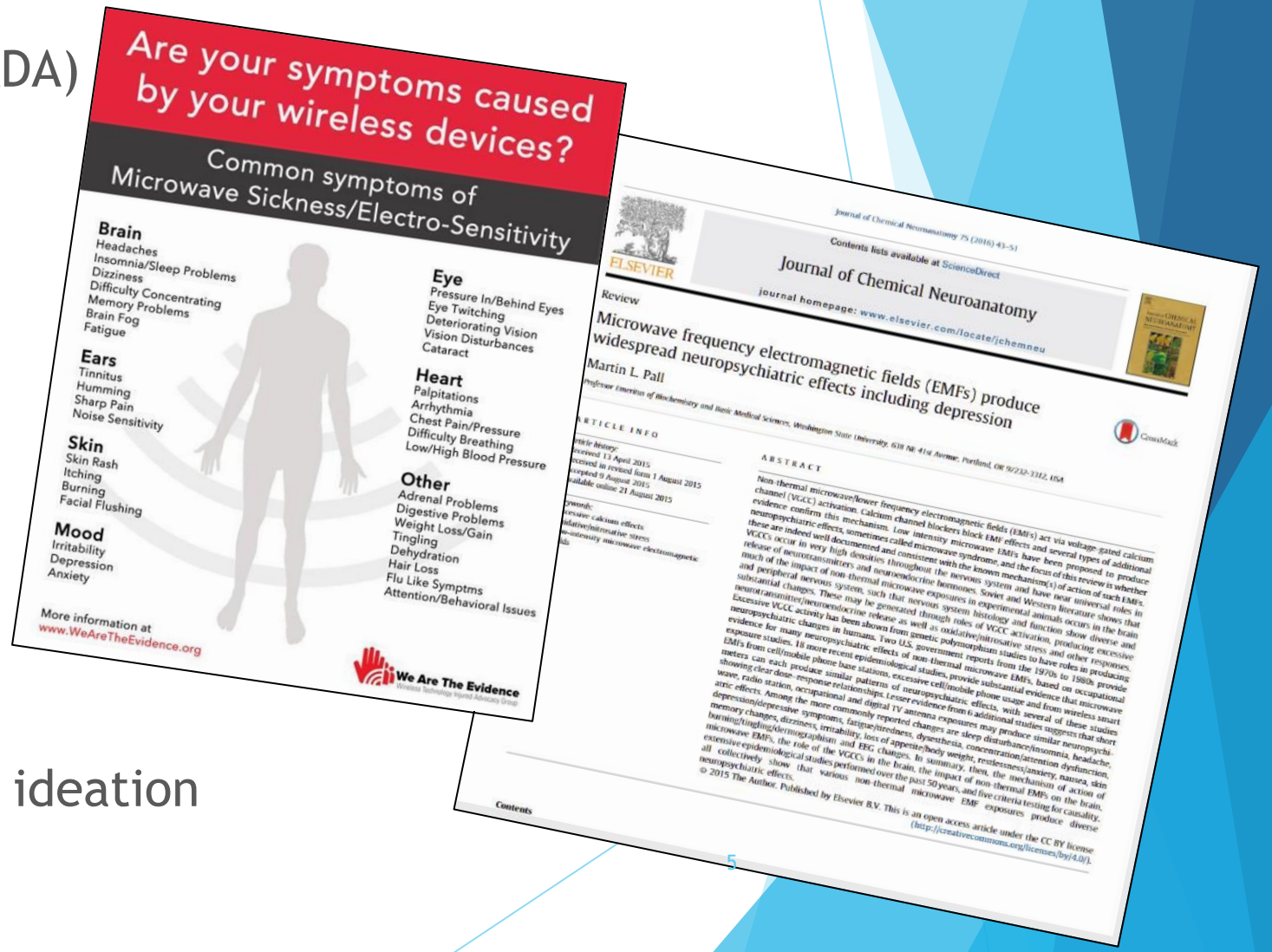
Science: Long-term Effects

- Child & Adult Cancers
- DNA Damage
- Infertility
- Neurotoxicity
  - ADD/ADHD
  - Autism
  - Alzheimer's
  - EWG Fact Sheets
- Children are especially vulnerable



Science: Short-term Effects

- Electromagnetic Sensitivities (ADA)
  - Insomnia
  - Headaches
  - Nosebleeds/earbleeds
  - Fatigue
  - Pain
  - Skin abnormalities
  - Irregular heartbeats
  - Cognitive impairment
  - Anger, behavior issues
  - Anxiety, depression, suicidal ideation



Science: Planetary Impact

- Pollinators
- Birds
- Energy consumption
  - Mineral extraction
  - Data warehouses
  - Networks
  - Personal devices
    - Streaming
    - Send/receive
    - Charging
    - Continuous app updates



Why Don’t We Know?

- FCC: Captured Agency
- ProPublica Article
- FDA: Conflict of Interest
- World Health Organization
  - Reopening investigation
  - Conflicts of interest



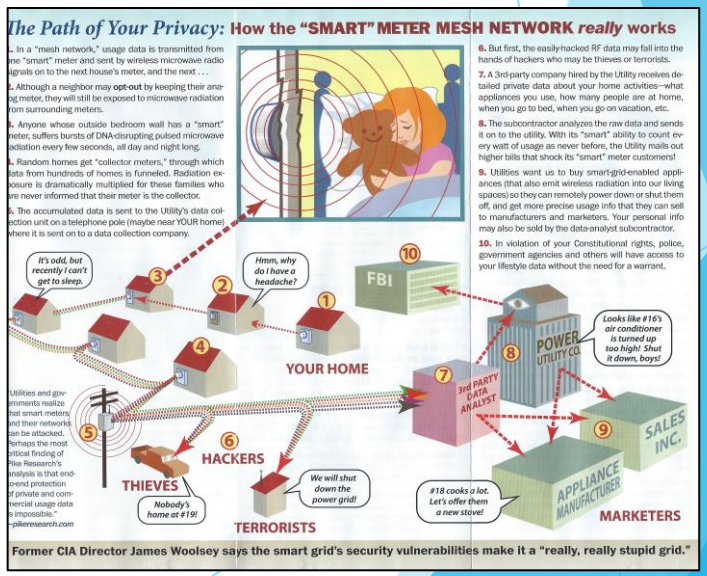
What Safe Technology Looks Like



Source: Utility “Smart” Meters



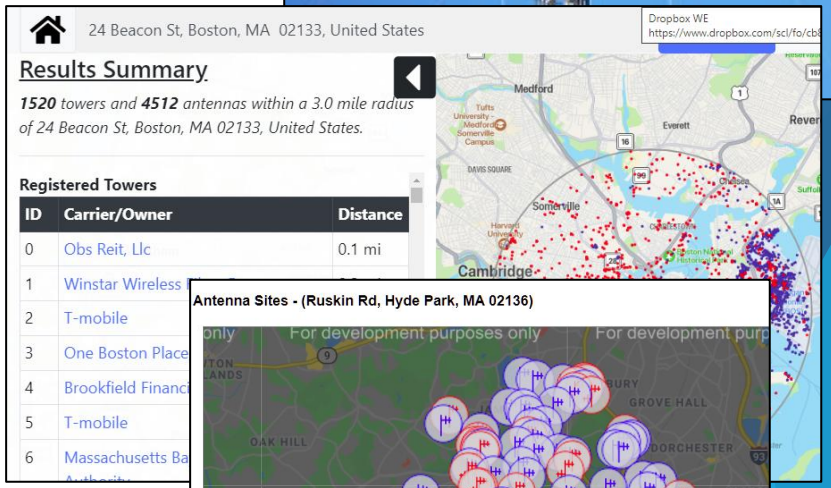
- Pulse radiation continuously
- Can hop on house wires/pipes
- Fires, explosions, improper grounding
- Data harvesting, privacy issues
- Leading cause of sudden onset microwave sickness
- Environmental justice/Worcester
- TedX Talk: Jeromy Johnson, engineer
- TedX Talk: Dr. Alexia McKnight

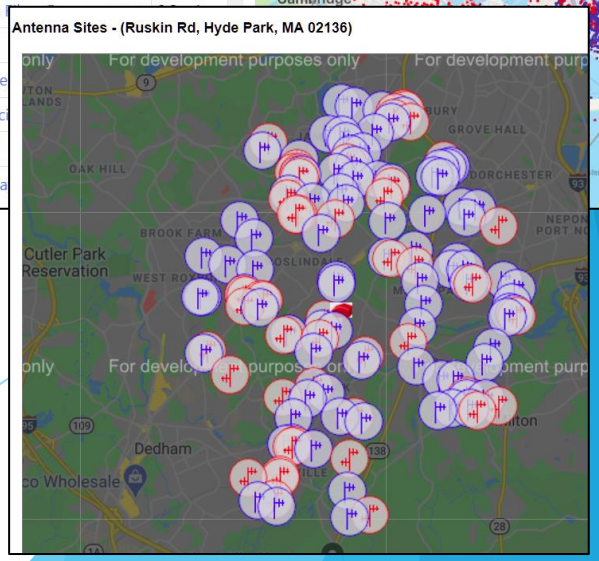


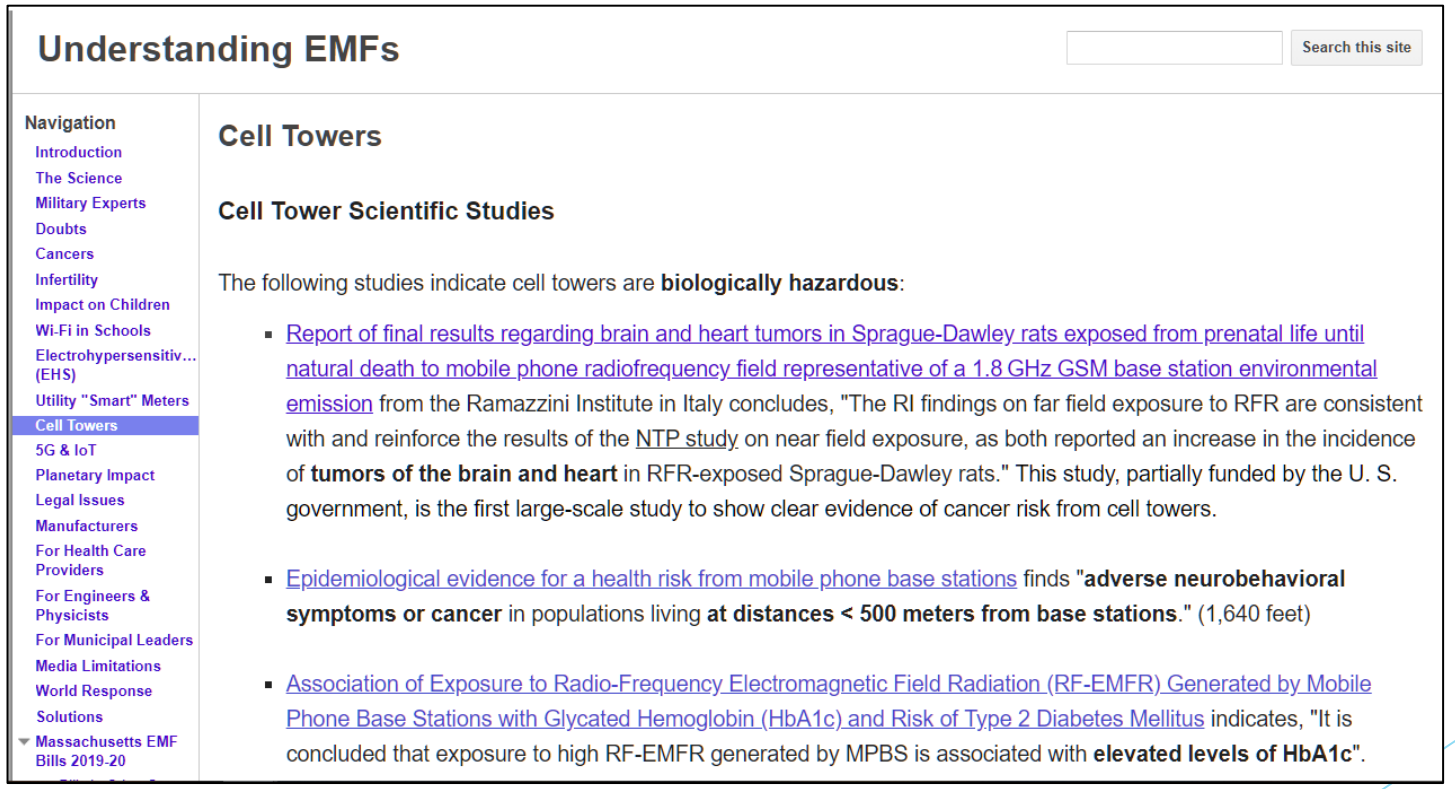
Source: Cell Towers

- Examine the non-industry funded science
- AntennaSearch.com







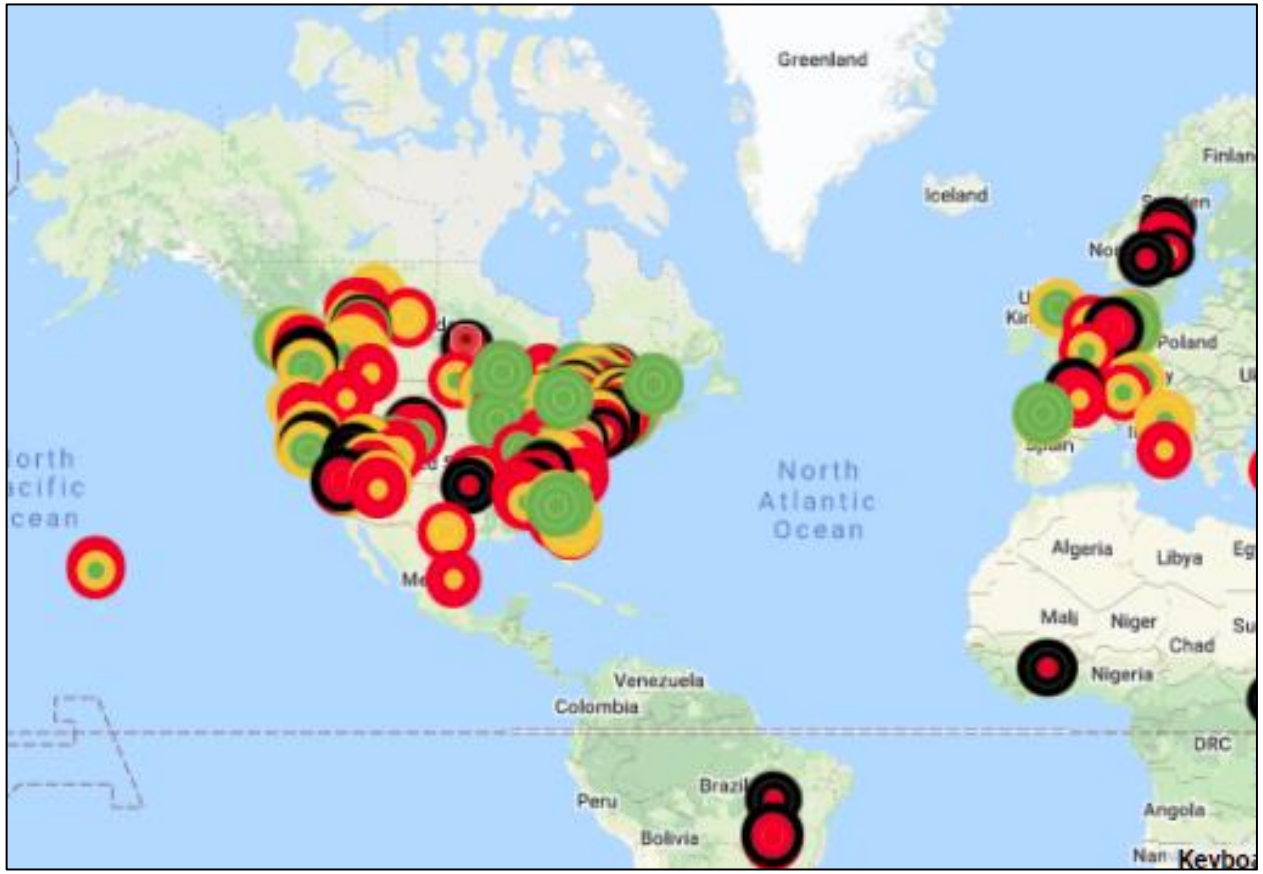


Now Add 5G Small Cells

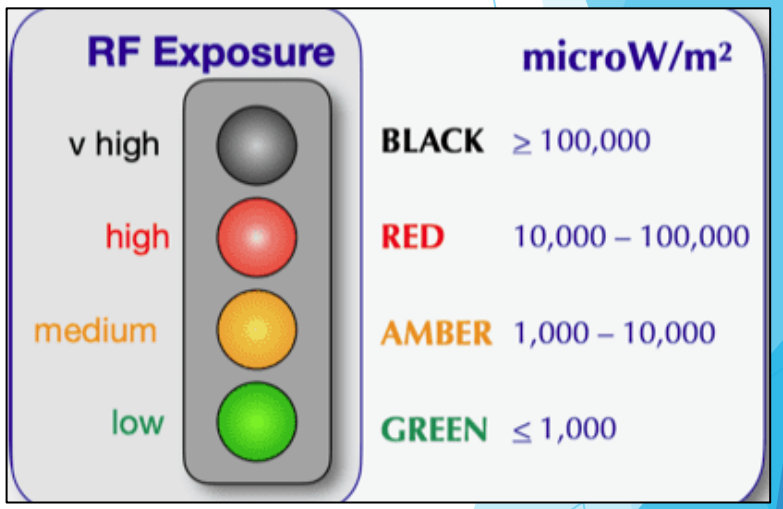
- 5th Generation technology
- Promises faster entertainment downloads, smart cities, etc.; buying the entertainment industry
- Uses existing 3G, 4G wavelengths to penetrate buildings, can't go through objects
- 5G is the *addition* of short millimeter waves
- Industry goal: millions of small cells at curb outside bedrooms in public access way, every 2-12 houses
- Clear-cutting trees
- Never tested for safety (Congressional hearing)
- ComputerWorld: 5G a Bad Joke
- Verizon exposed 100 million January 2022
- Rubik/Brown paper: Evidence for a connection between coronavirus disease-19 and exposure to radiofrequency radiation from wireless communications including 5G



Global EMF Monitoring Project



Outdoor Exposures



Salzberg Guidelines
https://globalemf.net/

Outdoor Measurements

- Goal: Less than 1,000 microwatts/square meter
- Westmoreland, NH Fire Department = 417
- Keene, NH = 7,460
- Nashua, NH = 14,500
- Concord, NH = 66,600
- Stratham, NH = 108,000
- North End Boston = 613,000



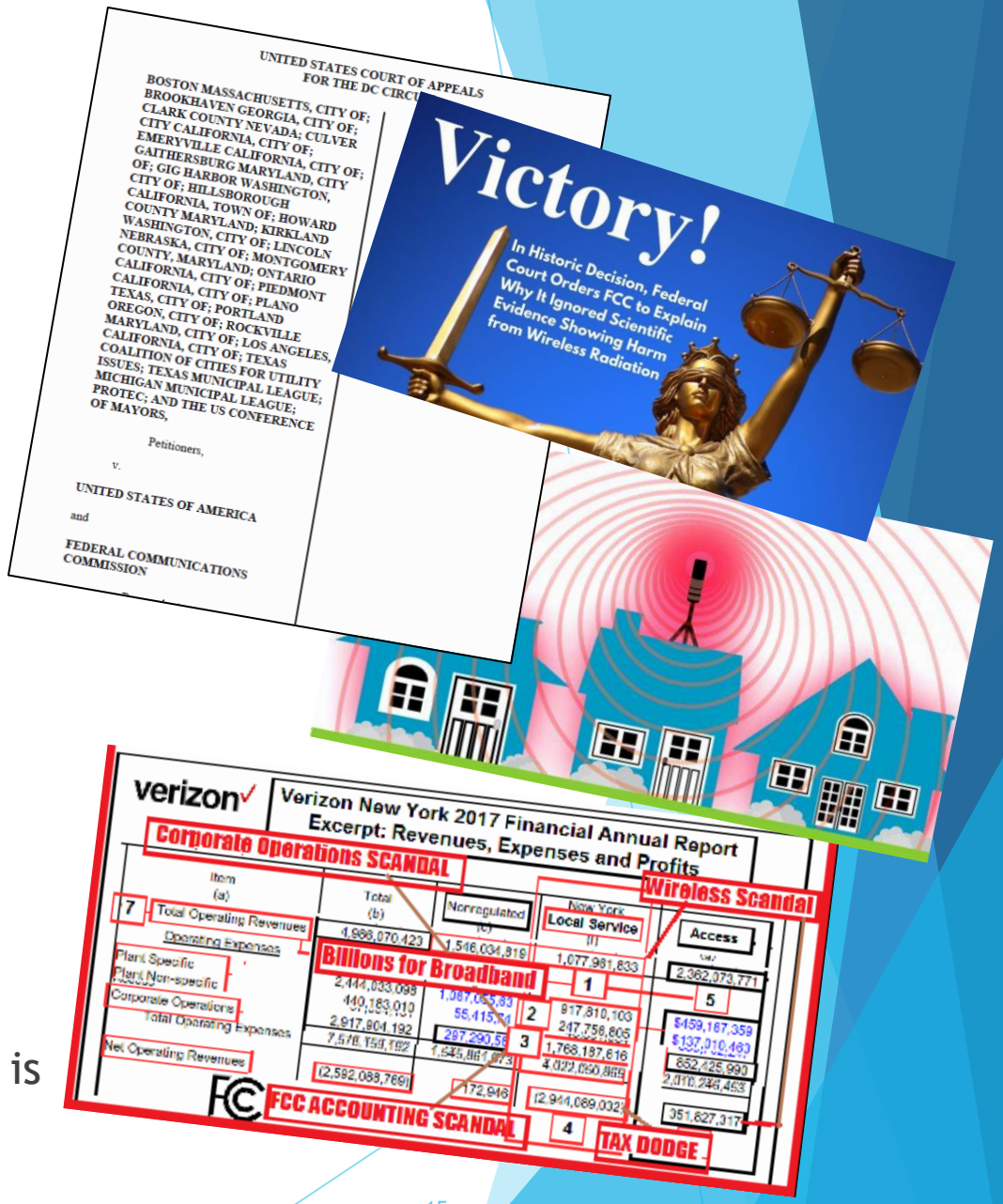
Social Norm Change

- Martin Luther King, Jr.
  - Public engages
  - Courts rule
  - Public policy enacted



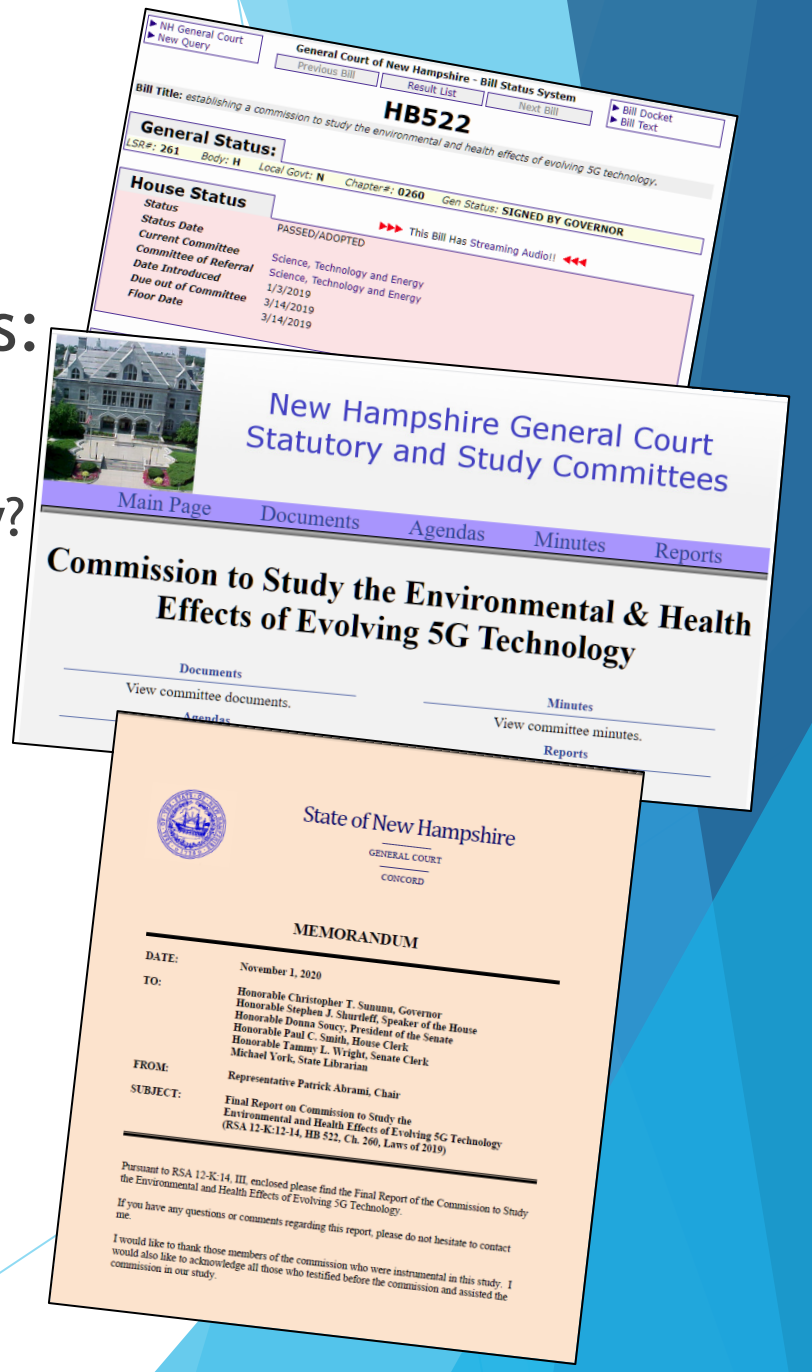
Legal Solutions

- FCC Sued:
  - Environmental Health Trust
  - IRREGULATORS v. FCC
  - Murray v. Motorola
- FDA Petition: Americans for Responsible Technology
- MA Board of Health Legal Guidelines:
  - BoH legally empowered to protect health
  - Pittsfield, MA BoH to Verizon: cease and desist order & citizen lawsuit with CHD
- Fay School ADA: Court recognizes non-thermal biological effects for the first time
- EHS: California Appellate Court holds that Wi-Fi sickness is a disability
- Many other lawsuits



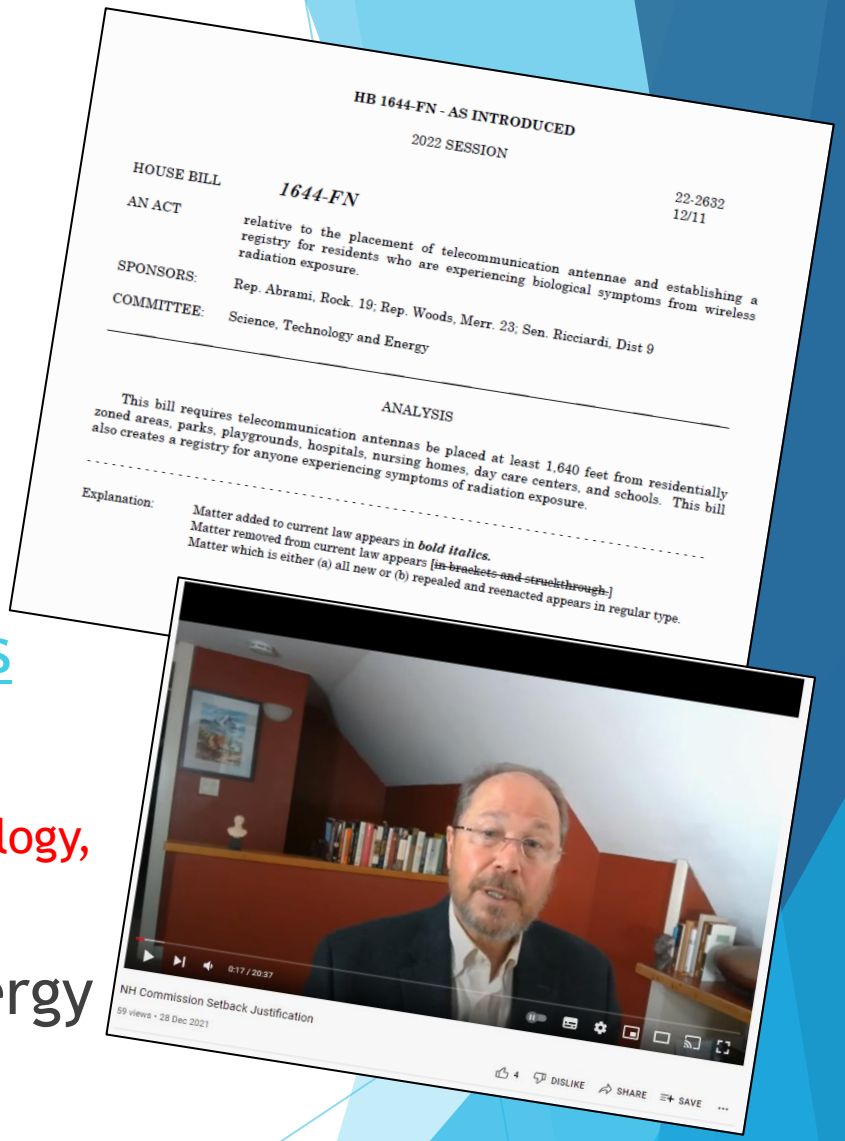
Leading Policy Solutions

- NH Rep. Patrick Abrami -- very pointed questions:
  - Why has the **insurance industry** put in RF exclusions?
  - Why does legal **fine print** say keep distance from the body?
  - Why are 1,000s of peer-reviewed **studies ignored by FCC**?
  - Why do FCC exposure limits not account for the non-thermal, non-ionizing, **biological effects**?
  - Why are **US limits 100 times higher** than other countries?
  - Why is the **cumulative effect** of increasing EMFs ignored?
- New Hampshire 2019 law in less than a year, groundbreaking Commission Report a year later
- Presentation by UNH Dr. Kent Chamberlin w/slides



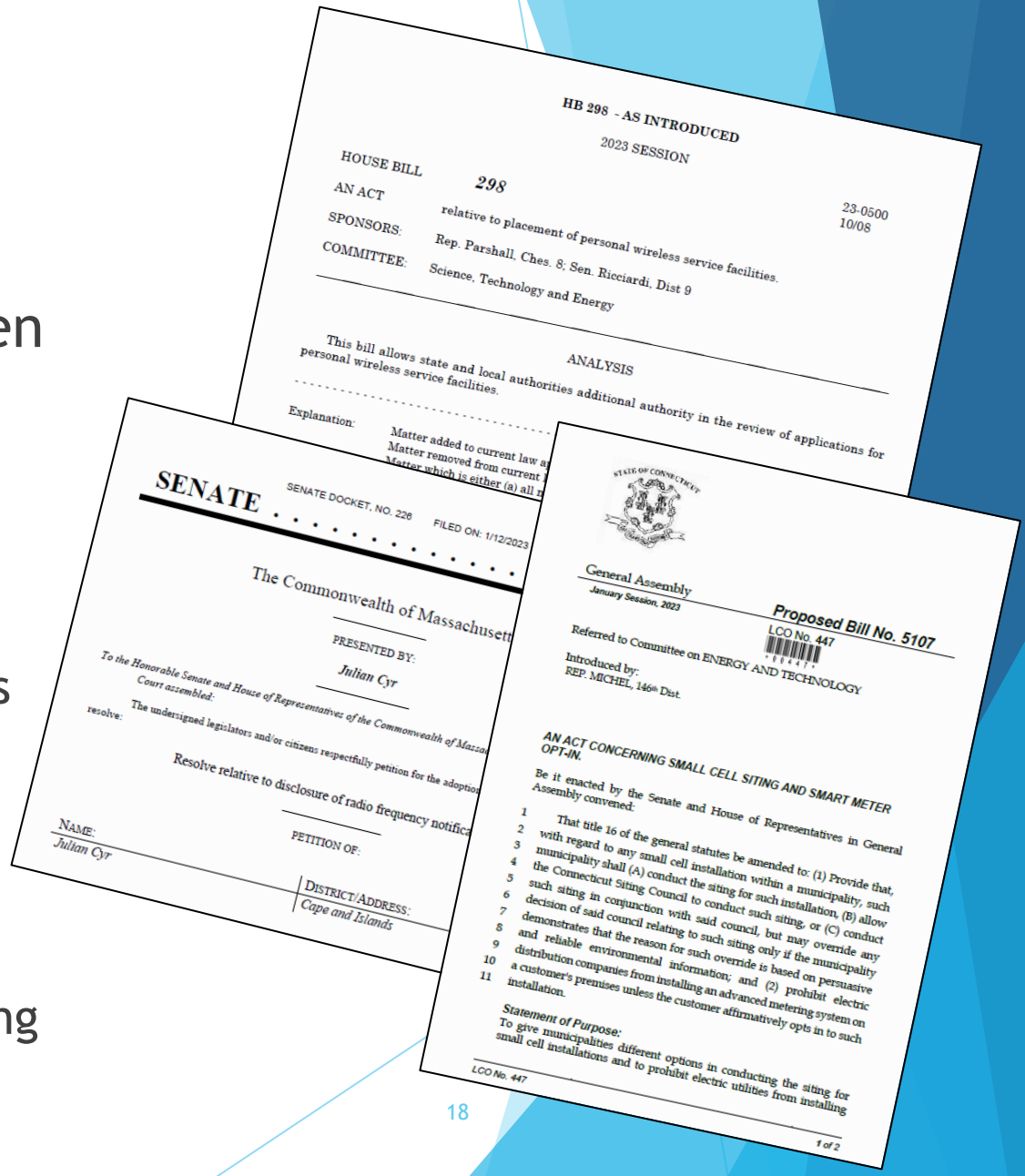
2022 NH Bill

- 2022: NH Rep. Patrick Abrami
  - HB1644, Bi-partisan
  - 1,640’ Setback (500 meters), registry of harm
- Presentation by UNH Dr. Kent Chamberlin w/slides
- Frank Clegg, Retired President Microsoft Canada testimony: “Wireless technology is no longer advanced technology, it has outlived its useful life as a main source of connectivity”
- House Committee on Science, Technology and Energy vote 15:3 to introduce new legislation in January



2023 Bills

- NH HB.298 State & municipal control
- ME LD 697 Birds, bees insects and children
- CT HB-5107 Small cells and smart meters
- MA Bills
  - S.155: Commission
  - S.156: Protect children from handheld devices
  - S.316: Schools
  - S.2152: Smart meter choice, emergency bill
  - S.1044: Civil rights
  - H.2158: EMS recognition, registry and reporting
- Bills in Other States


HB 298 - AS INTRODUCED

2023 SESSION

HOUSE BILL 298

AN ACT relative to placement of personal wireless service facilities.

SPONSORS: Rep. Parshall, Ches. 8; Sen. Ricciardi, Dist 9

COMMITTEE: Science, Technology and Energy

ANALYSIS

This bill allows state and local authorities additional authority in the review of applications for personal wireless service facilities.

SENATE

The Commonwealth of Massachusett

PRESENTED BY:

Julian Cyr

Resolve relative to disclosure of radio frequency notifica

NAME: Julian Cyr

DISTRICT/ADDRESS: Cape and Islands

General Assembly

January Session, 2023

Proposed Bill No. 5107

LCO No. 447

Referred to Committee on ENERGY AND TECHNOLOGY

Introduced by:

REP. MICHEL, 146th Dist.

AN ACT CONCERNING SMALL CELL SITING AND SMART METER OPT-IN.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

That title 16 of the general statutes be amended to: (1) Provide that, with regard to any small cell installation within a municipality, such municipality shall (A) conduct the siting for such installation, (B) allow the Connecticut Siting Council to conduct such siting, or (C) conduct such siting in conjunction with said council, but may override any decision of said council relating to such siting only if the municipality demonstrates that the reason for such override is based on persuasive and reliable environmental information; and (2) prohibit electric distribution companies from installing an advanced metering system on a customer's premises unless the customer affirmatively opts in to such installation.

Statement of Purpose:

To give municipalities different options in conducting the siting for small cell installations and to prohibit electric utilities from installing

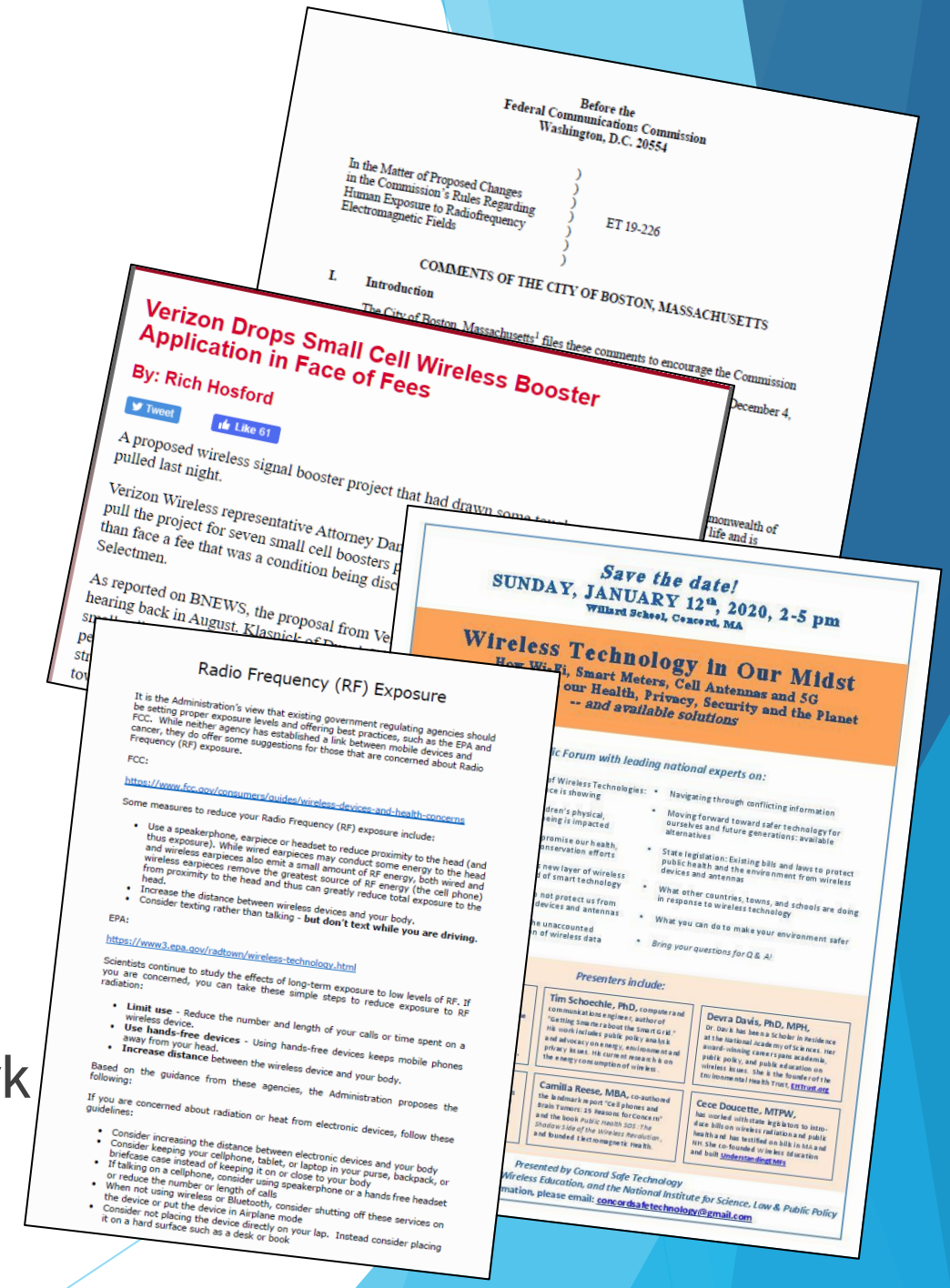
Public Taking Action

- 150+ national groups
- Cell towers in MA
  - Shelburne, MA 1,500’ setback in bylaw, 3,000’ from schools
  - Wayland 900’ setback in bylaw
  - Pittsfield Board of Health unanimous vote to issue Verizon cease and desist
  - Dover-Sherborn Regional won
  - Concord relocating tower
  - Petersham AT&T height waiver denied
  - Centerville Concerned Citizens @ Cape Cod
  - Holliston wireless antennas on power lines



MA Towns Taking Action

- City of Boston files with FCC
- City of Boston sues FCC
- Burlington Small Cell Policy
  - National example with Americans for Responsible Technology
    - Bedford, Lincoln, Andover adopting Burlington
- Shrewsbury Board of Health
- Concord Expert Forum 300+
- Worcester schools RF statement
- Ruskin Road Neighborhood Forum, Hyde Park with Mike Lynch, Broadband & Cable Office



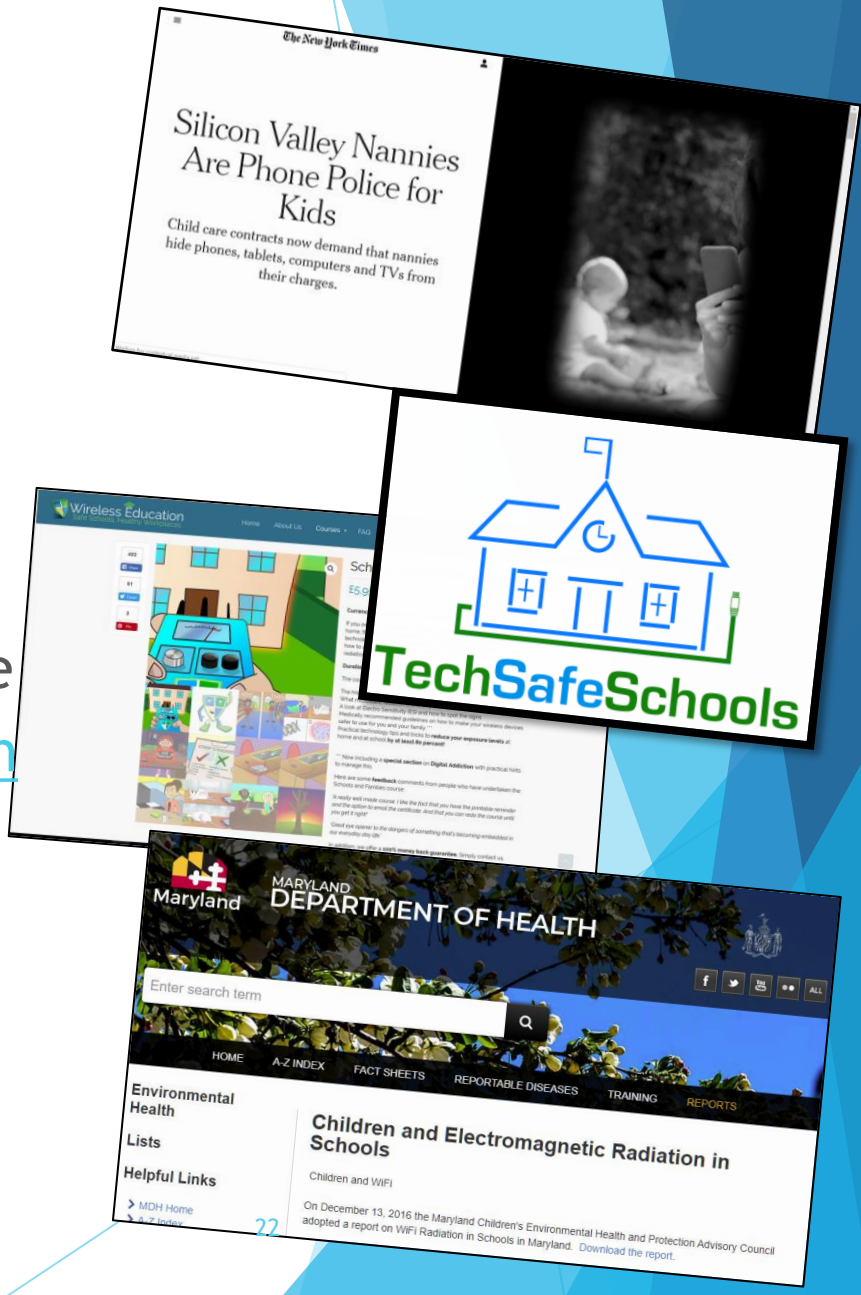
Public Servants Taking Action

- Easton, CT 5G moratorium
- Hawaii County bans 5G
- Worldwide actions



School Actions

- New York Times: Silicon Valley execs banning screens from their children
- **TechSafe Schools national program!**
- Curriculum & Professional Development
- Wireless Education's Schools & Families on-line course
- Extensive printable resources at Environmental Health Trust
- Maryland first public health agency to recommend hard-wiring in schools, see fact sheet
- U.S. Collaborative for High Performance Schools low-EMF best practices
- Cyprus safety recommendations for study at home



Professional Solutions

- Health Care Training
  - EMF Medical Conference & Letter
  - EMF Textbook
  - Physicians for Safe Technology



- Engineers, physicists, technologists, architects, etc.
  - Clegg et al., Building science and radiofrequency radiation: What makes smart and healthy buildings, Building and Environment, 2019
  - Heroux et al., Cell Phone Radiation Exposure Limits and Engineering Solutions, Int. J. Environ. Res. Public Health, 2023
  - Silicon Valley engineer Jeromy Johnson TEDx Talk, additional info for engineers and physicists

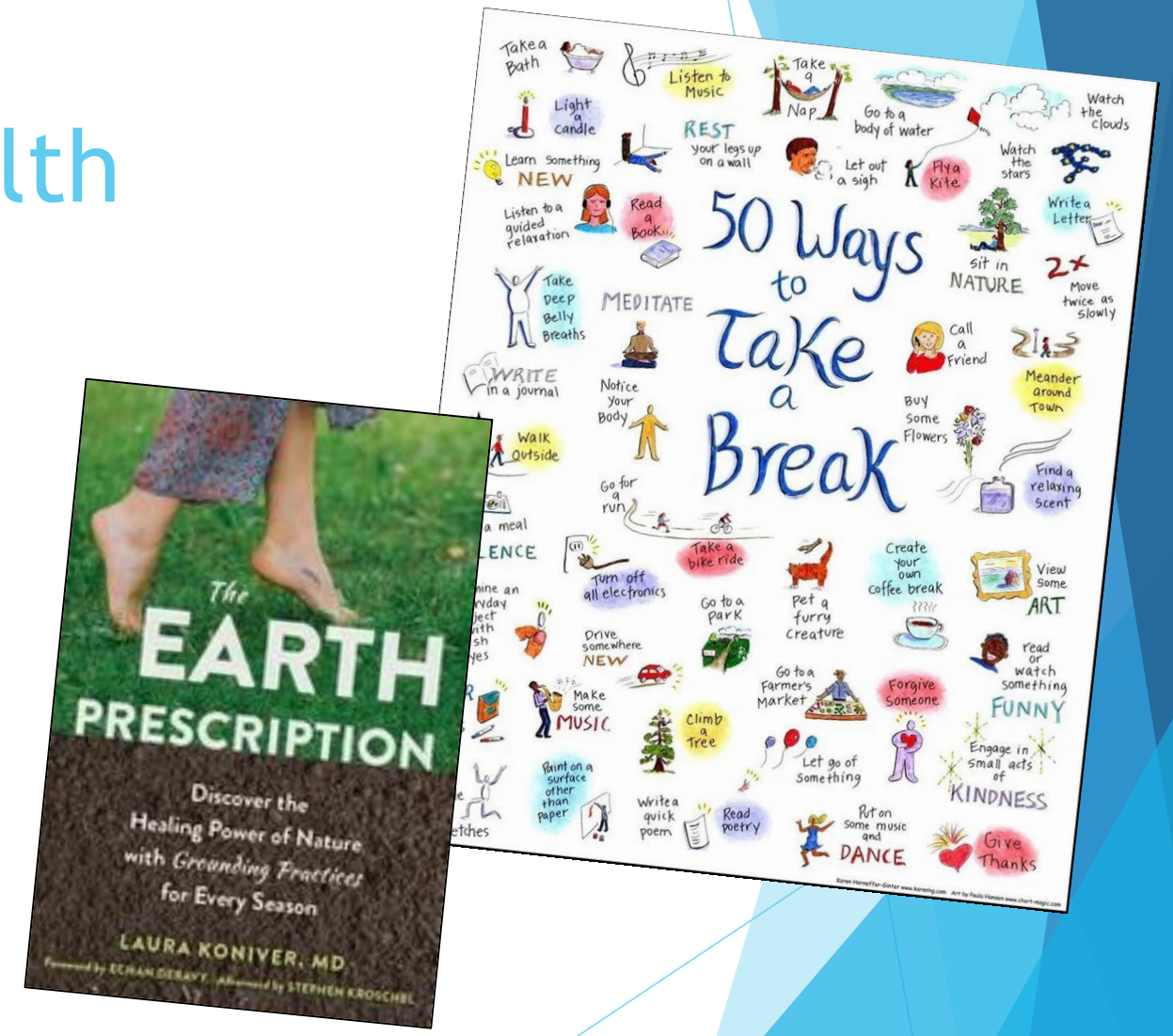
Home & Work Solutions

- Building Biology Institute consultants
- Award-winning film Generation Zapped
- PBS Burt Wolf 1808 & 1809
- Americans for Responsible Technology Tool Kit



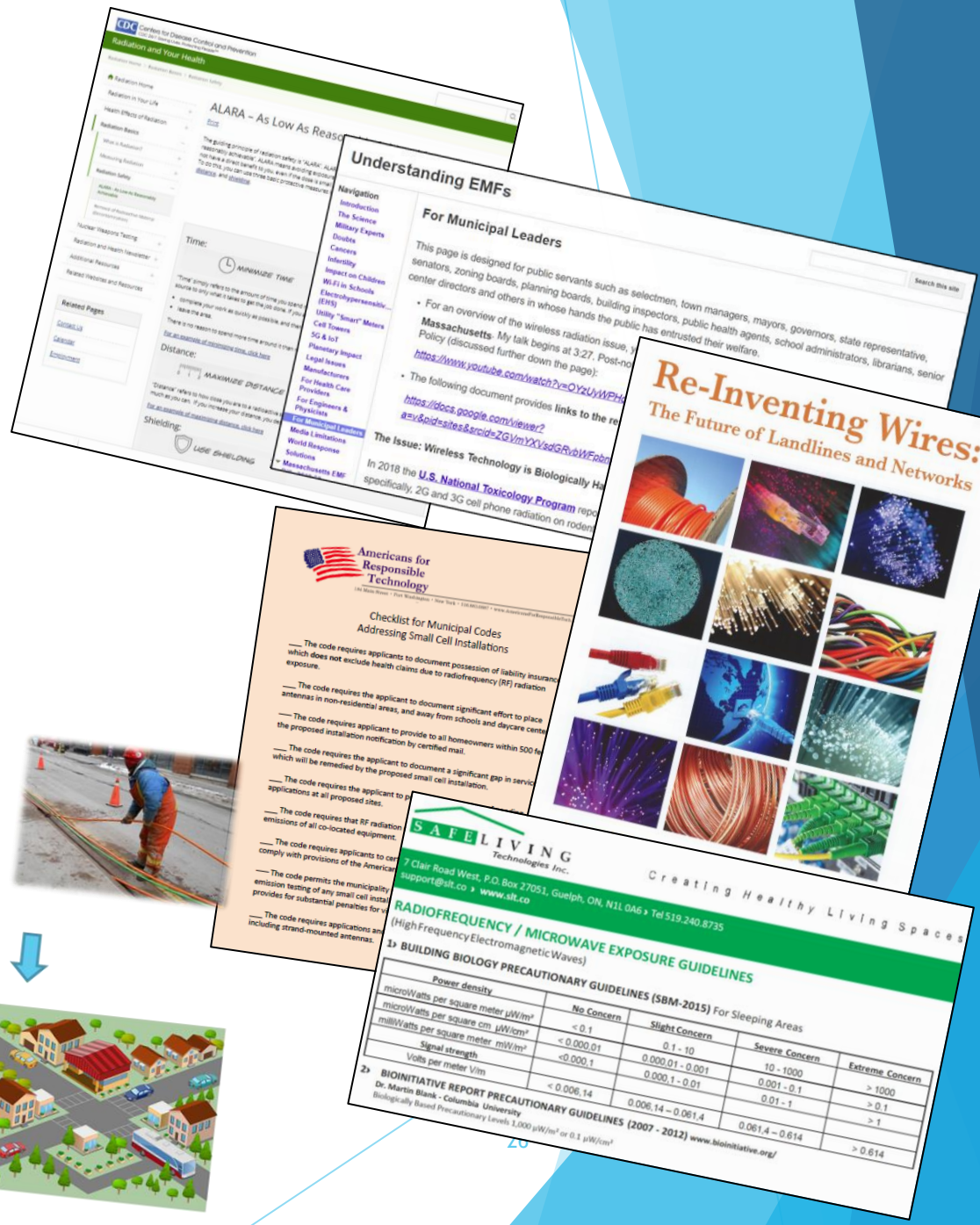
Safe Tech Solutions: Physical & Mental Health

- Avoid excessive screen time
  - Set limits for yourself and children
  - Model good behavior
- 50 Ways to Take a Break
- The Earth Prescription



Safe Tech Solutions: Municipal Level

- ALARA, As Low As Reasonably Achievable (CDC)
- Investigate:
  - Resources for Municipal Leaders
- Differentiate industry priorities vs. public's
  - *Reinventing Wires: The Future of Landlines and Networks*
- Measure vs. biological effects



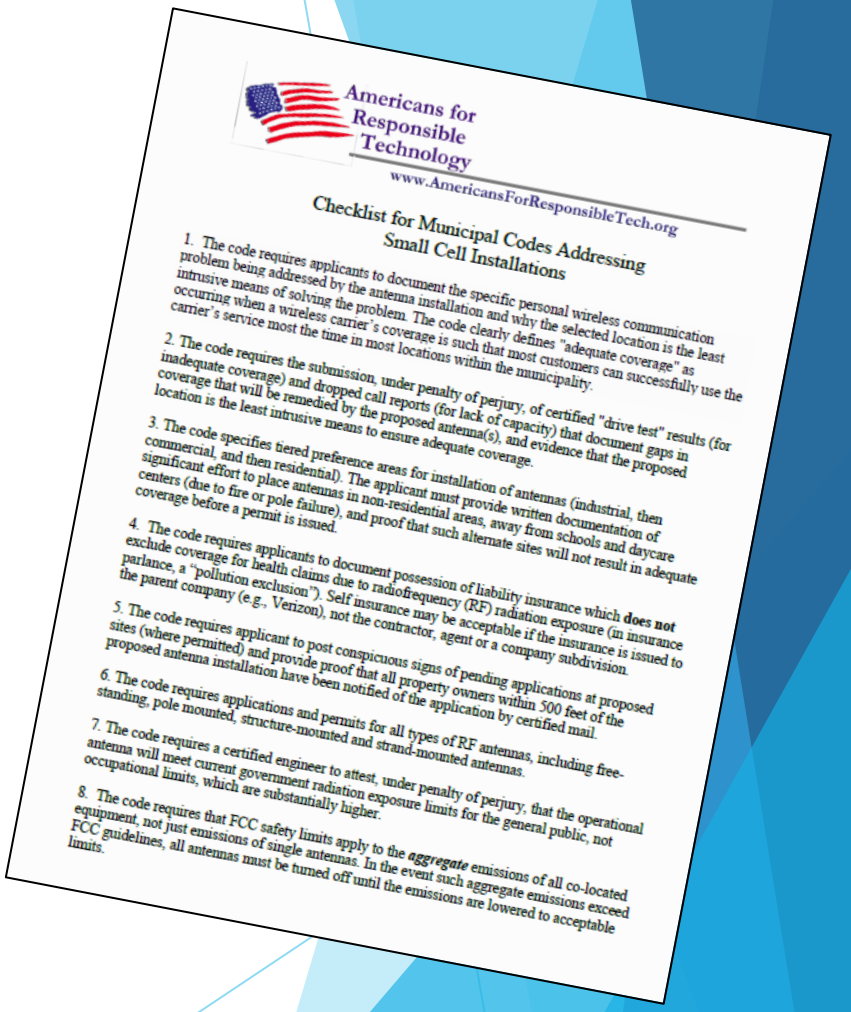
Next Steps

- No safe level of EMF/RF
- Dr. Linda Birnbaum: Need state efforts
- Educate the public
  - Upcoming info sessions
  - Sponsor public/regional forums (Tri Town Health Department, Hanscom Area Towns Selectboard)
  - Train schools & staff on safe tech ASAP
  - Engage professional associations (Municipal, Schools, AFL/CIO, Nurses Assoc., Children's Alliance, etc.)



Next Steps

- Local:
  - Form town-wide tech safety committees
  - Offer no-fee “smart” meter opt-out
  - Transition to hard-wired in public spaces
  - Strengthen wireless communication facility by-laws: Americans for Responsible Technology tool kit
  - National Attorney Andrew Campanelli



Americans for Responsible Technology

www.AmericansForResponsibleTech.org

Checklist for Municipal Codes Addressing Small Cell Installations

1. The code requires applicants to document the specific personal wireless communication problem being addressed by the antenna installation and why the selected location is the least intrusive means of solving the problem. The code clearly defines "adequate coverage" as occurring when a wireless carrier's coverage is such that most customers can successfully use the carrier's service most the time in most locations within the municipality.

2. The code requires the submission, under penalty of perjury, of certified "drive test" results (for inadequate coverage) and dropped call reports (for lack of capacity) that document gaps in coverage that will be remedied by the proposed antenna(s), and evidence that the proposed location is the least intrusive means to ensure adequate coverage.

3. The code specifies tiered preference areas for installation of antennas (industrial, then commercial, and then residential). The applicant must provide written documentation of significant effort to place antennas in non-residential areas, away from schools and daycare centers (due to fire or pole failure), and proof that such alternate sites will not result in adequate coverage before a permit is issued.

4. The code requires applicants to document possession of liability insurance which **does not** exclude coverage for health claims due to radiofrequency (RF) radiation exposure (in insurance parlance, a "pollution exclusion"). Self insurance may be acceptable if the insurance is issued to the parent company (e.g., Verizon), not the contractor, agent or a company subdivision.

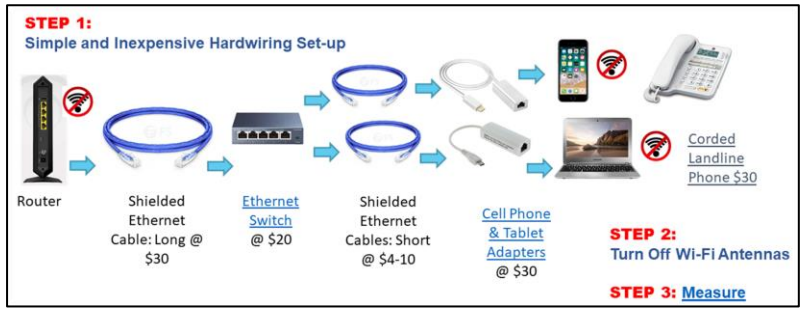
5. The code requires applicant to post conspicuous signs of pending applications at proposed sites (where permitted) and provide proof that all property owners within 500 feet of the proposed antenna installation have been notified of the application by certified mail.

6. The code requires applications and permits for all types of RF antennas, including free-standing, pole mounted, structure-mounted and strand-mounted antennas.

7. The code requires a certified engineer to attest, under penalty of perjury, that the operational antenna will meet current government radiation exposure limits for the general public, not occupational limits, which are substantially higher.

8. The code requires that FCC safety limits apply to the ***aggregate*** emissions of all co-located equipment, not just emissions of single antennas. In the event such aggregate emissions exceed FCC guidelines, all antennas must be turned off until the emissions are lowered to acceptable limits.

For Today

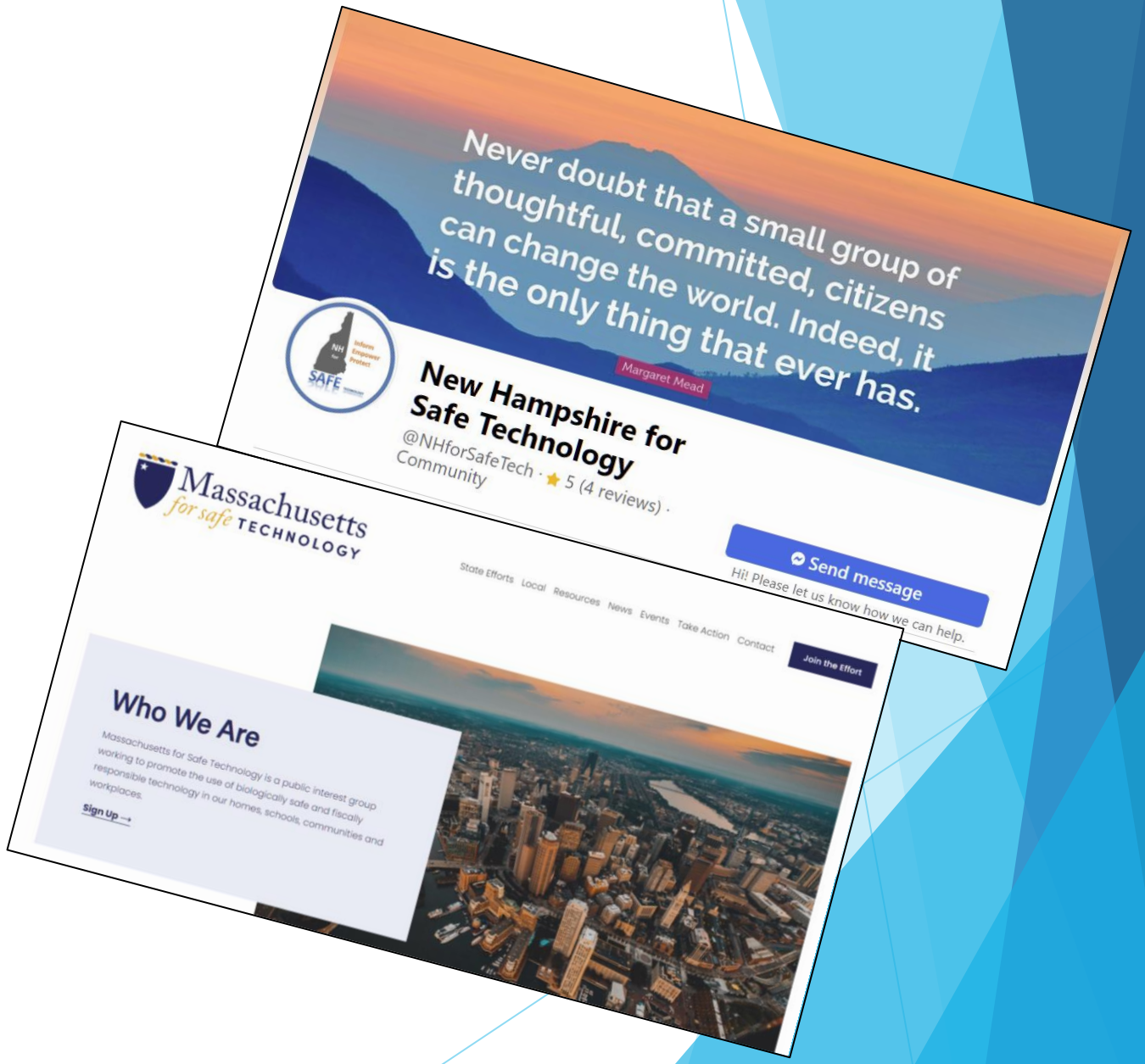


- Reduce your exposures
  - Notice what is radiating
  - Start with baby steps
    - Create a sleep sanctuary
    - Ethernet cables and adapters
    - Choose airplane mode
  - Environmental Health Trust Resources



Thank You!

- New Hampshire for Safe Technology
- NewHampshireforSafeTechnology@gmail.com
- Massachusetts for Safe Technology
- MA4SafeTech@gmail.com



The Municipal Art Society of New York
MASNYC

488 Madison Avenue, 19th Floor
New York, NY 10022
212 935 3960
MAS.org

June 6, 2023

Jennifer Gutiérrez
New York City Council
City Hall
New York, NY 10007

Dear Chair Gutiérrez,

MAS is pleased that the New York City Council Committee on Technology is holding an oversight hearing on the installation of new 32-foot tall Link5G towers across the city. We have heard from many constituents raising concerns about the poor design of these oversized installations, their adverse effect on our streetscapes, and the chaotic and opaque review process for their approval.

The City's Office of Technology & Innovation (OTI) should provide the City Council with a public update on the project, including (1) clarification of the process for identifying and approving locations for Link5G towers, including (a) which city agencies must review them, (b) what agency approvals they have received and what were the conditions of these approvals, (c) how the borough presidents are informing residents of the installations, and (d) how communities have been able to provide feedback on installations in their areas; (2) a detailed list of the siting requirements and siting conditions imposed by all city agencies, with representative illustrations; (3) a list of Link5G installations to date, with equity districts noted; and (4) maps showing all installations to date at the borough, neighborhood and street scale.

Design
The Link5G structures are poorly designed and oversized. Instead of a holistic new design for 5G infrastructure, the city has taken a piecemeal approach. The 5G towers have been forced into the existing LinkNYC design, resulting in a clunky structure sandwiched between signage panels.

The towers are out-of-scale for many residential and commercial areas, especially where narrow sidewalks and lower-scale buildings are prevalent. Link5G will clutter the city's streetscapes, which are already host to many competing uses, resulting in impeded pedestrian flow and blocked views.

Process
The Public Design Commission (PDC) has binding jurisdiction on the design, and approved the installations in limited districts (commercial, commercial overlay, and manufacturing) with strict siting requirements. While reviewing the expansion of the program to residential and historic districts in September 2022, PDC Commissioners asked whether the visual impact could be reduced. They pressed OTI and vendor CityBridge to return to the PDC with a global design comparison, but that has not occurred in a public meeting.

According to the City's presentations to the PDC, Link5G installations in historic areas require review and

approval of the Landmarks Preservation Commission (LPC) and installations adjacent to public parks require review and approval of the Department of Parks & Recreation (DPR). It is unclear if any of these reviews have taken place to date and how they will be administered transparently.

Overall, the review process for the initial installations has been piecemeal and confusing, leading to uneven or nonexistent community engagement, and a lack of clarity on the full effects of 5G towers across the City.

The Federation Communications Commission has only now undertaken the required historic preservation review (106 Review) for this project in New York City. The Nationwide Programmatic Agreement under which the review will take place seems at first blush to be ill-suited for a project that could potentially effect neighborhoods in every part of the city.

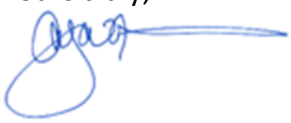
It is also unclear whether the Environmental Assessment for the project was undertaken.

Equity
MAS supports the stated goal of bridging the digital divide and providing wireless and cellular services to underserved communities, but the City has not demonstrated how the initial roll-out will achieve this goal. The City claimed that no installations would be made in Manhattan's core until after installations in high-need neighborhoods have been completed. And yet, the Upper East Side and SoHo have been selected for an initial roll-out of new towers. Furthermore, don't our lower-income neighbors also deserve well-designed streetscape structures?

There are additional questions about the financing of the towers, which ones will have advertising screens, which ones will replace the older, obsolete kiosks, and where the new towers will be distributed across the entire city.

We urge the City Council to seek answers to all of these questions about the new 5G towers.

Yours truly,



Elizabeth Goldstein
President

cc: Hon. Adrienne Adams, Speaker

ACLU of New York

Legislative Affairs
125 Broad Street
New York, NY 10004
212-607-3300
www.nyclu.org

Testimony of Daniel Schwarz

On Behalf of the New York Civil Liberties Union

Before the New York City Council Committee on Technology

Regarding the Oversight of LinkNYC

June 7, 2023

The New York Civil Liberties Union ("NYCLU") respectfully submits the following testimony regarding the oversight of LinkNYC. The NYCLU, the New York affiliate of the American Civil Liberties Union, is a not-for-profit, non-partisan organization with eight offices throughout the state and more than 180,000 members and supporters. The NYCLU's mission is to defend and promote the fundamental principles, rights, and values embodied in the Bill of Rights, the U.S. Constitution, and the Constitution of the State of New York. The NYCLU works to expand the right to privacy, increase the control individuals have over their personal information, and ensure civil liberties are enhanced rather than compromised by technological innovation.

LinkNYC, the public WiFi kiosks, run by a consortium of companies including Alphabet (*Google*) subsidiary Sidewalk Labs, has after nine years of operation still not disclosed a detailed list of the thirty sensors included in the kiosks nor how LinkNYC uses the personal information it collects in its ad-driven business model.[1] Further, the severely overdue and fairly limited audit by the Office of Technology and Innovation (OTI) of LinkNYC found several violations of its privacy policy. And despite littering the streets with thousands of sensors, the project has also failed to deliver on its promise to improve New Yorkers' access to the internet and close the digital divide, as kiosks are primarily located in more affluent neighborhoods[2] and do not offer

[1] Ava Kofman, *Are New York's Free LinkNYC Internet Kiosks Tracking Your Movements?*, THE INTERCEPT (2018), https://theintercept.com/2018/09/08/linknyc-free-wifi-kiosks/.

[2] *See LinkNYC*, NYC DOITT, https://www1.nyc.gov/site/doitt/initiatives/linknyc.page; see also Annie McDonough, *DoITT head Jessica Tisch's hard line against LinkNYC vendor*, CITY & STATE, Mar. 4, 2020, https://www.cityandstateny.com/articles/policy/technology/doitt-headjessica-tischs-hard-line-against-linknyc-vendor.html ("CityBridge has failed to install 537 promised LinkNYC kiosks – many of which were set to be built in outer boroughs, which suffer[] from a dearth of the kiosks, which provide free WiFi, telephone and device charging services. CityBridge has not installed a single kiosk since the fall of 2018[.]").

the speed and reliability of a broadband connection. Instead of centering community needs, privacy, transparency, and civil liberties protections as base-level requirements, they were unfortunately treated as an after-thought.

"Hypertargeting in the physical world"

From the very beginning of LinkNYC in 2014, transparency and privacy protections were treated as an afterthought and not given the needed attention. In response to NYCLU's concerns, the initial privacy policy was amended in 2017, yet has remained unchanged since. The privacy policy still contains unspecific, ambiguous language, left open to interpretation, and raises many questions particularly in light of the technological capabilities and the vendor's advertisement targeting claims.

Each kiosk is equipped with multiple technologies, including WiFi, Bluetooth, NFC, video cameras, and many sensors, that can facilitate the tracking of people or devices and other data. Taken together at scale at the city level, they allow for vast surveillance powers. It is important to note that the remote technologies allow for the possibility to track pedestrians or devices whether they affirmatively connect to the network or not. Such unwitting data leakage and collection can occur through wireless technologies, such as WiFi and Bluetooth, which emit unique device identifiers when looking for and pinging nearby connections and devices.

And let's be clear, these surveillance aspects are not by accident but are instead core features of the business model which, according to Intersection, promises advertisers highly detailed "audience insights" and allows for "hypertargeting in the physical world." Intersection describes further that "[d]evices connected to WiFi, app-sensing beacons, NFC interactions, and third party data sources can all be anonymously overlaid and aggregated to understand real-time, geospatial audience segmentation." How this is implemented, and which third party data sources are tapped into remains unclear. The vendor materials continue:

> Ads on LinkNYC will respond to the audience nearby much like ads online, showing the right ad to the right people at the right time wherever they are. These data sources also can deliver real-time analytics and a pipeline to programmatic buying.

These central capabilities make it plainly clear how this advertisement model is fundamentally different from prior advertisement billboards at a phone booth or bus stop. Each of the thousands of kiosks continuously collects unknown amounts of data which are aggregated, analyzed, and further processed or shared. Claims of anonymization are worth little without full transparency and independent auditing of how they are implemented and how collected data is leveraged for targeting specific audiences. Given the myriad ways of combining the data with other datasets re-identification is trivial. And the high density of LinkNYC kiosks across the City can result in detailed location information about people's commutes, habits, and associations.

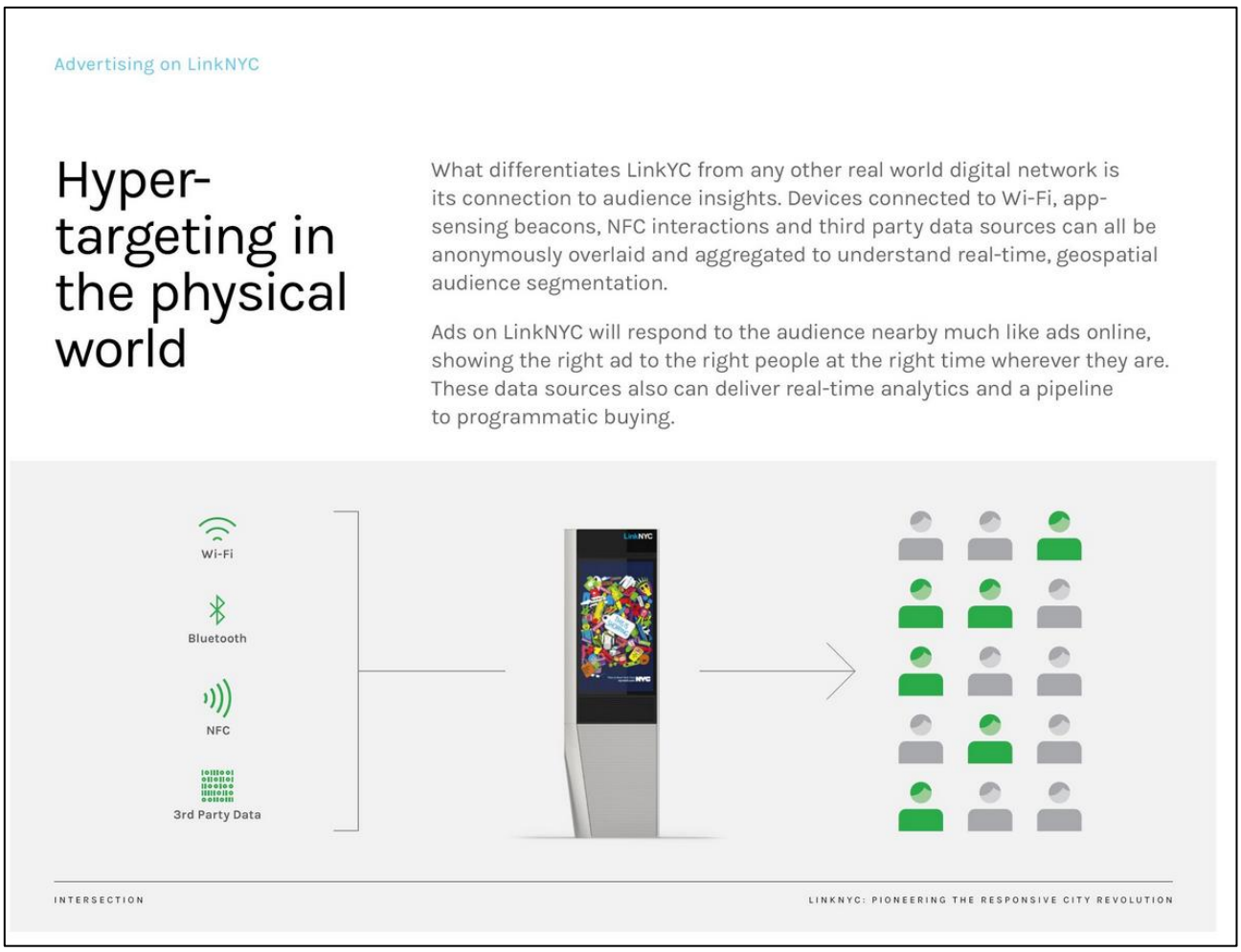


Figure 1: Slide from Intersection, LinkNYC: Pioneering the Responsive City Revolution.

Nonetheless, according to the City, the advertising business model failed and LinkNYC faced bankruptcy. The City agreed to amend the franchise agreement in 2021, switching to a mixed financial model from ad and 5G cell service revenue, and instead of receiving 50% of revenue, only 8% revenue will go to NYC. However, Intersection continues to present the project as highly lucrative in its presentations: for example, a presentation to the City of Los Angeles disclosed that LinkNYC created a revenue of $69 million in 2019.[3] It should also be noted that Intersection purchased the largest municipal advertising company in North America, Titan Outdoor LLC.

In order for the public to clearly assess the situation, *CityBridge* and *Intersection* must be fully transparent about their business model. We need answers about what data are collected, how they are combined, for what purpose, and how they are integrated with other ad services.

[3] Intersection, Technical Proposal, Sidewalk and Transit Amenities Program, p. 28, https://streetsla.lacity.org/sites/default/files/intesection_streetsla_rfp_technical_020821_electronic_redacted5.31.22_%281%29_reducedsize.pdf

We need a comprehensive list of the hardware, and the software needs to be independently audited. Public infrastructure, especially public technology deployed in such fashion across all of New York City can only be sustainable with full democratic oversight. Even City officials tasked with the oversight have apparently no understanding of the technology. Shockingly, OTI Chief Operating Officer McGrath, who testified at the most recent oversight hearing in May 2022 was not even aware of the sensors included in every LinkNYC kiosk and did not know about their Bluetooth capabilities – which, as *Figure 1* illustrates, has been central to Intersection's advertisement claims to prospective clients from the very start.

This ignorance towards the true capabilities is telling. OTI (and DoITT before) has not upheld its much-needed oversight role. When pressed regarding audits, COO McGrath disclosed that OTI had just conducted an audit which "can be released." His statements regarding LinkNYC raised serious doubts about the scope and rigor of this audit, and it would take many months and repeated outside pressure for OTI to finally release this audit.

OTI – KPMG Audit Found Violations of Privacy Policy

The LinkNYC audit was conducted by KPMG from July to December 2021 and was finally released in January 2023[4] – without any announcement, let alone placement on the main LinkNYC website or the LinkNYC project page on OTI's website. Instead, it was quietly added to OTI's reports page in non-chronological order further hindering its discovery by the public.[5]

Although limited in scope, the audit still shows concerning violations of LinkNYC's privacy policy. In light of aforementioned privacy risks exacerbated by Intersection's targeted advertisement offerings, the most troubling finding highlights CityBridge's neglect to anonymize MAC addresses of user devices as stated in their privacy policy and the franchise agreement (PF-01). It is unclear whether OTI or KPMG examined how MAC addresses could be used for tracking and for Intersection's stated advertising goals of "hypertargeting the physical world."

The audit is heavily redacted and entire sections are missing from the published document, which makes it impossible to understand its full scope and the extent to which the system was examined. It is not clear what methodology and testing procedures were used by KPMG, and what level of access they received to the underlying software and systems. It does not appear that the auditors had access to or examined how the ad platform functions and what

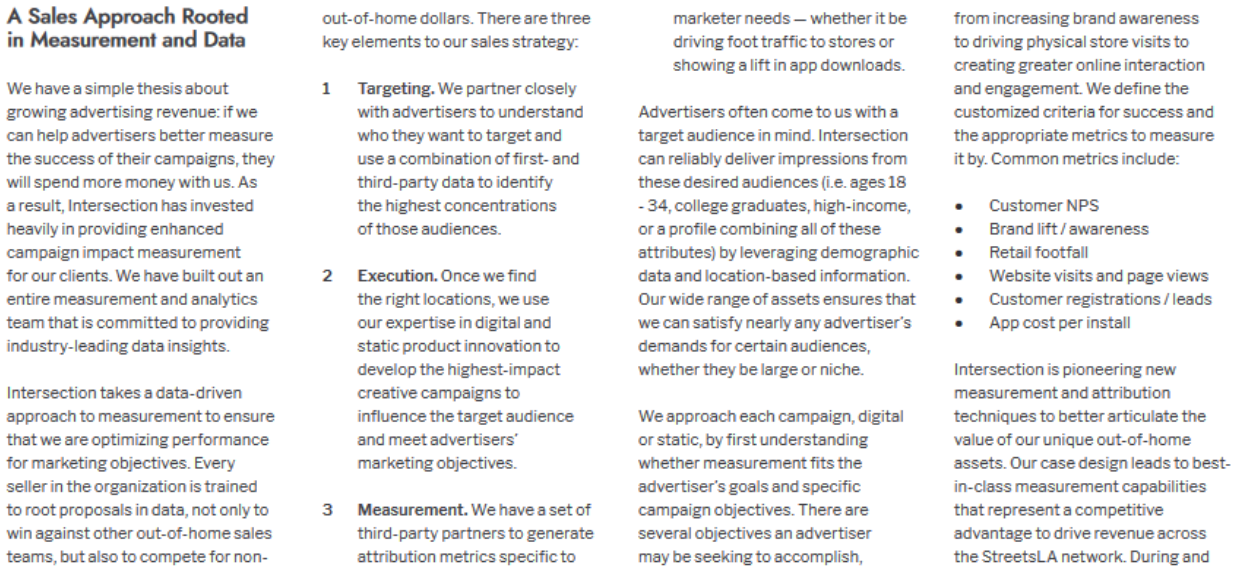
[4] See: OTI Cover Letter, https://www.nyc.gov/assets/oti/downloads/pdf/reports/Cover-Letter-to-Release-of-Privacy-Audit.pdf; KPMG LinkNYC Audit, Privacy Assessment, https://www.nyc.gov/assets/oti/downloads/pdf/reports/LinkNYC-Audit-Report-Privacy-Section-of-March-2022_Redacted.pdf; CityBridge Privacy Assessment Response, https://www.nyc.gov/assets/oti/downloads/pdf/reports/12.16.22-OTI-CityBridge-Letter-re-Privacy-Audit-Remediation-Response.pdf.

[5] Reports - NYC Office of Technology and Innovation - OTI, https://www.nyc.gov/content/oti/pages/reports.

third party data is utilized to analyze, correlate, geolocate, and profile people. We are still left to guess how Intersection's offer of "geospatial audience segmentation" looks in practice and how people's data are leveraged in this process. In a presentation to the City of Los Angeles in 2021, they went into further detail stating they:

> … can reliably deliver impressions from these desired audiences (i.e. ages 18 – 34, college graduates, high-income, or a profile combining all of these attributes) by leveraging demographic data and location-based information. Our wide range of assets ensures that we can satisfy nearly any advertiser's demands for certain audiences, whether they be large or niche.

The audit also offers no insights on the sensors deployed in each kiosk.



A Sales Approach Rooted in Measurement and Data

We have a simple thesis about growing advertising revenue: if we can help advertisers better measure the success of their campaigns, they will spend more money with us. As a result, Intersection has invested heavily in providing enhanced campaign impact measurement for our clients. We have built out an entire measurement and analytics team that is committed to providing industry-leading data insights.

Intersection takes a data-driven approach to measurement to ensure that we are optimizing performance for marketing objectives. Every seller in the organization is trained to root proposals in data, not only to win against other out-of-home sales teams, but also to compete for non-out-of-home dollars. There are three key elements to our sales strategy:

1 **Targeting.** We partner closely with advertisers to understand who they want to target and use a combination of first- and third-party data to identify the highest concentrations of those audiences.

2 **Execution.** Once we find the right locations, we use our expertise in digital and static product innovation to develop the highest-impact creative campaigns to influence the target audience and meet advertisers' marketing objectives.

3 **Measurement.** We have a set of third-party partners to generate attribution metrics specific to marketer needs — whether it be driving foot traffic to stores or showing a lift in app downloads.

Advertisers often come to us with a target audience in mind. Intersection can reliably deliver impressions from these desired audiences (i.e. ages 18 - 34, college graduates, high-income, or a profile combining all of these attributes) by leveraging demographic data and location-based information. Our wide range of assets ensures that we can satisfy nearly any advertiser's demands for certain audiences, whether they be large or niche.

We approach each campaign, digital or static, by first understanding whether measurement fits the advertiser's goals and specific campaign objectives. There are several objectives an advertiser may be seeking to accomplish, from increasing brand awareness to driving physical store visits to creating greater online interaction and engagement. We define the customized criteria for success and the appropriate metrics to measure it by. Common metrics include:

- Customer NPS
- Brand lift / awareness
- Retail footfall
- Website visits and page views
- Customer registrations / leads
- App cost per install

Intersection is pioneering new measurement and attribution techniques to better articulate the value of our unique out-of-home assets. Our case design leads to best-in-class measurement capabilities that represent a competitive advantage to drive revenue across the StreetsLA network. During and

Figure 2: Intersection, Technical Proposal, Sidewalk and Transit Amenities Program.

Provide Privacy-Preserving, Net-Neutral Internet Access

Unsurprisingly, LinkNYC has not been successful in bridging the digital divide. It is not a real solution given its limited reach and inherent advertisement goal. On top of this, new deployments with emphasis on underserved neighborhoods under the equitable deployment mandate have been slow, and only a few kiosks were installed over the last two years. Instead, the City should no longer avoid its responsibility to provide privacy-preserving and net neutral internet access to all New Yorkers. The pandemic has highlighted how crucial internet connections are to participate in society.

Principles and Good Practices for "Smart City" Technologies

The highlighted issues around LinkNYC are emblematic of many "smart city" projects in New York City and elsewhere. Yet we have also seen some encouraging steps in the right direction and commend the City's settlement regarding Verizon's failed fiber rollout in under-resourced communities and for joining the Cities Coalition for Digital Rights and signing its Declaration in 2018.[6] The Cities Coalition for Digital Rights builds on five primary principles: (1) Universal and equal access to the internet, and digital literacy; (2) Privacy, data protection, and security; (3) Transparency, accountability, and non-discrimination of data, content and algorithms; (4) Participatory democracy, diversity, and inclusion; and (5) Open and ethical digital service standards. These set crucial guidelines, yet, unfortunately, the City's actions have fallen far short of these promises, and little has been done to implement these principles.

For "smart city" technologies to deliver on their goals and promises, we urge the City to center and implement these key principles:

- *Internet for All.* High-speed, privacy-preserving, and net-neutral broadband should be universally available and provided for free where needed.

- *Ban Discriminatory Technologies*. Enact bans on technologies that show discriminatory impact or threaten people's fundamental rights.

- *Community Inclusion*. Impacted people need to have a seat at the table throughout the project's lifecycle.

- *Restructuring Procurement*. The City's procurement process must be more transparent and include sufficient information and details for public review.

- *Impact and Risk Assessments.* The City should require agencies to conduct publicly accessible Racial and Non-Discrimination Impact Assessments and Environmental Impact Assessments before acquiring new technologies and throughout their lifecycle.

- *Clear, Concise Privacy Protections and Policies*. Meaningful notice must include information about the data collection, purpose, limitations, access, sharing, storage, and deletion. It must be clear and prominent and be written in plain language at a simple reading level.

- *Privacy by Design*. The City and any involved party must work during all product stages to build privacy safeguards into "smart city" technologies.

[6] Declaration of Cities Coalition for Digital Rights, https://citiesfordigitalrights.org/assets/Declaration_Cities_for_Digital_Rights.pdf.

- *Data Minimization.* Only collect the minimal data needed. Clear limits on initial collection of personal information. Data should not be generated, collected, analyzed, retained, transmitted, or aggregated excessively.

- *Security and Encryption.* Data should be encrypted (in transit and at rest) and communications must be authenticated.

- *Anonymize* data where possible.

- *Minimal Retention.* Only keep data for as long as necessary.

- The default way to give consent must be *Opt-In*, instead of *Opt-Out*. People should be in the position to decide how, when, and why their data is processed and with whom it is shared.

- *Data Ownership* must be with the individual where possible. People must have rights over their personal data, as well as data that is derived, inferred or predicted from their data, actions, and behavior.

- *No Third-Party Access*. Clear limitations on the access, sharing, or selling of data. Information should not be accessible for law enforcement without a warrant. Ban the access by or sharing with federal agencies, including Immigration and Customs Enforcement.

- *Open source and Open Standards*. Avoid proprietary solutions, vendor lock-ins, and long-term dependencies. Adopt initiatives like "Public Money, Public Code," which requires publicly financed software developed for public use to share its source code. Standard, interoperable protocols are in general also more secure and better tested.

- *Auditing and Reviewing Mechanisms*. All systems should be subject to independent, transparent review to ensure – and to assure the public – that such technologies are being used appropriately and treating personal information with the care required.

- *Accountability and Liabilities*. New York City must enable both regulatory oversight, and a private right of action, to remedy any violations of New Yorker's right to control their data.

- *Equitable Access*. Ensure technologies serve people and communities in need, not companies' shareholders.

- *Public Education*. Improve digital literacy and privacy education in order to show New Yorkers how technology, whether used by governments or private companies, impacts their lives.

Conclusion

We thank the Committee for the opportunity to provide testimony. The Council has a crucial role to play in overseeing large-scale tech deployments like LinkNYC, setting much-needed guardrails, safeguarding New Yorkers' privacy interests and rights, and providing broadband access to all New Yorkers.

Old Astoria Neighborhood Association (OANA)
www.OANA-NY.org

NYC COUNCIL TESTIMONY

Technology Committee

June 7, 2023

Good afternoon members of the New York City Council,

I'm proud to testify today on behalf of Old Astoria Neighborhood Association (OANA) about the LinkNYC program. LInkNYC Is an important tool for outreach to businesses, workers, residents, and tourists alike.

LinkNYC's free municipal WiFi and video screen programs are of great value in our neighborhood. Tax free, New Yorkers and visitors have used the wifi network, which includes the internet, free nationwide calling, 911 emergency services, and city services.

The internet access this will provide to areas of equity is of extreme importance to OANA, as our mission of outreach and information sharing to the public saves lives and creates opportunity, especially during but not limited to the COVID Pandemic. Our area includes 3 major public housing campuses, including the largest in the US, Queensbridge, plus Ravenswood and Astoria Houses.

The LinkNYC ad screens are well known for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to civic and community board meetings. Our recent work with NYC Small Business Services "Avenue NYC" program was greatly enhanced by LinkNYC outreach.

LinkNYC has allowed us to tailor our outreach depending on the subject we are dealing with, up to citywide, in a cost-effective manner. We would never be able to extend our services in such a fashion without their help.

We would also advocate for additional kiosks, especially around NYC Ferry landings and NYCHA Campuses.

By expanding the network, including the Link5G component, the awareness of our residents to local issues and opportunities only enhances our democracy.

Old Astoria Neighborhood Association (OANA)
www.OANA-NY.org

Our support of 5G is contingent upon the FDA and FCC's findings advising of their safety to the public, and protection against privacy and data mining issues.

But this is not the only solution. We are also in favor of providing common fiber service to all buildings as a separate program, not only for in home access to all, but also to create a one cable into each residence for all internet providers to use so we eliminate the web of proprietary cables on our streets that create a useless eyesore. Both the fiber and wifi services should work together to provide optimum coverage.

We appreciate the NYC's support of LinkNYC and CityBridge, whose support is essential to OANA's service to our community. We look forward to their continued growth.

Regards

Richard Khuzami

President

PRIDE LIVE™

June 5, 2023

Good morning, Members of the New York City Council,

I'm proud to testify today on behalf of **Pride Live, Inc.** about the LinkNYC program. We've seen first-hand how the LinkNYC program greatly benefits businesses, workers, residents, and tourists alike.

LinkNYC is already the largest free municipal Wi-Fi program in the US, and this has been achieved at zero cost to taxpayers. We've heard that over 10 million New Yorkers and visitors have used the free Wi-Fi network, which has become a lifeline for access to the internet, free nationwide calling, 911 emergency services, and city services. This has been especially critical during and since the COVID-19 pandemic as access to the internet has become more important than ever.

LinkNYC has been a supporter of Pride Live, Inc. since 2002. In 2023, LinkNYC agreed to display and promote the Pride Live visual campaign on screens across several boroughs in New York City. The amplification of this campaign provides visibility to the mission and vision of our organization. Simultaneously, through this partnership, LinkNYC is showing a commitment to the advancement of LGBTQ+ people. New York City is where the modern LGBTQ+ rights movement took shape and LinkNYC is helping to ensure our community is seen.

The Link ad screens have become iconic for their emphasis on local artists and small businesses, as well as important information on everything from wayfinding to community board meetings.

We're excited for the next phase - Link5G. Link5G will bring more of the same free services we know and love to the communities that need them the most. They will also now have 5G technology which will bring better cell service, faster data speeds, and perhaps most importantly, new fiber infrastructure to enhance broadband access in historically underserved communities. We're glad that the City and CityBridge have figured out an innovative way to continue and expand this critical program.

CityBridge has been a fantastic partner and LinkNYC is a critical program for our city. We look forward to seeing the program's continued success.

With Pride,

Diana Rodriguez
Founder
Pride Live, Inc.

Pride Live is a 501(c)3 organization dedicated to accelerating awareness and support for the LGBTQ+ community via social advocacy and community engagement to advance the fight for full equality.

SAVE GANSEVOORT

92 Horatio St. #5i, New York NY 10014 • 212 633-2040 • info2@statesofcontrol.com

Testimony before New York City Council Committee on Technology
Oversight Hearing on LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.
June 7th, 2023

Dear Chair Gutiérrez and members of the Committee,

Thank you for this opportunity to testify. Save Gansevoort is a community organization that works on landmarking, zoning, and quality of life issues in the western portion of Manhattan Community Board 2.

I'd like to discuss the multiple problems with the siting process for the LinkNYC 5G towers, giving examples from our own community.

The New York Office of Technology and Innovation (OTI) and CityBridge have emphasized the detailed guidelines and multiple layers of review that govern the siting process. But reviews are meaningless if project planners never analyze the results and respond to complaints and suggestions. And guidelines are meaningless if they are routinely ignored.

On January 16th, 2023, Manhattan Borough President Mark Levine sent a letter to OTI expressing detailed concerns about the LinkNYC 5G tower project. As of today he has received no response.

On February 1st, 2023, our local elected officials —State Senator Brad Hoylman-Sigal, State Senator Brian Kavanagh, Assemblymember Deborah Glick, and Council Member Erik Bottcher—sent a joint letter to OTI asking for a moratorium on the construction of these towers. To the best of my knowledge, there has been no response.

On January 20, 2023, Community Board 2 sent OTI a detailed 3 page resolution requesting a moratorium on the construction of these towers. There has been no response.

But in this last case, the problem is not just that OTI failed to respond. OTI and CityBridge told CB2 that they were still reviewing comments and that there was therefore still time to consider CB2's input. However, a mere 10 days later CityBridge started pouring foundations for two LinkNYC 5G towers on Washington Street. Given the lead times necessary to survey the sites and schedule construction, the decision to proceed with these towers must have already been made before the CB2 hearing took place.

Furthermore, OTI and Citybridge have regularly failed to follow their own guidelines. On the basis of the "definitive" list of tower locations presented to CB2 by CityBridge's Robert Sokota:

A tower has been sited at 445 West Street, immediately adjacent to Westbeth, a designated individual landmark. This violates the guideline that no tower can be sited next to an individual landmark.

Two towers have been sited on one block of Horatio Street, at 100 and 113 Horatio. This violates the guideline that no more than one tower will be located on each block.

The towers sited at 113 Horatio Street and 108 Gansevoort Street are both within the Gansevoort Market Historic District, and both will contain illuminated advertising screens. This violates the guideline that advertising screens are not allowed on towers within historic districts.

There are towers placed less than 8' from trees, placed so that there is less than an 8' width of sidewalk for pedestrians, placed so that they block Stop signs—all in violation of the guidelines.

If OTI and CityBridge have made such a mess of the siting process, how can we trust that they will be able to avoid going bankrupt, efficiently bring broadband access to underserved communities, and insure that the 5G towers are being operated in compliance with all federal safety standards, inadequate as those standards may be?

Sincerely,

Zack Winestine

Co-founder, Save Gansevoort

SOHO BROADWAY INITIATIVE

594 BROADWAY, SUITE 1107
NEW YORK, NY 10012

T. 212.390.1131
SOHOBROADWAY.ORG

June 9, 2023

Re: Oversight – LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City

Dear Chair Gutiérrez and Members of the Committee on Technology:

My name is Mark Dicus, Executive Director of the SoHo Broadway Initiative. We are the not-for-profit organization that manages the neighborhood-focused business improvement district on Broadway from Houston Street to Canal Street in Manhattan.

Thank you, Chair Gutiérrez, for holding this week's hearing on the deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.

The City is proposing a Link5G kiosk adjacent to 568 Broadway within the SoHo Broadway Business Improvement District. While our organization supports the expansion of access to 5G, wi-fi, and other amenities provided by this infrastructure, the site proposed is an inappropriate location for such an installation due to a number of specific conditions:

- The intersection of Broadway and Prince is the single most congested sidewalk location within the SoHo Broadway District.
- The adjacent Prince Street subway station, narrow sidewalks, retail stores, upstairs office and residential uses, and existing obstructions including vendors, standpipes, trash receptacles and traffic signals at this intersection have created sidewalk conditions that are presently challenging for pedestrians to navigate at times.
- The proposed site is directly in the path of pedestrians entering and exiting the NYC DOT curb extension on the corner of Prince and Broadway. Adding an additional sidewalk obstruction will negatively impact the pedestrian experience.
- In addition to impacts on pedestrian flow, the ultra-modern 32-foot-tall Link5G kiosk would add visual clutter inappropriate to the internationally recognized historic architecture surrounding it and negatively impact the quality of the SoHo-Cast Iron Historic District.

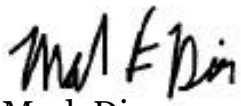
We understand that Citybridge has extensive siting requirements. However, the existing requirements must consider pedestrian safety; kisoks should not block access to curb extensions and not add sidewalk obstructions in areas with significant pedestrian traffic. In historic districts, co-locating this technology on existing infrastructure (e.g. street lights) should be prioritized.

In addition to our concerns about the placement of Link5G kiosks, recent sidewalk repair work in front of 458 Broadway permitted by DOT and related to Citybridge's payphone removal/replacement program has resulted in significant damage to the basement of the building.

Moving forward, permit applicants should contact the office of the Community Board or Business Improvement District in advance of any future work relating to Citybridge's payphone removal/replacement program or to any LinkNYC-related work, along with contacting impacted property owners.

Thank you Chair Gutiérrez and fellow Committee members for your consideration of this testimony. The SoHo Broadway Initiative is eager to work with the Committee, our own Council Member Chris Marte, Borough President Mark Levine and Manhattan Community Board 2 in ensuring technology infrastructure is installed locally in a way that is sensitive to pedestrians, property owners, and the historic context of SoHo.

In partnership,



Mark Dicus
Executive Director

COMMENTS OF THE SURVEILLANCE RESISTANCE LAB
New York City Council
Committee on Technology

Hearing: "Oversight – LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City"

June 7, 2023

Ed Vogel, Senior Policy Researcher, Surveillance Resistance Lab

Introduction

By notice published on May 25, 2023, the New York City Council Committee on Technology requests public testimony on the topic of "Oversight – LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City."

Pursuant to the Committee on Technology's notice, the Surveillance Resistance Lab (the Lab) submits these comments as an organization focused on how government use of technological solutions impacts democracy and equity. The Lab has major concerns regarding how the LinkNYC program has failed to meet its promises of equitably delivering high quality WiFi to all New York residents.

This history of LinkNYC illustrates that the cost of free WiFi was the cultivation of a data mining and surveillance infrastructure throughout NYC. As a function of its use, LinkNYC extracts data from its users for the primary purpose of selling it to advertisers for highly tailored, "context aware" advertising, offsetting the cost of its installation. By contracting with a consortium of companies to deliver this as a solution to the digital divide, the City chose to have the private sector respond to a structural inequity, a problem that market-based solutions are not equipped to fix. Rather than equitably addressing the digital divide, the LinkNYC business model created another problem: infrastructure that relies on surveilling our communities to survive.[1] This model violates our civil rights and liberties and has the potential to facilitate further criminalization of New York's communities who are most acutely experiencing the worst of these digital inequities. LinkNYC epitomizes what the City loses if we do not consider the risks to civil and human rights at the core of digital infrastructure roll-out. At the foundation of LinkNYC is a structural failure in how the program was designed.

The program is a case study in the challenges the City faces when transparency and accountability are not guiding the design, development, and implementation of large-scale technological solutions. The Lab is committed to working with the City to ensure that technological solutions do not become police and corporate surveillance tools which exacerbate inequality.

[1] https://www.link.nyc/privacy-policy.html#info_collect

Background

Announced in 2014 by then Mayor de Blasio, LinkNYC was framed as a program to deliver free WiFi to New York City's residents without access. LinkNYC would replace the City's technologically outdated payphone infrastructure with kiosks for accessing WiFi, making calls, and charging devices, among other uses. All of this was promised to be free of charge to users and as a revenue generator for the City, as a way of addressing the digital divide which plagued the City, but also at "no-cost to taxpayers" as the program would be entirely funded through advertising revenues. Through a competitive bid process, CityBridge, which is a consortium of companies, was chosen to develop and implement the LinkNYC program.[2] The program launched in 2016 with a goal of installing between 7,500 - 10,000 kiosks and promised to generate more than $500 million in revenue for the City. While all of the data that the kiosks collected would be owned by CityBridge, the Mayor's office promised that the program would provide the "most user-centric privacy policy of any public WiFi network."[3] To date, more than 2,000 LinkNYC kiosks and towers in total have been installed across the City's boroughs.[4]

Concerns and Controversies

While seemingly well-intentioned, controversy has plagued the program, exposing its structural flaws. Within weeks of the debut of the first kiosk, the New York Civil Liberties Union (NYCLU) and the Electronic Frontier Foundation[5] raised concerns regarding the volume of data that LinkNYC could gather and the lack of clear data retention schedules for this data. NYCLU warned that the City was willingly participating in the corporate development of a massive database of user data which held all of the same problems of other large corporate databases—the possibility for data breaches of sensitive information and invasive surveillance by law enforcement like the New York Police Department.[6] At the time, LinkNYC's privacy policy did not contain explicit language regarding data sharing with the police. Despite these concerns, the City continued its partnership with CityBridge.

In 2017, one of the companies in CityBridge's corporate consortium, Intersection, was in the news for raising $150 million in financing in order to expand free WiFi services into more cities across the world. While LinkNYC was still in the initial phase of rolling out kiosks, investors felt confident in the model's ability to collect enough data to make the context-aware advertising revenue structure sustainable. Prior to this infusion of funds, earlier investors in Intersection included Sidewalk Labs, a company owned by Google. Sidewalk Labs designed a failed

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[2] https://www.theverge.com/2020/3/5/21166057/linknyc-wifi-free-kiosk-google-new-york-sidewalk-labs-payments-revenue

[3] https://observer.com/2016/02/de-blasio-unveils-linknyc-wifi-kiosks-with-promises-to-protect-privacy/

[4] https://www.link.nyc/find-a-link.html

[5] https://www.eff.org/deeplinks/2017/09/linknyc-improves-privacy-policy-yet-problems-remain

[6] https://www.aclu.org/press-releases/nyclu-citys-public-wi-fi-raises-privacy-concerns

proposal for a sensor-laden data collecting area in Toronto which it abandoned after facing much opposition.[7]

Despite Intersection's ability to raise substantial capital for expansion, LinkNYC hit snags in meeting the initiative's contracted promises. In March 2018, *Politico* reported that LinkNYC had installed about 1,800 kiosks with a goal of installing 4,500 by mid-2019. Additionally, most of the kiosks weren't installed in the City's neighborhoods that lacked adequate access to the internet, an early indicator that LinkNYC was not primarily focused on addressing the digital divide.[8]

Then, in May 2018, an undergraduate student at the New York City College of Technology stumbled upon CityBridge's public library for LinkNYC on GitHub, a platform used to share and develop source code, among other uses. This student found that LinkNYC's code "collects user's longitude and latitude, as well as the user's browser type, operating system, device type, device identifiers, and full URL clickstreams (including date and time) and aggregates this information into a database."[9] Based upon the student's research, LinkNYC's code would allow CityBridge to track users' locations and deliver advertisements in real-time, which was a violation of the program's privacy policy. As expected, LinkNYC denied that they were tracking users' locations in real-time but the *Intercept* did confirm with multiple technologists that the code had the potential to track precise locations, whether or not LinkNYC was tracking precise locations is another question.[10] In response, LinkNYC demanded that GitHub remove the copy of their code that the undergraduate student had made, calling it a copyright violation. LinkNYC continued its growth and expansion across New York, unabated.

April 2019 brought renewed concerns to LinkNYC in response to an arrest of a man who vandalized 42 of the kiosks across the city.[11] His arrest added public concern to what NYCLU and the undergraduate student had previously identified–the sheer volume of data that the kiosks were collecting about people. The footage recorded by the kiosks of the man smashing the kiosks' screens prompted questions about why the kiosks had cameras in the first place. As reported by the *Intercept*, cameras were added to the kiosks in 2017 and LinkNYC was retaining footage for seven days in order to improve the services of the program. With no public dialogue or warning, this new layer of surveillance was added and there was no mechanism to opt-out. At the public hearing on June 7th, 2023, CityBridge did state that cameras on the kiosks had been mostly turned off since 2020, which begs the question that if the cameras are turned off, should the cameras be removed from the kiosks in general. Over time, more information surfaced as to

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[7] https://www.technologyreview.com/2022/06/29/1054005/toronto-kill-the-smart-city/s

[8] https://www.politico.com/states/new-york/albany/story/2020/03/03/city-hall-calls-google-backed-linknyc-consortium-delinquent-1264966

[9] https://theintercept.com/2018/09/08/linknyc-free-wifi-kiosks/

[10] https://theintercept.com/2018/09/08/linknyc-free-wifi-kiosks/

[11] https://gothamist.com/news/yes-linknyc-kiosks-are-giant-data-harvesting-surveillance-cameras-obviously

the extent to which these kiosks were amplifying the existing large surveillance apparatus in place across the city.

Later that year, it was reported that the program was not hitting its revenue targets. At the time, there were about 1,800 kiosks across the City and the program had seen a revenue shortfall of more than $21 million between 2015-2018 with expected losses both in 2019 and 2020. The City's contract with CityBridge should have been lucrative for the company as the terms were friendly to CityBridge.[12] Yet LinkNYC was not as profitable as CityBridge expected.[13] In March 2020, the *New York Post* reported that CityBridge had yet to pay more than $30 million that was owed from 2019 and had not made any payments towards the $43 million that was owed by June 30, 2020.[14] These early problems demonstrated that the program's revenue model threatened the integrity of the program in general. In 2020, the head of the City's Department of Information Technology and Telecommunications (DoITT) testified that the City was considering ending its contract for LinkNYC as the program was behind on deploying 537 kiosks and owed the City $75 million, per the terms of the contract. While the Department representative stated that the City's "patience was up,"[15] the contract remained, LinkNYC persisted, and continued its slow but steady expansion. Despite these persistent problems, there was a demonstrated desire for public WiFi as it was reported in 2020 that more than 8.7 million people had used LinkNYC since the program launched.[16]

In July 2021, the New York State Comptroller released their multi-year audit of LinkNYC and found the initiative, "to a great extent," did not meet its objectives.[17] It is worth quoting in full the Comptroller's findings: "DoITT did not sufficiently monitor, oversee, and enforce the Consortium's compliance with the Agreement terms, including the collection of almost $70 million due to the City from the Consortium; that the required number of Links were installed according to the specified distribution schedules and equitably distributed in the five boroughs; that Links were activated by the stipulated time frames; that a Gigabit Center was established in each of the five boroughs; and that liquidated damages were assessed and collected for late activation. Our audit identified significant shortfalls, in terms of both revenue to the City and services, that occurred as a result."[18] According to the State Comptroller, LinkNYC's failures

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[12] https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf

[13] https://www.gothamgazette.com/city/8502-city-s-much-heralded-link-kiosks-not-generating-projected-revenue

[14] https://nypost.com/2020/03/03/de-blasios-tech-czar-rips-google-linked-group-for-wifi-kiosks-delays/

[15] https://www.thecity.nyc/2020/3/3/21210474/city-hall-may-pull-plug-on-linknyc-owner-over-missing-kiosks-and-75m-owed

[16] https://www.timeout.com/newyork/news/nycs-linknyc-kiosks-have-racked-up-millions-in-debt-030420#:~:text=That%20being%20said%2C%20a%20rep,the%20wi%2Dfi%20to%20date.

[17] https://www.osc.state.ny.us/files/state-agencies/audits/pdf/sga-2021-19n5.pdf, 8

[18] https://www.osc.state.ny.us/files/state-agencies/audits/pdf/sga-2021-19n5.pdf, 1

were not isolated only to the company but also the lack of proper oversight provided by the Department of Information Technology and Telecommunications. This raises another set of concerns regarding the structural failures of the LinkNYC initiative as it relates to the possibilities and limits of proper and effective oversight.

Following the New York State Comptroller's audit, the New York City Office of Technology and Innovation (OTI), formerly DoITT, issued their own audit as part of their oversight of LinkNYC. In contrast to the concerns raised by the State Comptroller, OTI's cover letter discussing the audit[19] offers little in terms of concerns regarding LinkNYC.[20] However, one major concern found by KPMG, the firm who conducted the audit on behalf of the OTI, was that "CityBridge does not anonymize the MAC address of user devices as stated in the Privacy Policy and Franchise agreement."[21] The MAC address is one of several unique identifiers that a device like a smartphone has. The fact that LinkNYC kiosks collected MAC addresses in the first place, even if the addresses were anonymized, is a major privacy concern. Failing to anonymize these addresses sacrifices any privacy that users may have as whatever data is compiled through LinkNYC can be directly tied to a device and a person. This is a heightened concern for anyone who is from a historically criminalized community, as this data can facilitate NYPD's surveillance of individuals and communities. Additionally, while KPMG reported this issue in the company's assessment, the OTI makes no note of it and arguably downplays any concerns in the Office's cover letter. This feeds into the question raised by the State Comptroller regarding oversight failures with LinkNYC and further confirms the structural problems at the core of this program.

At the May 3, 2022 Committee on Technology oversight hearing on LinkNYC,[22] Nick Colvin, CEO of CityBridge, testified and initially could not state the total number of sensors on each kiosk.[23] *Vice* later reported, for the first time, that each kiosk has roughly thirty sensors collecting a variety of information, including environmental data, at all times.[24] This revelation exposed that

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19 https://www.nyc.gov/assets/oti/downloads/pdf/reports/LinkNYC-Audit-Report-Privacy-Section-of-March-2022_Redacted.pdf

20 From OTI's cover letter reporting on KPMG's audit: "The results indicated that CityBridge appeared to have largely complied with the terms of the privacy provisions of the franchise agreement. Additionally, there was no evidence found to suggest either inappropriate collection or usage of Personal Identifiable Information (PII) or that CityBridge shared PII with third parties and/or law enforcement beyond what is permitted by the Franchise Agreement."

21 https://www.nyc.gov/assets/oti/downloads/pdf/reports/LinkNYC-Audit-Report-Privacy-Section-of-March-2022_Redacted.pdf

22 https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=5541021&GUID=280043BA-4189-4454-9287-44F61ED23426&Options=&Search=

23 https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=5541021&GUID=280043BA-4189-4454-9287-44F61ED23426&Options=&Search=

24 https://www.vice.com/en/article/epzmvj/privacy-advocates-say-nycs-fix-for-the-digital-divide-is-a-hyper-surveillance-mess

the promise of “free” WiFi came at a cost to the user. While free WiFi was CityBridge’s pitch, their business model is to collect personal, visual, passive, and other data on NYC communities in order to earn advertising revenues to fund this project. By relying on this profit model, CityBridge constructed an infrastructure that violates civil liberties and rights as a function of this service provision.

Finally, as it stands, LinkNYC’s deployment continues to lag behind stated distribution schedules and goals for equal distribution in meeting the CityBridge’s initial promises of addressing the digital divide. As reported at the June 7, 2023 hearing, the program has installed more than 2,000 kiosks and towers—well below the 7,000 that were scheduled to be installed by now—but these are installed primarily in the City’s wealthier areas, including mostly in Manhattan.[25] At the same hearing, CityBridge stressed that a majority of the new 5G towers will be installed in areas most acutely experiencing the digital divide in order to address this past concern. The City and CityBridge have signed multiple amendments to the initial contract and have slowed the timeline for installation of kiosks as CityBridge consistently failed to meet goals named in each agreement.[26] Not only is the program behind schedule but it’s also failing to meet its goals in terms of addressing structural inequities regarding internet access while growing New York City’s already behemoth surveillance apparatus.

Amidst these controversies, Mayor Adams and Chief Technology Officer Fraser held a press conference on July 10, 2022 to debut LinkNYC’s latest iteration, a thirty-two foot tall 5G tower in the Bronx. Focusing on the need to address the digital divide, the City’s presentation did not highlight the significant concerns that have emerged from the implementation of LinkNYC.[27] While there are certainly strong opinions about the aesthetic value of this new tower, the primary concerns remain regarding the viability of LinkNYC to accomplish anything the City or CityBridge claim. The history of LinkNYC should raise concerns regarding the plans to now deploy 5G sensors across the City. With the new towers, WiFi will remain “free” but CityBridge will also draw revenues from cell service providers who will pay to install 5G cells into these towers. However, growing the 5G network through this program means that accessing the 5G network will require users to demonstrate that they already subscribe to a cellular provider.[28] This 5G service will only be available to people who are already paying for its service. While LinkNYC promised free internet for all New York City residents, this next phase of the program only promises 5G to those who can pay.

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[25] https://www.vice.com/en/article/epzmvj/privacy-advocates-say-nycs-fix-for-the-digital-divide-is-a-hyper-surveillance-mess

[26] https://www.nyc.gov/content/oti/pages/franchises/linknyc-franchises

[27] https://www.nyc.gov/office-of-the-mayor/news/485-22/mayor-adams-cto-fraser-linknyc-first-link5g-kiosk-new-york-city#/0

[28] https://www.vice.com/en/article/epzmvj/privacy-advocates-say-nycs-fix-for-the-digital-divide-is-a-hyper-surveillance-mess

Recommendations
The history outlined demonstrates that at the core of the LinkNYC program is a structural issue. The digital divide is fundamentally about equity, and this must be a central concern to the City. Yet, LinkNYC raises significant questions about how public-private partnerships created to deliver a public good can fail to prioritize the public over profit. Can the City equitably address the digital divide without ensuring that residents do not become targets for further data mining and profit? Can we build the technological infrastructure that New York will need in the future without buttressing an already overwhelming surveillance apparatus of cameras and sensors which criminalize our neighbors, friends, and family? Can the City commit to designing and developing technological infrastructure that enhances rather than undermines democracy?

The controversial history of LinkNYC should be reason enough for the Committee on Technology to bring more transparency to the program and accountability regarding its extractive data mining profit structure. We are recommending that the Committee on Technology co-develop new mechanisms and processes with communities experiencing the digital divide to increase the transparency and accountability for technology-driven infrastructure projects. A first step could include more information around how LinkNYC collects data, including transparency on each sensor that is used, what data it collects, how CityBridge uses each type of data, and who else has access to the data that is collected. Ultimately, LinkNYC should promote democratic values and realistically close the digital divide without making New York residents subject to data mining nor worsening the City's already highly invasive surveillance system.

Until the Committee and City take these concerns seriously, LinkNYC will be another idea that fails to put the interest and needs of City residents above corporate interests.

We look forward to discussing these recommendations with the Committee on Technology. We hope you will reach out to our organization should you have any further questions.

Sincerely,

Ed Vogel
Senior Policy Researcher
Surveillance Resistance Lab

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June 5, 2023

Delivered online

Committee on Technology
New York City Council
The Hon. Jennifer Gutierrez, Chair
New York City Hall
City Hall Park
New York, N.Y. 10007

Dear Hon. Gutierrez and Committee Members:

I am writing you as a former member of the New Hampshire State Commission that was tasked with exploring the Environmental and Health Effects of Evolving Wireless and 5G Technology. This Commission was formed through bipartisan legislation and was supported by the governor. The Commission was comprised of unbiased experts in fields relating to health and radiation and were highly qualified to evaluate the issue in a fair and in-depth manner. The Commission submitted its final report in November 2020, with a key finding being that exposure to wireless communication radiation is harmful to the health of humans and the environment. Those findings apply to all forms of wireless radiation, which include all generations of cellphone radiation.

My purpose in writing is to alert you to the dangers of siting a cell tower near to where people, particularly young people, live, work or recreate. I provide relevant details about the New Hampshire Commission's findings on this issue in a presentation I gave to the Lenox, MA Board of Health. Please know that the International Association of Fire Fighters (IAFF) in 2004 adopted a position statement still in effect today forbidding wireless communication facilities on or near fire stations as firefighters were being injured by the radiation. Many of the firefighters exposed to the wireless radiation could not remember where they were going during emergencies, nor how to administer CPR. As Dr. Gunnar Heuser indicates at the EMF Medical Conference, functional MRIs showed damage to the gray matter of their brains from the radiofrequency radiation exposure.

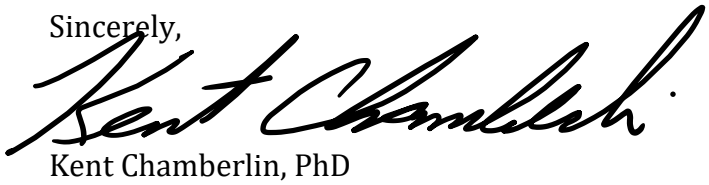
Scientists, physicians, environmental and public health physicians, epidemiologists, pediatricians along with engineers such as myself have been calling for state and local governments to be proactive in protecting your citizens against radiation exposure. I realize that providing such protection may seem challenging. However, initiatives such as the New Hampshire Commission and the successful lawsuit brought about by the Environmental Health Trust and others are exposing the dubious claims by the FCC that wireless radiation is harmless. Given the mounting evidence regarding the clear harm of radiation, it is only a matter of time before meaningful protective regulations are put in place.

While telecom companies currently have the upper hand in that they seem to be able to force communities to accept whatever tower sites they mandate, there are actions that those communities can take to delay or stop installations where people will be excessively exposed. For example, citizens in York, Maine have delayed the installation of antennas positioned close to a neighborhood. The Board of Health in Pittsfield, Massachusetts issued a cease-and-desist order against Version regarding a cell tower that was causing illness in a surrounding neighborhood. There are many other examples where citizens and administrators have worked together to protect people against cell tower radiation. Those examples can be used to strengthen your ordinances to help protect against inappropriate cell tower siting.

I am currently working with my state legislators to pass legislation that would provide protections against excessive radiation exposure. The original legislation called for a 1,640-foot setback for all new cell towers; this setback is one of the recommendations made by the New Hampshire Commission, and the rationale for picking that distance is explained here. The legislation is currently being revised so that it can be acted on in the next legislative session.

Wireless radiation dangers are real, and they can be significant in their impact on human health and the environment. I encourage you to do whatever is within your power to protect your constituents against it.

Sincerely,



Kent Chamberlin, PhD
Professor & Chair Emeritus
Fulbright Distinguished Chair

To whom it may concern,

I am president of the West 50s Neighborhood Association, and my membership is astounded at the arrogance of LinkNYC:

“Once again the NIMBYs are lobbying elected officials for their own privileged self-interest; they want to stop the deployment of the Link5Gs and even remove the kiosks that have been in place for years–impacting our most vulnerable neighbors and denying TRIE neighborhoods and underserved communities the 5G Connectivity and Wi-Fi they deserve.”

J. RueMel Parkin, NYCPS-P | *Executive Director & Chair*

These towers are indescribably ugly and dangerous. LinkNYC is trying to keep its ownership hidden from the public, because Google is out only to obtain personal information on every person in NYC.

The Towers can only transmit around a short distance and would have to be on every street to provide coverage. We have to finally stand up to this big money group and actually do something for the people who actually live here as opposed to a big, evil corporation.

David Achelis
President
West 50s Neighborhood Association
West 56th St,
New York, NY 10019

From: George Stonbely <gstonbely@spectacularventures.com>
Sent: Tuesday, June 6, 2023 9:28 PM
To: Land Use Testimony <landusetestimony@council.nyc.gov>
Cc: District3 <district3@council.nyc.ny.us>; Joanna Cawley <joanna@chneighbors.org>; Office of Council Member Powers <kpowers@council.nyc.gov>; Lo Van der Valk <LoVandervalk@chneighbors.org>; Simeon Bankoff <sbankoff@gmail.com>; district5@councilnyc.com
Subject: [EXTERNAL] LinkNYC, Deployment of 5G Infrastructure Connection, June 7 at 1 PM

Members of The City Council:

I am writing as the president of the board of 1115 Fifth Avenue, as well as a board member of Carnegie Hill Neighbors, in opposition to the installation of 5G towers in the residential neighborhood of the Carnegie Hill Historic District. Generations of NYC leaders and community members have spent decades working to preserve our unique and beautiful streetscapes. These 32' structures will destroy the character of the historic district, render decades of stewardship meaningless, and discourage the hope of having a voice in such fundamental issues.

The Carnegie Hill community was astonished by the announcement that the first of these unnecessary, unwanted and overwhelmingly out-of-scale 32' towers are being planned for one of NYC's most beautiful historic districts - - Carnegie Hill - -where 5G service is more than ample and the addition of 32' towers will not provide any benefit to the public, or even the cell companies, who already provide 5G service in the area. So what will these 32' towers accomplish?

As New York City residents, we believe we should have the best plan for 5G services for all of our residents. There exists technology that is superior, less obtrusive, and less costly to expand 5G service in our City than imposing these 32' towers on communities in residential areas where existing infrastructure (street furniture) can accommodate current and future telecom equipment needs.

Our opposition transcends the above and spans a long history of incompetence and failure on the part of the ever-changing variety of companies involved. Starting almost 10 years ago, NYC was promised internet service, revenue of hundreds of millions of dollars - - (as per the contract only 15 million of a required minimum payment of $75 million has been paid) - -and the installation of desperately needed WiFi service on an equitable basis to a diverse and inclusive population. They totally failed. - - on all three counts. There also has been a total disregarded for the public by the tolerance of abhorrent standards of behavior in the misuse of their Link/NYC Kiosks - -that continues to the day.

All of the preceding are well-known, well-documented and indisputable.

As to the potential to derive revenue from renting space in these towers to telecom providers, it is dubious, and is as flawed as the original financial model that failed and left our great City $60 million - -and counting - -in the hole. No financial model or projections have been released to the public, and people in the financial, marketing and advertising, and telecommunications industry are extremely skeptical about how CityBridge will generate revenue.

In addition to the above, CityBridge and its partners circumvented and violated the standard public review process and has been rebuked by the Federal Communications Commission (FCC). CityBridge has been ordered by the FCC to participate in these public hearings that will allow the public the right to speak about the use of the public realm.

Finally, there is the issue of what our City stands to lose from this scheme. Aside from the continued disappointment of failed installation schedules, loss of anticipated revenue, despoiling historic districts in all 5

boroughs, and not delivering on its promise to provide internet service for all, we submit that our City will lose much-needed real estate tax revenue as the value of the apartment buildings with 32’ 5G towers installed in front of their buildings will be negatively impacted, and lose value, thus reducing their assessed valuation. Real property tax revenue is by far the largest contributor of revenue to the City, and we cannot afford to lose revenue on such an ill-conceived scheme.

We urge the City Council to reject the CityBridge plan to install these unnecessary, unwanted, and unneeded 32’ towers in residential historic districts and to refocus its attention on its mission to provide to all New Yorkers - -where the service is needed most- -in a more technological and attractive manner, and not rubber stamp a twice-failed program enacted under a previous administration based on mythical revenue forecasts, but rather be required to put forward a better plan that reflects the excellence of the Greatest City in The World.

Respectfully,
George N Stonbely
President of the Board
1115 Fifth Avenue
New York City 10128

For the sake of full disclosure, 1115 Fifth Avenue has been sited for the installation of a 32’ 5G tower.
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George N. Stonbely

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Oral Testimony of
Odette Wilkens, President & General Counsel
Wired Broadband, Inc.
owilkens@wiredbroadband.org

Hearing of Committee on Technology
June 7, 2023

I'm Odette Wilkens, Pres & General Counsel of Wired Broadband, Inc, a non-profit in Forest Hills, Queens advocating safe technology for the public. I've also been a technology attorney for the past 20 years having represented many multinational corporations. I am familiar with the benefits of technology as well as the risks.

Community boards are increasingly rising in opposition to the Link5G cell towers. Sixteen community boards to date have disapproved or called for moratoria. This represents up to 800 community board members, and an average of about 2 million residents. That is more than a quarter of the NYC population. The message is clear, they:

Do Not Need the 5G Towers and Do Not Want Them

Even equity districts are bristling at 5G towers.

Just to name a few of the 16 districts:

- Brooklyn Community Boards 1 (Greenpoint and Williamsburg) and 4 (Bushwick)
- Manhattan Community Boards 9 (Morningside Heights), 10 and 11 (East Harlem)
- Queens Community Board 1 (Astoria and Long Island City)

Bridging the digital divide is supposed to enhance social welfare

But the Federal Housing Administration will not provide federal mortgages for homes within the fall zone of a cell tower. For these towers at 32' tall, 3 stories high, there's an insufficient fall zone, when they are as close as 8' to a structure. Property values go down about 20% near cell towers. The devaluation of property does not enhance social welfare.

Also, in case of structural failure, a tower can crash into buildings and pedestrians.

CitBridge's failed to comply with federal law based on the FCC's recent notice. Wouldn't that mean that they are in material breach of their franchise agreement? Why is there no moratorium on construction?

Under federal caselaw in NY, for federal pre-emption to apply, telecoms must show a gap in phone service. OTI and CityBridge have confirmed they have no records of gaps. The FCC rule that allows telecoms into communities based on capacity needs for future demand does not comply with federal law and does not apply in NY jurx. *Extenet v. Flower Hill.* Why then is OTI

telling community boards that 5G is federally mandated? It is not. ***There is no federal preemption for imposing 5G in NYC.***

The Public Design Commission conditioned approval of a pilot to install 200 towers on getting feedback from the community. Communities are speaking out in opposition.

Therefore, as a proof of concept, the Link5G project has failed and should be abandoned for a better plan for NYC residents, with meaningful community input and approval before entering into any formal agreements.

Odette J. Wilkens
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Written Testimony of
Odette Wilkens, President & General Counsel
Wired Broadband, Inc.
owilkens@wiredbroadband.org

Hearing of New York City Council Committee on Technology
June 7, 2023

Supplemental Update

This supplements and updates the written testimony of Wired Broadband, Inc. This is presented as general background information for the Committee's consideration.

Community Board Disapprovals and Moratoria

In connection with community board disapprovals and moratoria on the Link5G cell towers, here is a list of 16 community boards, to date, which have disapproved or called for moratoria. That is 40% of the community boards listed on OTI's dataset[1] as part of the pilot program set forth by the PDC – about 40 out of 59 community boards. Therefore, all community boards have not yet been engaged in this process. Documentation of disapprovals and moratoria has been compiled in a separate pdf document for easy reference and is incorporated herein by reference.

1. Manhattan CB2: -moratorium (1/19/23)
2. Manhattan CB5: disapproval and request for moratorium (1/12/23)
3. Manhattan CB8: moratorium resolution (12/14/22)
4. Manhattan CB 9: disapproval (1/19/23)
5. Manhattan CB10 - Economic Development & Technology Committee approve letter calling for a 'hold' on the proposal & a Public Hearing (4/13/23) – to be approved by full board in May
6. Manhattan CB11 - Public Safety Committee approved Letter of Dis-Support for installations in MCB11 ratified by Full Board on 4/26/23
7. Brooklyn CB1 - disapproval (3/14/23)

[1] https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux.

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8. Brooklyn CB4 -moratorium (2/15/23)
9. Brooklyn CB9 - moratorium (3/23/23) Full Board
10. Brooklyn CB10: disapproval (1/23/23)
11. Bronx CB6: letter of rejection of 5G polesl March 16, 2023
12. Queens CB1- letter of denial (2/28/23)
13. Queens CB3 - disapproved 4 out of 5 Link5G Towers
14. Queens CB #6 rejects all future requests for 5G towers until they pass proper historic preservation and environmental review. Video of May 10, 2023 Meeting
15. Queens CB12- opposition to the 5G poles (March 15, 2023 Committee meeting) – moratorium (6/1/23)
16. Queens CB14- disapproval (2/7/23)

The Built-In Obsolescence of Wireless Will Perpetuate the Digital Divide

There is a planned, built-in obsolescence with wireless. This is a trend, as reported by an industry publication, where "companies have turned to planned obsolescence to artificially render older products obsolete."[2] It is a tactic used to ensure that tech companies "can consistently turn a profit every time they launch new products."[3]

For instance, the major telecom carriers are shutting down their 3G networks, by design.[4] That means that 3G-enabled only phones will become obsolete and consumers will be forced to buy a new cell phone for the new network.[5] It would also apply to other 3G-enabled equipment, such as "medical devices, tablets, smart watches, vehicle SOS services, home security systems."[6] This is artificially creating demand for future generations of wireless services, such as 4G or 5G, as people are forced to buy 4G or 5G-enabled cell phones and equipment, and soon 6G and beyond.

Buying into the 5G rhetoric is relegating people to a perpetual cycle of obsolescence, apparently for corporate profit. This cycle will be perpetuated with future generations of wireless as it becomes necessary for more devices to be connected to ever-new generations of wireless in order for devices to work. Those who cannot afford new devices will be left behind, further exacerbating the digital divide.

Moreover, wireless equipment and facilities have a much shorter life span, and require continuous periodic maintenance and replacement. Fiber has been federally prioritized as the

[2] https://cellularnews.com/mobile-phone/planned-obsolescence/.
[3] Id.
[4] https://www.fcc.gov/consumers/guides/plan-ahead-phase-out-3g-cellular-networks-and-service.
[5] Id.
[6] Id.

superior choice to implement broadband nationwide to bridge the "digital divide." There is no planned, built-in obsolescence with fiber, and is therefore more cost effective for underserved communities, ensuring that they are not left behind.

NYC should avail itself of the federal funds being made available for fiber to the premises under the Infrastructure Investment and Jobs Act. The NTIA has prioritized fiber to bridge the digital divide. NYC should, as well, or be left behind.

Respectfully Submitted,

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Written Testimony of
Odette Wilkens, President & General Counsel
Wired Broadband, Inc.
owilkens@wiredbroadband.org
(Based on Oral Testimony)

Hearing of Committee on Technology
June 7, 2023

I'm Odette Wilkens, a resident of Queens Community Board 6. I am President & General Counsel of Wired Broadband, Inc, a non-profit in Forest Hills, Queens advocating safe technology for the public. I've also been a technology attorney for the past 20 years having represented many multinational corporations. I am familiar with the benefits of technology as well as the risks.

Community boards are increasingly rising in opposition to the Link5G cell towers. Sixteen community boards to date have disapproved or called for moratoria. This represents up to 800 community board members, and an average of about 2 million residents. That is more than a quarter of the NYC population. The message is clear, they:

Do Not Need the 5G Towers and Do Not Want Them

Even equity districts are bristling at 5G towers.

Just to name a few of the 16 districts:

- Brooklyn Community Boards 1 (Greenpoint and Williamsburg) and 4 (Bushwick)
- Manhattan Community Boards 9 (Morningside Heights), 10 and 11 (East Harlem)
- Queens Community Board 1 (Astoria and Long Island City)

(see Appendix A for examples)

Bridging the digital divide is supposed to enhance social welfare

But the Federal Housing Administration will not provide federal mortgages for homes within the fall zone of a cell tower.[1] For these towers at 32' tall, 3 stories high, there's an insufficient fall zone, when they are as close as 8' to a structure. Property values go down about 20% near cell towers. The inability to get a mortgage (or buy a home) and the devaluation of property does not enhance social welfare.

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[1] Hazards & Nuisances: Overhead High Voltage Transmission Towers and Lines
Chapter 1: Appraisal & Property Requirements (Page 1-18f)
https://archives.hud.gov/offices/hsg/sfh/ref/sfh1-18f.cfm. *Powerlines and Cell Antennas Lower Property Values,* https://ehtrust.org/cell-phone-towers-lower-property-values-documentation-research/; see also online commentary, https://www.city-data.com/forum/mortgages/577383-fha-loans-cellphone-towers-did-you.html.

Also, in case of structural failure, a tower can crash into buildings and pedestrians.

CitBridge has failed to comply with federal law based on the FCC's recent notice. Wouldn't that mean that they are in material breach of their franchise agreement? Why is there no moratorium on construction? There was an eye witness who saw and photographed workers installing antennas into a Link5G tower at 2nd Avenue and 1st Street on May 5, 2023, after the FCC letter of April 20, 2023 to CityBridge notifying it of its failure to comply with federal law (see Appendix B).

Under federal caselaw in NY, for federal pre-emption to apply, telecoms must show a gap in phone service. OTI and CityBridge have confirmed they have no records of gaps. The FCC rule that allows telecoms into communities based on capacity needs for future demand does not comply with federal law and does not apply in NY jurx. *Extenet v. Flower Hill*. Why then is OTI telling community boards that 5G is federally mandated? It is not. ***There is no federal preemption for imposing 5G in NYC.***

The Public Design Commission conditioned approval of a pilot to install 200 towers on getting feedback from the community. Communities are speaking out in opposition.

Therefore, as a proof of concept, the Link5G project has failed and should be abandoned for a better plan for NYC residents, with meaningful community input and approval before entering into any formal agreements. Therefore, we recommend full public hearings where the public, community boards and organizations can be heard on a range of issues including health, safety, environment and what will really bridge the digital divide.

***

Additional information is being provided in a position paper being submitted for general information.

The National Telecommunications Information Administration (NTIA) has a fiber-first policy for bridging the digital divide. Why is NYC not taking advantage of the BEAD monies being distributed for fiber deployment under the Infrastructure Investment and Jobs Act? Why is NYC being left behind?

There were various assertions made by CityBridge which need amplification or correction.

As to privacy and tracking, CityBridge stated that they have agreements with third parties that they will not collect personal data other than providing the services. Yet, neither the privacy policy nor the base franchise agreement appears to state any prohibition against its third parties collecting personal data beyond providing the services.

Further, regarding community concerns of being tracked, the privacy policy under the franchise agreement with CityBridge specifies that its website does not support a "do not track" function.

Even NYC's Chief Technology Officer and Chief Security Officer spotlighted 5G's privacy and security vulnerabilities in a letter to the NTIA in 2020 (see Appendix C):

> Such complex systems [5G] present ***more opportunities for security and privacy breaches***. By moving away from firmware-based technology of 4G telecommunication components to ***software-based 5G telecommunication components that will need to be updated, the opportunity for manipulation exists*** within the supply chain. Furthermore, movement away from centralized network systems to decentralized network systems ***increases the attack surface of a network***. That increased attack surface is ***amplified*** by the anticipated introduction of the increasing number and variety of connected devices (IoT) and big data industries. (top of p.3)
>
> The problem of IoT vulnerabilities will only become ***exacerbated by the increased speeds of 5G*** and other future wireless broadband technologies. (middle of p.3)
>
> IoT protection is historically poor and ***malware distribution is easily scalable***, which suggests that the creation of IoT botnets ("robot networks") for malicious purposes, including ***large-scale distributed denial of service (DdoS) attacks***, is ***likely to increase*** as well. This poses a ***significant threat*** to vital digital infrastructure and resident services at all levels of government, as well as private sector enterprise. (penultimate paragraph on p.3)[2]

The Chair had asked CityBridge what it was doing to restore public trust in the City and the project.

- First, CityBridge in its presentations to community boards has failed to address or acknowledge that there are any scientific studies showing harm. This despite the D.C. Circuit Court of Appeals' decision in 2021 that acknowledged the 11,000 pages of peer-reviewed scientific studies submitted into the FCC docket showing harm even below the FCC limits. The Court ruled against the FCC and remanded back its limits for failure to review those studies, or examine its effects on children or long-term exposure (Environmental Health Trust v. FCC). To date, the FCC has failed to update its limits dating back to 1996, and can no longer be viewed as safety limits.

[2] Letter from Chief Security Officer, Geoff Brown, and Chief Technology Officer, John Paul Farmer, to National Telecommunications Information Administration of the U.S. Chamber of Commerce, June 2, 2020.

- Second, CityBridge brought in an "expert" at Queens Community Board 12 to discount any health impacts. However, the "expert" was revealed at that meeting to also have presented at the Board of Health in an out-of-state community where he was discredited (see the Cease and Desist Order of April 11, 2020, by the Pittsfield, MA, Board of Health, item #21 on page 10).[3]

- Third, CityBridge had presented at a digital conference where CityBridge referred to New Yorkers on the Upper East Side and the Village as "digital nimbies." (City & State sponsored "Digital NY Summit," March 15, 2023; comment of Mr. Robert Sakota during the last panel, where the author was present.) This is not conducive to having an open dialogue and reveals a contempt for community input.

CityBridge incorrectly stated that there are thousands of studies of 5G showing no adverse impact. In fact, there is a dirth of 5G studies. Senator Blumenthal held a hearing on Capitol Hill asking telecom executives if they were conducting any tests of the safety of 5G; the answer was no. Senator Blumenthal replied "we're flying blind as far as health and safety is concerned." Case studies recently published since January 2023 show personal injury from 5G antennas.[4]

The Chair asked how to improve communications with the community. I recommend that there be a long enough period for community boards to become acquainted with the subject matter of 5G technology, that the public be able to participate and ask questions during OTI's and CityBridge's presentations, and that the presentations and Q&A be recorded so that others who cannot attend will have the benefit of the information in making their decisions.

The following is a summary of what I also stated at the hearing in response to the Chair's question, with some additional information:

1. The 60-day comment period afforded by OTI to community boards is insufficient. When considering that the issue needs to be reviewed by a committee and then referred to the full board for consideration and a vote, it leaves very little time for the board

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[3] https://ehtrust.org/cease-and-desist-order-against-verizon-cell-tower-by-board-of-health-pittsfield-ma/.

[4] **Feb 2023 study of two previously healthy men rapidly developed typical "microwave syndrome" symptoms shortly after a 5G cell tower was installed on the roof of their office: headaches, joint pain, tinnitus, abnormal fatigue, sleep disturbances, burning skin, anxiety and trouble concentrating.** https://www.anncaserep.com/open-access/development-of-the-microwave-syndrome-in-two-men-shortly-after-9589.pdf.
Jan 2023 study of a previously healthy man and woman developed similar "microwave syndrome" symptoms soon after a 5G tower was installed on top of their apartment.
https://www.gavinpublishers.com/assets/articles_pdf/Case-Report-The-Microwave-Syndrome-after--Installation-of-5G-Emphasizes-the-Need-for--Protection-from-Radiofrequency-Radiation.pdf.
April 2023 study of a 52 year old woman whose apartment was 60 meters from a 5G base station who developed "microwave syndrome" symptoms, https://acmcasereport.com/pdf/ACMCR-v10-1926.pdf?fbclid=IwAR2J-mE3XeBxqaXPQdFxslf9Q23bMCer9vgUBHnCvJXBrgBv-w7YdRUDwF0;
The studies show that non-ionizing radiation from 5G — well below levels allowed by authorities — can cause health problems in individuals who had no prior history of electromagnetic sensitivity (EMS).

members to become familiar with the subject and are left to make decisions with insufficient knowledge.

2. Regarding CityBridge CEO Nick Colvin's presentation to the Landmarks Committee of Manhattan Community Board 7 on 5-30-23, the author and a constituent were present. There is no recording of the 5-30-23 meeting because, as the community board office stated to the constituent, CityBridge did not want the meeting recorded or archived for the public. What does CityBridge have to hide?

3. In Queens Community Board 6 (QCB6), OTI and CityBridge presented during an Executive Committee meeting on February 15, 2023 where the public, although able to view it, could not participate or ask questions. Although my name was mentioned during deliberations, and I kept raising her hand when it was being taken down by the host, I was not afforded the opportunity to be a panelist. Further, in the letter that QCB6 sent to OTI, it stated that since they "will not be able to effectively halt the installation of the 5G proposed tower," they proposed a different location. OTI has been advising community boards (CBs) that they will only entertain different siting proposals as community feedback (contrary to the PDC's directive).

CityBridge's assertion that there was overwhelming support for the Link5G towers/services was only based on a survey of 1303 people.[5] That is hardly a large enough sample to represent almost 8 million New Yorkers.[6]

In addition, Nick Colvin in his 5-30-23 presentation at MCB7 stated (the one which CityBridge asked not to be recorded) that while he didn't think that the towers would collapse, he did mention that the top was made of light plastic which could easily fall off. But he gave his assurance that it would not hurt anyone. As the saying goes, "from his lips to God's ears." Even light plastic hurtling from 3 stories can cause injury or property damage, just based on Newtonian physics of gravity and velocity. Another factor is that the aesthetic that has been promoted by CityBridge would be marred, with the towers likely taking on the appearance of having missing teeth.

Committee Member Ari Kagan asked OTI if there were any complaints of adverse health effects. Mr. Brett Sikoff responded that franchisees are contractually required to comply with the FCC emission limits. In not answering the question posed, Mr. Sikoff failed to disclose that in Jan 2023, he heard comments from a police lieutenant in Queens Community Board 1 (Astoria) that when an antenna was placed on top of a utility pole outside his third floor window, he was

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[5] Link NYC – Link5G in Residential Zoning and Historic Districts, PDC Preliminary/Final Review, Aug 8, 2022, see footnote referencing GfK Independent survey of 1303 New Yorkers at 10, https://www.nyc.gov/assets/designcommission/downloads/pdf/08-08-2022-pres-OTI-f-Link%205G.pdf.

[6] See Manhattan Community Board 8, Transportation Committee hearing where OTI and CityBridge presented on Dec 7, 2022, where this issue arose.

severely injured experiencing heart arrythmias, sleeplessness and other symptoms. The lieutenant's testimony was read during today's hearing.

His sister also became very sick. His sister's oncologist said that if she stayed, her cancer could come back. She evacuated the house.

The lieutenant told a heart-wrenching account of how he had undergone invasive cardiac procedures, only to find that the cardiologist could not replicate the arrythmias when he was in the office. His symptoms disappeared when he also evacuated the house. Now he is shouldering a large mortgage for a house where he and his sister cannot live in. Although he goes back for clothing, etc, he cannot stay for long periods.

Despite this life-threatening situation, OTI has not responded to requests to move the antenna away from the lieutenant's house.

At a meeting with OTI on May 17, 2023, the author and others provided a list of questions for OTI (see Appendix D). After several weeks OTI has not provided answers.

Similarly, there are FOIL requests dating back to October 2021, as well as more recently filed FOIL requests, which, except for a few instances, have gone unanswered (see Appendix E).

APPENDIX A

Russell Squire
Chair

Will Brightbill
District Manager

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The City of New York
Community Board 8 Manhattan

December 20, 2022

Edward F. Pincar
Manhattan Borough Commissioner
Department of Transportation
59 Maiden Lane, 37th Floor
New York, NY 10038

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

RE: Disapproval of new Link5G Kiosks within CB8

Dear CTO Fraser and Commissioner Pincar,

At the Full Board meeting of Community Board 8 Manhattan held on December 14, 2022, the board approved the following resolution by a vote of 40 in favor, 2 opposed, 0 abstentions and 0 not voting for cause:

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS; CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free wireless internet connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 8 and constituents of its district have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32' tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI have proposed 18 sites across Community District 8;

WHEREAS; CityBridge and OTI have stated that the siting of proposed Link5G towers in Community District 8 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; 15 of the 18 sites proposed are in or near either the Upper East Side Historic District or the Carnegie Hill Historic District, where renowned architecture and iconic streetscapes would be interfered with if Link5G structures were installed; and

WHEREAS; locations proposed along Madison Avenue would be in conflict with strict guidelines for illuminated storefronts and signage, and would be in conflict with the Special Madison Avenue Preservation District's design standards that specifically prohibit illuminated advertising; and

WHEREAS; residents of Community District 8 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred in front of 520 East 90th Street, and

WHEREAS; 10' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; Neither CityBridge nor the cellular network providers that Link5G service is intended to supplement have provided any evidence that dropped calls and limited capacity are present at the proposed Link5G locations;

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 8; and

WHEREAS; OTI and CityBridge have not provided detailed plans regarding the full build-out of Link5G, both within Community District 8 and in areas north of 96th Street and in the outer Boroughs; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there have been questions raised by some residents as to whether sufficient research has been performed to fully assuage concerns that the radiation emitted by 5G infrastructure won't have any long-term impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants, and parks;

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 8 at present and until many of the issues identified have been resolved;

WHEREAS; New York City is in control of this process through its contract with the provider;

THEREFORE BE IT RESOLVED, that Community Board 8 Manhattan disapproves the proposal as presented to install Link 5G towers in Community District 8; and

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G poles and devices in Community District 8 Manhattan.

Please advise us of any action taken on this matter.

Sincerely,

Russell Squire *Craig Lader and Charles Warren*

Russell Squire
Chair

Craig Lader and Charles Warren
Co-Chairs, Transportation Committee

cc: Honorable Eric Adams, Mayor of the City of New York
Honorable Carolyn Maloney, 12th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Liz Krueger, NYS Senator, 28th Senatorial District
Honorable José M. Serrano, NYS Senator, 29th Senatorial District
Honorable Edward Gibbs, NYS Assembly Member, 68th Assembly District
Honorable Dan Quart, NYS Assembly Member, 73rd Assembly District
Honorable Rebecca Seawright, NYS Assembly Member 76th Assembly District
Honorable Keith Powers, NYC Council Member, 4th Council District
Honorable Julie Menin, NYC Council Member, 5th Council District

THE CITY OF NEW YORK
COMMUNITY BOARD 9
MANHATTAN

Morningside Heights
Manhattanville
Hamilton Heights

EXECUTIVE COMMITTEE

Ratification of Reso re: Disapproval of new Link5ZG Kiosks within MCB9

January 16, 2023

Edward F. Pincar
Manhattan Borough Commissioner
Department of Transportation
59 Maiden Lane, 37th Floor
New York, NY 10038

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

RE: Disapproval of new Link5G Kiosks within CB-9M

Dear CTO Fraser and Commissioner Pincar,

At its regularly scheduled Executive Committee meeting of Community Board 9 Manhattan held on January 12, 2023, the Executive Committee acting on behalf of the full board approved the following resolution by a vote of 15 in favor, 0 opposed, 0 abstentions and 1 not voting for cause; 2 other CB9 members who are not members of the Executive Committee present voting in favor:

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS; CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free wireless internet connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 9 and constituents of its district have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32' tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI have proposed 4 sites across Community District 9;

WHEREAS; CityBridge and OTI have stated that the siting of proposed Link5G towers in Community District 9 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; 4 of the 18 sites proposed are either in or near the Morningside Historic District or the central Columbia University campus and the historic St. John the Divine Church, where renowned architecture and iconic streetscapes would be interfered with if Link5G structures were installed; and these addresses are:

- 2880 Broadway, *between* 112th Street and 113th Street, Residential
- 1060 Amsterdam Avenue, *between* 112th Street and 113th Street, Residential / *across from the* Cathedral of St. John the Divine
- 1125 Amsterdam Avenue, *between* 115th Street and 116th Street, Residential /St. Luke's Hospital
- 1181 Amsterdam Avenue near Columbia University, *between* 118th Street and 119th Street, Columbia University

WHEREAS; locations proposed along Broadway and Amsterdam Avenue would be in conflict with strict guidelines for illuminated storefronts and signage; and

WHEREAS; residents of Community District 9 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred in front of 520 East 90th Street in Manhattan Community District 8, and

WHEREAS; 10' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; Neither CityBridge nor the cellular network providers that Link5G service is intended to supplement have provided any evidence that dropped calls and limited capacity are present at the proposed Link5G locations;

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 9; and

WHEREAS; OTI and CityBridge have not provided detailed plans regarding the full build-out

of Link5G, both within Community District 9 and in areas north of 96th Street and in the outer Boroughs; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there has not been any information presented to Manhattan Community Board 9 that these street sites for Link5G poles are necessary to correct coverage gaps that could not otherwise be covered through normal wireless antenna placements on local structures, which is the routine method by which wireless carriers provide 5G and other wireless service coverage in an area; and

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 9 at present and until many of the issues identified have been resolved;

WHEREAS; New York City is in control of this process through its contract with the provider.

THEREFORE, BE IT RESOLVED, that Community Board 9 Manhattan disapproves the proposal as presented to install Link 5G towers in Community District 9; and

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G poles and devices in Community District 9 Manhattan.

Please advise us of any action taken on this matter.

If you have any questions and/or further information is needed, please do not hesitate contacting me or District Manager, Eutha Prince, at the board office (212) 864-6200.

Sincerely,

Barry Weinberg
Chair

cc: Honorable Eric L. Adams, Mayor of the City of New York
Honorable Jumaane Williams, Public Advocate of the City of New York
Honorable Jerrold Nadler, 12th Congressional District Representative
Honorable Adriano Espaillat, 13th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Cordell Cleare, NYS Senator, 30th Senatorial District
Honorable Daniel J. O'Donnell, NYS Assemblymember, 69th Assembly District
Honorable Inez Dickens, NYS Assemblymember, 70th Assembly District
Honorable Al Taylor, NYS Assemblymember, 71st Assembly District
Honorable Shaun Abreu, Member of the NYC Council, 7th Councilmanic District
Honorable Kristin Richardson Jordan, Member of the NYC Council, 9th Councilmanic District
Honorable Charles Schumer, U.S. Senator, State of New York
Honorable Kirsten Gillibrand, U. S. Senator, State of New York

Xavier A. Santiago
Chair

Angel D. Mescain
District Manager

April 26, 2023

Matthew C. Fraser
Chief Technology Officer
Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Re: Proposed LinkNYC 5G Cell Tower Installations in East Harlem

Dear Mr. Fraser,

Community Board 11 is opposed to the proposed installations of LinkNYC 5G cell towers in Manhattan Community District 11.

The Office of Technology & Innovation (OTI), in franchise-agreement with CityBridge, aims to enhance wireless communication coverage throughout the city by installing and maintaining mobile telecommunications equipment on street poles.

Members of the public have iterated their concerns regarding the potential health and environmental implications of these installations, citing OTI's lack of transparency on potential impacts on residential quality of life. Further, the Federal Communications Commission (FCC) has levied a moratorium on the construction of LinkNYC 5G tower kiosk facilities, as they fall within the scope of the Commission's rules for implementation of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA) *letter enclosed*.

The need to expand network accessibility in underserved communities is recognized - however, until NYC OTI and CityBridge allay constituent health concerns, including satisfy the FCC's requirement to complete procedures pursuant to Section 106 of the NHPA, and the environmental review process pursuant to NEPA - Manhattan Community Board 11 cannot support the installations of the LinkNYC 5G cell towers.

If you have any questions, please contact Khalid Nixon, Assistant District Manager, at knixon@cb11m.org or 212-831-8929.

Sincerely,



Xavier A. Santiago
Chair

Cc: Hon. Mark D. Levine, Manhattan Borough President
Hon. Diana Ayala, Deputy Speaker, New York City Council
Hon. Kristin Richardson Jordan, New York City Council
Hon. Julie Menin, New York City Council
Hon. Keith Powers, New York City Council
Hon. Jose M. Serrano, New York State Senate
Hon. Cordell Cleare, New York State Senate
Hon. Eddie Gibbs, New York State Assembly
Hon. Inez Dickens, New York State Assembly
Judith Garcia, NYC OTI, Mobile Telecom Franchise Unit
Brett Sikoff, NYC OTI, Mobile Telecom Franchise Unit
Stacy Gardener, NYC OTI, External Affairs
Robert Sokota, President, CityBridge, LLC
Margaux Knee, General Counsel, CityBridge, LLC
Rafael Escano, NYC Department of Transportation
Jose Altamirano, Community Board 11
Michelle Wiltshire-Clement, Community Board 11

COMMUNITY BOARD No. 1

435 GRAHAM AVENUE - BROOKLYN, NY 11211- 8813
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PHILIP A. CAPONEGRO
MEMBER-AT-LARGE

March 21, 2023

Mr. Brett Sikoff
Executive Director, Franchise Administration
NYC Department of Information Technology & Telecommunications
15 Metro Tech Center, 18th Floor
Brooklyn, NY 11201

Re: Proposed New Link5G Pole & Cap Installations in Brooklyn Community District #1

Dear Mr. Sikoff,

Thank you for the information you and CityBridge provided to Brooklyn Community Board #1 and for participating in a presentation and discussion, regarding the proposed new Link5G transmission pole & cap installations in Brooklyn Community District #1.

On March 14, 2023, Brooklyn Community Board #1 voted 21 "YES"; 1 "NO", 3"ABSTENTIONS" to approve the following comments regarding the proposed Link5G installations to be performed and operated by CityBridge. The board does not sanction installing 6 new Link5G poles at the following locations:

Site ID	Street Address	Cross Street 1	Cross Street 2
BK-01-125285	640 MANHATTAN AVENUE	BEDFORD AVENUE	NASSAU AVENUE

Site ID	Street Address	Cross Street 1	Cross Street 2
BK-01-GF34896	21 INDIA STREET	WEST STREET	DEAD END
BK-01-GF34897	22 NORTH 6 STREET	NORTH 6TH STREET	DEAD END
BK-01-GF34906	419 KENT AVENUE	SOUTH 8TH STREET	BROADWAY
BK-01-GF34907	26 SOUTH 9TH STREET	KENT AVENUE	WYTHE AVENUE
BK-01-GF34908	26 SOUTH 10TH STREET	SOUTH 10TH STREET	SOUTH 11TH STREET

nor installing a cap on a lamppost located less than 10' from a building on the block of Lorimer Street between Scholes Street and Siegel Street (OTI #25821), until more extensive research is done to prove that these devices do not pose health safety hazards to residents. NYC OTI and CityBridge both deferred to the Federal Communications Commission (FCC) and the Food & Drug Administration (FDA) for supporting science related to safety. The FDA cites this study, *Wireless phone use in childhood and adolescence and neuroepithelial brain tumours: Results from the international MOBI-Kids study*, which on the one hands states "We have no evidence of a causal association between wireless phone use and brain tumours" while also noting "Because of likely biases we cannot rule out a small increased risk." The latter highlight we find to be very disconcerting.

Additionally, the following studies were presented to the board by the Environmental Health Trust, that raise major concerns regarding the potential health hazards of 5G technology: *"Electromagnetic fields, 5G and health: what about the precautionary principle?,* John William Frank; *"Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA,* Tarmo Koppel And Lennart Hardell; *"Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective,* Dominique Belpomme, Lennart Hardell, Igor Belyaev, Ernesto Burgio, David O. Carpenter; and *"Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads", T*armo Koppel, Mikko Ahonen, Michael Carlberg, Lennart Hardell. All of these authors state that more studies are needed.

It was further brought to the board's attention that US FCC standards for Wi-Fi, Cell Phones and Cell Towers have remained unchanged since 1996. In an August 2021 court decision the FCC ignored record evidence in *Environmental Health Trust et al. v. the FCC.* After reviewing 10,000+ pages of evidence, the United States Court of

Appeals for the D.C. Circuit ruled that the FCC's 2019 decision not to update 1996 wireless radiation limits was "arbitrary and capricious." The Court found that the FCC did not provide evidence of properly examining non-cancer harms such as:

- long-term exposure
- children's vulnerability
- testimony of persons injured
- Impacts to the developing brain and reproductive
- system
- "Complete failure" to address environmental effects

Until more extensive and substantial scientific, ***and updated,*** evidence is produced to create strong assurances that 5G technology is safe and non-hazardous to people, Brooklyn Community Board #1 does not sanction installation of these units in our district.

Furthermore, the board urges OTI and CityBridge to (re)locate new 5G units in locations in the district other than solely the wealthy waterfront area, to create equitable distribution and access to the newest technology, also avoid redundant installation locations such as S 9th St & S 10th St. Instead consider alternative locations such as Greenpoint Landing, Domino and River Ring, massive residential development and park projects that are in the process of bringing thousands of new residents and visitors to Williamsburg and Greenpoint.

Working for a Safer Williamsburg-Greenpoint.

Sincerely,

Dealice Fuller

Dealice Fuller
Chairperson

Cc: Congresswoman Nydia Velazquez
Senator Kristen Gonzalez
Assembly Member Emily Gallagher
Brooklyn Borough President Antonio Reynoso
Councilmember Lincoln Restler
Councilmemer Jennifer Gutierrez

BROOKLYN COMMUNITY BOARD 9

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Member-at-Large

Khyrie Alleyne
Member-at-Large

BROOKLYN COMMUNITY BOARD 9
5G TOWER MORATORIUM RESOLUTION

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and

WHEREAS; City Bridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free 4G wireless cellular connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 9 in Brooklyn and other communities through out the NYC and constituents of their districts have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32' tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI installed 5G towers without notification and input from the residents and Community Board 9 in Brooklyn; and

WHEREAS; City Bridge and OTI have proposed unknown number of sites across Community District 9; and

BROOKLYN COMMUNITY BOARD 9

WHEREAS; City Bridge and OTI have stated that the siting of proposed Link5G towers in Community District 9 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; where the currently proposed locations for 5G towers are not disclosed to residents and Community Board 9; and

WHEREAS; residents of Community District 9 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred on Bedford; and

WHEREAS; 1O' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; there are no reported issues by residents of Community District 9 of cellular gaps and frequent dropped calls that would justify Link5G being installed in the proposed locations; and

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 9; and

WHEREAS; OTI and City Bridge have not provided detailed plans regarding the full build-out of Link5G, both within Community District 9 and other parts of the Borough; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there have been questions raised by some residents as to whether sufficient research has been performed to fully assuage concerns that the radiation emitted by 5G infrastructure won't have any long-term impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants, and parks; and

WHEREAS: there has the 5G towers pose safety risk including combustion, accidents related to the falling over of the 5G towers; and

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 9 in Brooklyn at present and until many of the issues identified have been resolved; and

BROOKLYN COMMUNITY BOARD 9

WHEREAS; New York City is in control of this process through its contract with the provider.

THEREFORE BE IT RESOLVED, Community Board 9 Brooklyn disapproves the proposal as presented to install Link 5G towers in Community District 9; and

BE IT FURTHER RESOLVED, to a request for a moratorium on the installation and activation of any new towers in the community district 9 and that OTI, DCP, the Departments of Health and Environmental Protection and any other relevant agencies are requested to come to the district to address community concerns around the installation of new towers, and the towers that have already been erected; and

BE IT FURTHER RESOLVED, the existing 5G are deactivated and removed; and

BE IT FURTHER RESOLVED, to require the listed organizations and agencies affiliated with the 5G Towers to make a presentation to CB9 Genera Board and host a question and answer session following the presentation.

Adopted:
5/23/2023

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City of New York
Community Board #1, Queens

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Andre Stith
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Rosemary Yelton

March 1, 2023

Stacey Gardener,
Senior Director of External Affairs
New York City Office of Technology and Innovation
2 Metro-tech Center
Brooklyn, NY 11201

Dear Ms. Gardener,

Community Board 1, Queens Environmental and Transportation Committees met with the Office of Technology and Innovation (OTI) City of New York formerly known as Department of Information Telecommunication and Technology (DOITT). On January 25, 2023 the committees also invited several experts in 5G to discuss the health risks surrounding the installation of 5G services closest to homes, residential buildings, schools and spaces in direct contact with people. After the committees reviewed the PowerPoint presentation presented by OTI and later heard from the expert's rebuttals related to safety concerns the committee deliberated.

The Environmental Committee and Transportation Committee came to a consensus that there needed to be more information provided to prove the safety of 5G in the community. Therefore, they voted to recommend to Community Board 1, Queens Full Board a denial of the use of LinksNYC podiums for 5G towers until proof of safety was provided.

At the February 28, 2023 Full Board Meeting the Board voted in favor of this recommendation. Therefore, Community Board 1, Queens recommends denial of installations of any and all 5G antennas within the boundaries of the district until OTI can prove the health safety verification statistics of these monopoles for our residents. We seek documented follow up from your office with statistical information supporting the safety of the equipment used and installed by OTI.

Please provide this information to the District Office prior to any installations.

Thank you.

Sincerely,

Marie Tomiali
Chairperson

Florence Koulouris
District Manger

Community Board 12
The City of New York
Borough of Queens

Jamaica, Hollis, St. Albans, South Ozone Park, and Springfield Gardens

90-28 161st Street, Jamaica, New York 11432 ▪ (718) 658-3308 ▪ Fax (718) 739-6997 ▪ qn12@cb.nyc.gov

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DONOVAN RICHARDS
Borough President

REV. CARLENE O. THORBS
Chairperson

MARICELA CANO
Director of Community Boards

YVONNE REDDICK
District Manager

June 1, 2023

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Nicole Garcia
Queens Borough Commissioner
NYC Department of Transportation
120-55 Queens Boulevard., Room 285
Queens, NY 11424

RE: Disapproval of New and Additional LinkNYC and Link5G Kiosks and Towers and Existing Link5G Towers within Queens Community District 12

Dear CTO Fraser and Borough Commissioner Garcia:

WHEREAS, The City of New York through its Office of Technology and Innovation (OTI) commissioned CityBridge to install and operate a citywide wireless telecommunications network, commonly referred to as LinkNYC; and

WHEREAS, The LinkNYC network was designed so that telecommunication kiosks and/or towers would supersede the now defunct public pay phones using the existing telecommunication lines rather than install new infrastructure; and

WHEREAS, LinkNYC was intended to provided free wireless internet connectivity (Wi-Fi), mobile device charging, and emergency calls to the public using 9-1/2 foot LinkNYC kiosks placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS, as of February 28, 2023, the catchment area of Queens Community District 12 currently has 275 mobile telecommunication reservation pole locations, according to the City of New

York's Open Data website, https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6; and

WHEREAS, all of the Link5G towers that have so far been constructed and installed within Queens Community District 12 have been done without prior written notice to Community District 12 or prior community participation, input or approval by Community District 12; and

WHEREAS, all of the LinkNYC kiosks, and telecommunications devices such as pole tops and canisters of 4G/5G "small" cells on utility poles have been installed within Queens Community District 12 without prior written notice to Community District 12 or prior community participation, input or approval by Community District 12; and

WHEREAS, there are 104 Link5G towers planned for Queens Community District 12 under the "Equitable Deployment Mandate" set forth in OTI's Link5G Presentation of December 13, 2021 to the Public Design Commission at https://www.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf; and

WHEREAS, OTI presented the proposed installation of eleven (11) Link5G towers presented at the Transportation Committee meeting held on March 14, 2023 of Queens Community Board 12; and

WHEREAS, there are sixty-seven (67) Link5G towers now listed on OTI's LinkNYC New Site Permit Applications, updated as of May 26, 2023, at https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux; and

WHEREAS, CityBridge and OTI have stated that the siting of the Link5G towers in Community District 12 has been based on capacity needs for potential future demand in cellular service identified by commercial cellular carriers; and

WHEREAS, neither CityBridge nor the cellular network providers that the Link5G service is intended to supplement has provided any evidence that dropped calls and limited capacity are present at the proposed or current Link5G locations; and

WHEREAS, CityBridge and OTI are in the midst of upgrading the LinkNYC network from 4G to 5G to accommodate greater broadband capacity and associated features common in current mobile communication devices; and

WHEREAS, the Link5G infrastructure are primarily 32' tall towers which are installed on sidewalks in the public right-of-way; and

WHEREAS, 5G mobile technology has greater signal intensity over shorter distances which require further installation and densification of kiosks and towers to provide similar coverage to its 4G predecessor; and

WHEREAS, there was concern that the Link5G tower project had not undergone review otherwise required under NYC's Uniform Land Use Review Procedure (ULURP); and

WHEREAS, Queens Community District 12 constituents/residents have reported adverse impacts resulting from existing LinkNYC and Link5G infrastructure; including visual impact, light pollution, insufficient sidewalk clearances, and adverse physical health impacts; and

WHEREAS, there is concern regarding the peer-reviewed, scientific studies showing adverse impacts to humans from radio-frequency radiation, and other studies showing adverse impacts to flora and fauna: and

WHEREAS, Queens Community District 12 constituents/residents have reported concerns over the cyber security and privacy risks of Link5G towers; and

WHEREAS, Queens Community District 12 constituents/residents have strongly objected to the visual impacts of Link5G towers on the streetscapes; and

WHEREAS, there are widespread concerns that Link5G towers will be constructed at distances considered too close to adjacent buildings, without a sufficient fall zone in the event of structural failure collapse of such towers into homes, schools or onto the streets with pedestrian and vehicular traffic; and

WHEREAS, there was concern with the ability for constituents/residents to obtain federal mortgage and home ownership assistance in light of the U.S. Department of Housing and Urban Development (HUD) categorizing cell towers in general as "Hazards and Nuisances" and that the Federal Housing Administration will not issue mortgages for homes within the fall zone of a cell tower; and

WHEREAS, the inability to obtain federal mortgage and home ownership assistance does not serve economic equity or environmental justice goals in Community District 12; and

WHEREAS, there is a desire for any telecommunications infrastructure to be buried underground for capacity and reliability purposes, to minimize visual impacts, and to allow for sidewalk clearances; and

WHEREAS, there is a desire for telecommunications infrastructure to be wired to the premises for greater capacity and reliability, such as fiber optics, which the federal government has made a national priority under the Infrastructure Investment and Jobs Act of 2021; and

WHEREAS, scientific research has shown that light pollution endangers the reproductive processes of the endemic moth population and other nocturnal animals; and

WHEREAS, currently there is insufficient study and information on the potential long-term health impacts of continuous exposure to 5G signals/radiation on humans and animals that reside and/or work adjacent to 5G infrastructure; and

WHEREAS, the Federal Communications Commission (FCC) has notified CityBridge in its letter of April 20, 2023 of its failure to comply with federal law under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA) prior to its installation of the Link5G towers;

WHEREAS, CityBridge already installed Link5G towers in Queens Community District 12 prior to the FCC's April 20, 2023 letter;

WHEREAS, we the members of Queens Community Board 12 are opposed to the further installation of LinkNYC and Link5G kiosks and towers and pole installations; and therefore be it

RESOLVED, that Queens Community Board 12 disapproves of the proposed installation of the eleven Link5G towers presented at the Transportation Committee meeting held on March 14, 2023 and of any future installations, including without limitation the sixty-seven (67) Link5G towers now listed on OTI's LinkNYC New Site Permit Applications, updated as of May 26, 2023, at https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux; and

BE IT FURTHR RESOLVED, that Queens Community Board 12 disapproves of its designation as a district under the "Equitable Deployment Mandate;" and

BE IT FURTHER RESOLVED, that Queens Community Board 12 disapproves of provisioning for service current Link5G towers installed in Community District 12, and that any Link5G towers that have been provisioned for service be immediately deactivated and decommissioned; and

BE IT FURTHER RESOLVED, that an immediate moratorium be placed on the planning, addition, installation or construction of any further mobile telecommunication kiosks, towers, devices and pole locations in Queens Community Board 12, until conclusive data can be found showing little to no adverse health risks to humans, fauna, and flora, and the issues otherwise set forth herein have been resolved.

Please advise Community Board 12 on all actions taken on this matter.

Respectfully submitted,

Rev. Carlene O. Thorbs

Rene Hill

Rev. Carlene O. Thorbs, Chairperson
Queens Community Board 12

Rene Cheatham-Hill, Chairperson
Transportation Committee

cc: Hon. Eric L. Adams, Mayor of the City of New York
Hon. Donovan Richards, Queens Borough President
Hon. Adrienne Adams, Speaker of the New York City Council and Representative of the 28th Council District
Hon. Linda Lee, 23rd Council District, New York City Council
Hon. James Gennaro, 24th Council District, New York City Council
Hon. Nantasha Williams, 27th Council District, New York City Council
Hon. Selvena N. Brooks-Powers, 31st Council District, New York City Council
Hon. Jumaane D. Williams, Public Advocate, City of New York
Hon. Bradford S. Lander, Comptroller, City of New York
Hon. James Sanders, Jr., 10th Senatorial District, New York State Senate
Hon. Leroy Comrie, 14th Senatorial District, New York State Senate

Hon. Alicia Hyndman, 29th Assembly District, New York State Assembly
Hon. Khaleel Anderson, 31st Assembly District, New York State Assembly
Hon. Vivian E. Cook, 32nd Assembly District, New York State Assembly
Hon. Clyde Vanel, 33rd Assembly District, New York State Assembly



February 9, 2023

COMMUNITY BOARD #14

Matthew C. Fraser,
Chief Technology Officer
NYC Office of Technology & Innovation
2 Metro Tech Center, P1
Brooklyn, NY 11201

COMMUNITY BOARD #14
City of New York
Borough of Queens

DOLORES ORR
Chairperson

JONATHAN GASKA
District Manager

Dear Technology Officer Fraser:

On behalf of the Community Board, the Executive Board of Community Board #14 un-conditionally opposes the following: all proposed locations for Link5G/cell towers that are near or in front of residential homes, houses of worship or mixed use commercial/residential locations.

We oppose the following:

1. 1400 Brunswick Avenue
2. 71-02 Beach Channel Drive
3. 66-03 Beach Channel Drive
4. 32-11 Beach Channel Drive
5. 67-19 Rockaway Beach Blvd.
6. 72-19 Rockaway Beach Blvd.
7. 88-07 Rockaway Beach Blvd.

The Board also opposes the placement of a tower in front of 112-01 Beach Channel Drive until and unless further study as to safety and local community input has occurred. We thank you in advance for support.

Sincerely,

Jonathan Gaska,
District Manager

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qn14@cb.nyc.gov—NEW
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FACEBOOK: cb14rockaway

Cc:
Hon. Donovan Richards
Hon. Selvena Brooks-Powers
Hon. Joanne Airola
N. Garcia, Qns. DOT Comm.

Written Testimony of
Odette Wilkens, President & General Counsel
Wired Broadband, Inc.
owilkens@wiredbroadband.org
646.939.6855

Hearing of New York City Council Committee on Technology
June 7, 2023

This is a supplemental update on community board disapprovals and moratoria. These comprise 12 of the 16 community boards that have disapproved or called for moratoria.

Russell Squire
Chair

Will Brightbill
District Manager

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New York, N.Y. 10022-1106
(212) 758-4340
(212) 758-4616 (Fax)
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The City of New York
Community Board 8 Manhattan

December 20, 2022

Edward F. Pincar
Manhattan Borough Commissioner
Department of Transportation
59 Maiden Lane, 37th Floor
New York, NY 10038

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

RE: Disapproval of new Link5G Kiosks within CB8

Dear CTO Fraser and Commissioner Pincar,

At the Full Board meeting of Community Board 8 Manhattan held on December 14, 2022, the board approved the following resolution by a vote of 40 in favor, 2 opposed, 0 abstentions and 0 not voting for cause:

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS; CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free wireless internet connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 8 and constituents of its district have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32’ tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI have proposed 18 sites across Community District 8;

WHEREAS; CityBridge and OTI have stated that the siting of proposed Link5G towers in Community District 8 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; 15 of the 18 sites proposed are in or near either the Upper East Side Historic District or the Carnegie Hill Historic District, where renowned architecture and iconic streetscapes would be interfered with if Link5G structures were installed; and

WHEREAS; locations proposed along Madison Avenue would be in conflict with strict guidelines for illuminated storefronts and signage, and would be in conflict with the Special Madison Avenue Preservation District's design standards that specifically prohibit illuminated advertising; and

WHEREAS; residents of Community District 8 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred in front of 520 East 90th Street, and

WHEREAS; 10' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; Neither CityBridge nor the cellular network providers that Link5G service is intended to supplement have provided any evidence that dropped calls and limited capacity are present at the proposed Link5G locations;

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 8; and

WHEREAS; OTI and CityBridge have not provided detailed plans regarding the full build-out of Link5G, both within Community District 8 and in areas north of 96th Street and in the outer Boroughs; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there have been questions raised by some residents as to whether sufficient research has been performed to fully assuage concerns that the radiation emitted by 5G infrastructure won't have any long-term impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants, and parks;

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 8 at present and until many of the issues identified have been resolved;

WHEREAS; New York City is in control of this process through its contract with the provider;

THEREFORE BE IT RESOLVED, that Community Board 8 Manhattan disapproves the proposal as presented to install Link 5G towers in Community District 8; and

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G poles and devices in Community District 8 Manhattan.

Please advise us of any action taken on this matter.

Sincerely,

Russell Squire *Craig Lader and Charles Warren*

Russell Squire
Chair

Craig Lader and Charles Warren
Co-Chairs, Transportation Committee

cc: Honorable Eric Adams, Mayor of the City of New York
Honorable Carolyn Maloney, 12th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Liz Krueger, NYS Senator, 28th Senatorial District
Honorable José M. Serrano, NYS Senator, 29th Senatorial District
Honorable Edward Gibbs, NYS Assembly Member, 68th Assembly District
Honorable Dan Quart, NYS Assembly Member, 73rd Assembly District
Honorable Rebecca Seawright, NYS Assembly Member 76th Assembly District
Honorable Keith Powers, NYC Council Member, 4th Council District
Honorable Julie Menin, NYC Council Member, 5th Council District

Community Board 12
The City of New York
Borough of Queens

Jamaica, Hollis, St. Albans, South Ozone Park, and Springfield Gardens

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DONOVAN RICHARDS
Borough President

REV. CARLENE O. THORBS
Chairperson

MARICELA CANO
Director of Community Boards

YVONNE REDDICK
District Manager

June 1, 2023

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Nicole Garcia
Queens Borough Commissioner
NYC Department of Transportation
120-55 Queens Boulevard., Room 285
Queens, NY 11424

RE: Disapproval of New and Additional LinkNYC and Link5G Kiosks and Towers and Existing Link5G Towers within Queens Community District 12

Dear CTO Fraser and Borough Commissioner Garcia:

WHEREAS, The City of New York through its Office of Technology and Innovation (OTI) commissioned CityBridge to install and operate a citywide wireless telecommunications network, commonly referred to as LinkNYC; and

WHEREAS, The LinkNYC network was designed so that telecommunication kiosks and/or towers would supersede the now defunct public pay phones using the existing telecommunication lines rather than install new infrastructure; and

WHEREAS, LinkNYC was intended to provided free wireless internet connectivity (Wi-Fi), mobile device charging, and emergency calls to the public using 9-1/2 foot LinkNYC kiosks placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS, as of February 28, 2023, the catchment area of Queens Community District 12 currently has 275 mobile telecommunication reservation pole locations, according to the City of New

York's Open Data website, https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6; and

WHEREAS, all of the Link5G towers that have so far been constructed and installed within Queens Community District 12 have been done without prior written notice to Community District 12 or prior community participation, input or approval by Community District 12; and

WHEREAS, all of the LinkNYC kiosks, and telecommunications devices such as pole tops and canisters of 4G/5G "small" cells on utility poles have been installed within Queens Community District 12 without prior written notice to Community District 12 or prior community participation, input or approval by Community District 12; and

WHEREAS, there are 104 Link5G towers planned for Queens Community District 12 under the "Equitable Deployment Mandate" set forth in OTI's Link5G Presentation of December 13, 2021 to the Public Design Commission at https://www.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf; and

WHEREAS, OTI presented the proposed installation of eleven (11) Link5G towers presented at the Transportation Committee meeting held on March 14, 2023 of Queens Community Board 12; and

WHEREAS, there are sixty-seven (67) Link5G towers now listed on OTI's LinkNYC New Site Permit Applications, updated as of May 26, 2023, at https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux; and

WHEREAS, CityBridge and OTI have stated that the siting of the Link5G towers in Community District 12 has been based on capacity needs for potential future demand in cellular service identified by commercial cellular carriers; and

WHEREAS, neither CityBridge nor the cellular network providers that the Link5G service is intended to supplement has provided any evidence that dropped calls and limited capacity are present at the proposed or current Link5G locations; and

WHEREAS, CityBridge and OTI are in the midst of upgrading the LinkNYC network from 4G to 5G to accommodate greater broadband capacity and associated features common in current mobile communication devices; and

WHEREAS, the Link5G infrastructure are primarily 32' tall towers which are installed on sidewalks in the public right-of-way; and

WHEREAS, 5G mobile technology has greater signal intensity over shorter distances which require further installation and densification of kiosks and towers to provide similar coverage to its 4G predecessor; and

WHEREAS, there was concern that the Link5G tower project had not undergone review otherwise required under NYC's Uniform Land Use Review Procedure (ULURP); and

WHEREAS, Queens Community District 12 constituents/residents have reported adverse impacts resulting from existing LinkNYC and Link5G infrastructure; including visual impact, light pollution, insufficient sidewalk clearances, and adverse physical health impacts; and

WHEREAS, there is concern regarding the peer-reviewed, scientific studies showing adverse impacts to humans from radio-frequency radiation, and other studies showing adverse impacts to flora and fauna: and

WHEREAS, Queens Community District 12 constituents/residents have reported concerns over the cyber security and privacy risks of Link5G towers; and

WHEREAS, Queens Community District 12 constituents/residents have strongly objected to the visual impacts of Link5G towers on the streetscapes; and

WHEREAS, there are widespread concerns that Link5G towers will be constructed at distances considered too close to adjacent buildings, without a sufficient fall zone in the event of structural failure collapse of such towers into homes, schools or onto the streets with pedestrian and vehicular traffic; and

WHEREAS, there was concern with the ability for constituents/residents to obtain federal mortgage and home ownership assistance in light of the U.S. Department of Housing and Urban Development (HUD) categorizing cell towers in general as "Hazards and Nuisances" and that the Federal Housing Administration will not issue mortgages for homes within the fall zone of a cell tower; and

WHEREAS, the inability to obtain federal mortgage and home ownership assistance does not serve economic equity or environmental justice goals in Community District 12; and

WHEREAS, there is a desire for any telecommunications infrastructure to be buried underground for capacity and reliability purposes, to minimize visual impacts, and to allow for sidewalk clearances; and

WHEREAS, there is a desire for telecommunications infrastructure to be wired to the premises for greater capacity and reliability, such as fiber optics, which the federal government has made a national priority under the Infrastructure Investment and Jobs Act of 2021; and

WHEREAS, scientific research has shown that light pollution endangers the reproductive processes of the endemic moth population and other nocturnal animals; and

WHEREAS, currently there is insufficient study and information on the potential long-term health impacts of continuous exposure to 5G signals/radiation on humans and animals that reside and/or work adjacent to 5G infrastructure; and

WHEREAS, the Federal Communications Commission (FCC) has notified CityBridge in its letter of April 20, 2023 of its failure to comply with federal law under the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA) prior to its installation of the Link5G towers;

WHEREAS, CityBridge already installed Link5G towers in Queens Community District 12 prior to the FCC's April 20, 2023 letter;

WHEREAS, we the members of Queens Community Board 12 are opposed to the further installation of LinkNYC and Link5G kiosks and towers and pole installations; and therefore be it

RESOLVED, that Queens Community Board 12 disapproves of the proposed installation of the eleven Link5G towers presented at the Transportation Committee meeting held on March 14, 2023 and of any future installations, including without limitation the sixty-seven (67) Link5G towers now listed on OTI's LinkNYC New Site Permit Applications, updated as of May 26, 2023, at https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux; and

BE IT FURTHR RESOLVED, that Queens Community Board 12 disapproves of its designation as a district under the "Equitable Deployment Mandate;" and

BE IT FURTHER RESOLVED, that Queens Community Board 12 disapproves of provisioning for service current Link5G towers installed in Community District 12, and that any Link5G towers that have been provisioned for service be immediately deactivated and decommissioned; and

BE IT FURTHER RESOLVED, that an immediate moratorium be placed on the planning, addition, installation or construction of any further mobile telecommunication kiosks, towers, devices and pole locations in Queens Community Board 12, until conclusive data can be found showing little to no adverse health risks to humans, fauna, and flora, and the issues otherwise set forth herein have been resolved.

Please advise Community Board 12 on all actions taken on this matter.

Respectfully submitted,

Rev. Carlene O. Thorbs

Rene Hill

Rev. Carlene O. Thorbs, Chairperson
Queens Community Board 12

Rene Cheatham-Hill, Chairperson
Transportation Committee

cc: Hon. Eric L. Adams, Mayor of the City of New York
Hon. Donovan Richards, Queens Borough President
Hon. Adrienne Adams, Speaker of the New York City Council and Representative of the 28th Council District
Hon. Linda Lee, 23rd Council District, New York City Council
Hon. James Gennaro, 24th Council District, New York City Council
Hon. Nantasha Williams, 27th Council District, New York City Council
Hon. Selvena N. Brooks-Powers, 31st Council District, New York City Council
Hon. Jumaane D. Williams, Public Advocate, City of New York
Hon. Bradford S. Lander, Comptroller, City of New York
Hon. James Sanders, Jr., 10th Senatorial District, New York State Senate
Hon. Leroy Comrie, 14th Senatorial District, New York State Senate

Hon. Alicia Hyndman, 29th Assembly District, New York State Assembly
Hon. Khaleel Anderson, 31st Assembly District, New York State Assembly
Hon. Vivian E. Cook, 32nd Assembly District, New York State Assembly
Hon. Clyde Vanel, 33rd Assembly District, New York State Assembly

The City of New York

Community Board Ten

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Secretary
SHIRLEY CHIN
Treasurer

January 26, 2023

Leslie Brown
External Affairs Associate
New York City Office of Technology and Innovation
150 William Street
New York, NY 10038

Dear Ms. Brown:

At a duly publicized meeting of Community Board 10, Brooklyn, held on January 23, 2023, Members voted unanimously to disapprove the placement of the proposed LinkNYC kiosks without having more and better information about the potential health and safety effects. The proposed sites are: BK-10-GF34914 – 7701 Shore Road; BK-10-GF34915 – 8301 Shore Road; BK-10-GF34916 – 699 92nd Street; and BK-10-GF34917-166 Battery Avenue, all within the confines of Brooklyn Community District Ten.

Additionally, Board Members considered comments from the public that kiosks and free wifi are not needed. There were also concerns regarding the height of the poles and the potential for loitering crowds around the kiosks causing disruption to residents in very close proximity.

I have attached the Communications and Public Relations Committee Report for your review.

Thank you for your attention. If you have questions or need further information, please do not hesitate to contact my office.

Sincerely,

Josephine Beckmann
District Manager

JB:dg

cc: BP Antonio Reynoso
CM Justin Brannan

The Communications Committee Report
January 10, 2023

The communications committee of Community Board 10 met in quorum on Zoom on Tuesday, January 10, 2023, at 7:15pm. Committee members present were chair Henry Stewart, Salah Altayeb, Tracie Britton, Judith Collins, Carmen Feliciano, Elizabeth Lovejoy and Essa Masoud, as well as board chair Jaynemarie Capetenakis and district manager Josephine Beckmann.

Others present were Stacy Gardner, senior director of external affairs for the city's Office of Technology and Innovation, which oversees the LinkNYC franchise, operated by a consortium of companies called CityBridge; Brett Sikoff, executive director of franchise administration at OTI; and Nick Colvin and Rob Sokota of CityBridge.

On the agenda was a discussion of OTI's plan to install four LinkNYC sites in residential areas of CD10—at 7701 Shore Road, 8301 Shore Road, 699 92nd Street and 166 Battery Avenue. There are presently no LinkNYC sites in the district. They are in all five boroughs, but mostly Manhattan.

OTI has the authority to let companies use the city's rights of way, in this case streets and sidewalks, to deploy telecommunications technology, and in return they pay the city revenue. This is the franchise agreement.

The program began in 2014–15, as a way to replace payphones. The original Link kiosk provided free wi-fi, free nationwide calling, free device charging, a dedicated 911 button and a tablet to access city services—311, maps, nearby social services. They also had advertising screens on the sides, which provided the revenue source. It was not taxpayer funded. It makes money, so far $100 million, with approximately 2,000 kiosks.

There were problems with CityBridge and the franchise agreement, and the contract was amended, most significantly to require 90 percent of new kiosks to be outside of the central business district of Manhattan (above 96th Street and the other four boroughs). They also pivoted on the revenue source. Advertising screens continue to be a part of the program, but another source was sought, tied to expanding telecommunication service to the city. The LinkNYC kiosk was redesigned to accommodate mobile telecommunication infrastructure—antennas and radios. At the top of the redesigned kiosk is space for equipment that cell phone providers use to enhance their networks. The Public Design Commission approved the redesign in late 2021, after which OTI began fabricating the Link 5G structures.

OTI is now in a five-borough rollout in twenty community districts. Some of these are on commercial corridors, as in the original program; others are in historic districts, parks and residential areas. Three of the four proposed in CD10 are in zoned residential areas. Kiosks in residential areas do not have advertising screens. None of the towers proposed in CD10 would have advertising screens, but they would have the tablets,

charging stations and wifi. (The fourth, by Fort Hamilton High School, is zoned as parkland.) They are 32-foot poles with the tablets offering access to city services and the other services. They have room for a "multi-tenant structure" on top, so several different providers can utilize it. AT&T, Verizon and T-Mobile could all put equipment in there that decreases the amount of cell towers on rooftops and pole tops. The sites in CD10 were chosen for mobile communications companies' benefit.

Mr. Colvin said the new custom-built structures plug in coverage and capacity needs on the mobile-carrier networks and build out high-speed networks, particularly in the outerboroughs, where there's a dearth of available siting opportunities. He said they were necessary for building out the future of mobile wireless communication. There's a need and demand in the city for not just faster speeds but also service capacity. Every Link 5G site is driven by a specific request from a mobile carrier because of identified needs for service.

Mr. Sokota said he understands objections to new large infrastructure placed in neighborhoods, but the reality of changes in cellular service and the increasing demands all citizens place on the mobile-phone services means that over the next few years there will be a need for new infrastructure, additional places to broadcast their signal, to support the ever-increasing demand of their customers for service. As a result, this type of infrastructure is going to parade through the city in all neighborhoods; if it doesn't, for whatever reason, that neighborhood will have a much lower level of service, potential "holes in the network," creating problems for residents, visitors and emergency services.

It is difficult for carriers to provide service to parts of Bay Ridge because of the nature of the neighborhood—highly residential, largely low scale. From a siting perspective, it's a difficult place. Even from a Link5G perspective, there are limited place to put towers according to their siting rules, because of overhead wires or thick foliage. They cannot be placed on corners, at bus stops, in front of fire hydrants or curb cuts; they must be placed on sidewalks at least eight feet wide; they can't interfere with a driver's line of sight or be too close to a sidewalk café or newsstand. There are more than 100 limitations. Moving forward, more infrastructure will probably need to be placed on existing light poles and utility poles. The sites chosen were not done so randomly or arbitrarily; they are carefully vetted, though they may still prove unusable—perhaps someone installs a curb cut, or there's something unknown underground that prevents installation. They are meant to solve a problem that exists today but also will be worse tomorrow without new infrastructure.

The first site is 8301 Shore Road, in front of the high school, across from the park, just off the corner of Shore Road Lane, where the sidewalk is wide, hopefully creating minimum impact on residents while increasing coverage on Shore Road. The next is 699 92nd Street, in front of the hospital, just off the corner of Seventh Avenue, where the sidewalk is also wide. The next is in front of a private home at 166 Battery Avenue, with the kiosk actually on 92nd Street, just off the corner with Battery, approximately 600–1,000 feet away from the previous location. The house is set back from the street,

with a wide sidewalk, a site meant to cause less imposition on residents than others. The last is 7701 Shore Road, on the east side of the street, just south of the corner of 77th Street, in front of another private home. Finding locations on Shore Road are difficult, because of grassy areas on sidewalks, driveways and dense tree cover, but the site at 7701 is one of the few they found that was suitable.

These sites are residential but also heavily trafficked—Shore Road, 92nd Street—meaning there's a higher demand for services on them than there might be in other residential areas.

Chair Capetenakis said when these ideas were first presented to the board ca. 2017, the city was talking about parks, not residential areas, so this shift requires some serious consideration from the board. She also asked for the dimensions of the kiosks. Mr. Colvin said the Link 5G structures for residential areas are 32 feet tall, 18" in diameter at the base, 19" in depth with the tablet interface, and at the top 28" or 34" in diameter, to accommodate the telecommunications infrastructure, which begins about 17 feet up. Street poles (light, traffic, utility) are 32 feet tall. Height is important because it allows the signal to travel farther with fewer interruptions.

Chair Capetenakis asked why existing street poles aren't being used at this time, instead of new Link 5G towers. Ms. Garden said a separate franchise with OTI has been doing that work in cooperation with DoT for the last fifteen years, supplementing carriers' 4G coverage throughout the entire city, in every district. But that it's not an either/or proposition. Mr. Sokota said the 5G infrastructure is different from 4G, and also that street poles were not built for this purpose and can't handle the same capacity as a Link 5G tower, which are specially designed to handle four times the radios. He said this is more efficient. He added that in a neighborhood like Bay Ridge you will see both of these solutions deployed in the next few years.

Chair Capentenakis expressed concern about safety and nuisance concerns. BM Masoud expressed concern about radiation and radio-frequency emissions from the towers—the services from the kiosks are welcome, but not the communications infrastructure. Ms. Gardner said there are already these types of installments in residential areas, needed to provide cell phone service—on pole tops, on rooftops and private properties. This project reduces the number of towers that need to be deployed by allowing multiple tenants to use the same one.

The city does not regulate radio-frequency emissions, but the federal government does, and Ms. Gardner said the contract with CityBridge requires its equipment to comply with FCC regulations, which it does, as verified by independent testing. Mr. Sikoff said 4G and 5G are not novel technologies but have been employed in the city and elsewhere for years. Chair Beckmann said this is different, because it's a tower in front of a residence, facing windows; she added that the FCC requirements are antiquated, having been put in place ca. 1996. She said this is new, and we don't have up-to-date studies. Once, she reminded the committee, X-rays were considered safe.

BM Britton asked if there have been environmental studies on the effects on plants and wildlife. Mr. Sokota said he's not aware of any scientific studies looking at the different frequencies used by 4G compared with 5G and whether they have different impacts, and that these networks have been deployed for twenty or thirty years.

BM Stewart asked how far the service from these towers extends. Mr. Sokota said about 500 feet, perhaps a little longer. BM Stewart asked if the service only extends 500 feet, will there one day be a 5G tower on every block? Mr. Sokota said there will be more, in addition to pole-top installations, but not on every block. They must be at least 200 feet apart, one per block and only on one side of the block. Ms. Gardner said the original LinkNYC kiosks were permitted to be much closer together, but these are not.

BM Stewart also asked whether towers could continue to be placed on the tops of tall buildings, as there are many in Bay Ridge. Mr. Sokota said Shore Road, for example, is park on one side and residences on the other, so it makes it difficult to find the tall buildings needed to expand mobile service. BM Stewart said while ten to fifteen blocks of Shore Road featured private residences, the rest has apartment buildings six or more stories tall. Mr. Sokota said the cell service in those areas might be better. The parts of Shore Road they chose were generally lower-lying areas.

Member of the public George Shahin lives close to the tower proposed for 77th Street and said he was dissatisfied with the reasoning for it. He opposed all the towers, but at least the other three are not directly in front of homes; the tower on 77th Street would be very close to a private residence, without a setback. He also couldn't believe there was a restriction against placing a tower near a sidewalk café but not in front of a private home.

Mr. Sokota said he understood the objection, but in that area of Shore Road it was challenging to find a location, because it was essentially all residential homes similar to the ones they would build adjacent to. He said they desire to avoid building in front of homes wherever possible, but in this particular area there were no siting locations that wouldn't be in front of someone's house.

Ms. Gardner clarified that sidewalk cafés limit clearance space on the sidewalk, which is why they impact 5G tower placements.

BM Stewart said there was a religious building now being used as a school two blocks away from the proposed site on 77th Street, on Bay Ridge Parkway, and asked whether that site had been examined. Mr. Sokota said he'd have to check, but he thought maybe Bay Ridge Parkway might have been too far north for the coverage needed in the lower-lying area of Shore Road.

Member of the public Brenda Lutfey Avignone lives next door to Mr. Shahin and said this block has special challenges, going back to when the city tried to plant a tree in front of her house and broke the gas line. The block has ConEdison problems—a fire last year, and an explosion—the gas and electric lines underground are close together,

a fire hydrant, a sewage problem and people loitering, drinking and doing drugs, and she was worried that the tower would attract more people. She asked why the tower couldn't be placed in the park.

Ms. Gardner said some towers were being sited inside parks, so that was a possibility. And she was glad to know about potential underground infrastructure problems at this point in the process.

Member of the public Odette Wilkens is a technology attorney and the head of the nonprofit Wired Broadband. She said CB8 in Manhattan has placed a moratorium on Link 5G poles in its district, because of long-term health impacts; illuminated advertising; vagrants congregating around them; and that there were no reported gaps in phone or Internet access. She asked where the gaps in cell phone service are; there are no reports, just telecom say-so. She said OTI had no legal right to build without demonstrating gaps in coverage.

She said there's already a fiber-optic buildout on which 5G depends, so why not build out that superior network service to physical premises? In Chattanooga, she said, they installed fiber optics to all premises, so now they have the fastest Internet in the U.S. She added the FCC sets emission levels, but it doesn't track any tower below 200 feet; the telecoms do the testing to show they're in compliance, and those tests are unreliable. Their claims about gaps in coverage have also been found to be less than 100 percent reliable.

She spoke on behalf of Barbara Hayes, who was having a trouble unmuting. An elderly woman, Ms. Hayes lives in an apartment outside of which a 5G tower was placed; formerly healthy, she has since become very sick, which she attributes to the tower. In Pittsfield, Mass., 17 people became ill when Verizon placed a 5G tower on their street. Wireless radiation in parks have led to a decline in bird populations, beehive collapses and the deaths of trees. She said a school was not a good place for a tower because children exposed to 5G could lead to developmental problems later in life, and leukemia. Healthcare facilities were also no good because wireless radiation can impact cardiac function. She said 5G infrastructure runs hot, and it can eat up tremendous energy and catch fire.

In the chat, a member of the public asked about damaged kiosks going unrepaired, and about promised revenue falling short. Ms. Gardener said CityBridge must maintain the kiosks physically and clean them twice a week. Open data shows which kiosks need repair in near-real time, and if that system fails, there is a 311 category for reporting malfunctioning kiosks. The revenue issue was part of what drove the renegotiated contract/restructured franchise. These issues have been addressed.

Ms. Gardner has been at OTI for six years, during which it has deployed the kiosks. She said she receives all the complaints about LinkNYC; anecdotally, she receives very few, for the number of kiosks in the city, but when she does, they work with agency partners to remedy them immediately, such as vagrancy, scaffolding, debris or illegal activity.

She said 311 was the best way to get attention to these problems. Ongoing issues can get NYPD attention.

DM Beckmann said the most difficult problems to address that come in through 311 are quality-of-life issues, particularly noise.

BM Thum asked if the board had the final say in this matter, and DM Beckmann said the board's role tonight was to provide feedback to OTI about its proposal.

In the chat, a member of the public asked about the towers' effects on property values, and also about the security of the data from the kiosks and what kind of cameras they use. Ms. Gardner said property values were not her wheelhouse, but that these kiosks provide necessary services and OTI sees them as a boon to any community. OTI has an extremely strong privacy policy; the franchisee is not allowed by contract to collect any information except for email addresses provided by users when agreeing to terms of use, and those are purged after a year. They are not connected to you or your device. They don't retain any device identifiers. If you just walk by, they're not taking information from your phone.

Mr. Colvin said cameras are permitted on the structures above advertising screens. Those cameras are kept off unless needed, such as if there were a vandalism spree, during which they may be turned on for a brief time. There's a camera on the tablet for the deaf and hard of hearing to make phone calls in sign language. There are internally facing sensors that monitor the heat of the structures.

A member of the public commented that free wifi was not needed, and that locals on 77th Street paid for fiber-optic cable. Member of the public Julie Mardin asked about the new type of antennae used and about millimeter waves. Mr. Sokota said the federal government has made higher-bandwidth frequencies available to the mobile companies. The earliest cell phone service broadcast on 800 to 900 mHz, followed a decade later by about 1,800 mHz, and now the frequencies are going above 6 GHz, or 6,000 mHz, above which are called "millimeter waves." The principal difference to more traditional services, the higher frequency bandwidth travels a shorter distance, and as a result will be at a lower power than traditional frequencies, because it's not going as far. In some instances, they won't penetrate certain surfaces, such as a wall. But they can carry significantly more traffic, so there's a tradeoff—is capacity more important than how far the signal can travel? He said he was unaware of any information that these new frequencies have a different effect than the older frequencies.

Member of the public Donna Lu said studies have shown people are getting sick from CitiBike emissions; now we're talking about kiosks less than a mile from CitiBikes, in addition to apartment building towers. She said when cell phone towers were first being placed, there were restrictions about their proximity to schools, and now they're being built across the street from schools. She said she didn't know what the health effects would be five or ten years from now.

BM Stewart asked for the committee's input on a recommendation. BM Feliciano said she became disabled fifteen years after volunteering at Ground Zero and has received so many scans that she can no longer be exposed to unlimited radiation, and tests must be evaluated to be necessary. She said having these towers near schools, healthcare facilities, was too dangerous given the unknowns about their health effects. That's the number one issue, because those things cannot be reversed.

BM Collins said further study was needed and the board shouldn't be pressured to make a decision this quickly.

The board also received at least 15 emails from local residents concerned about loitering and the health implications of placing these technologies in residential areas.

BM Stewart proposed a motion that CB10 denies support to the placement of these towers without having more and better information about the potential health and safety effects. It was seconded by BM Britton, and the motion passed unanimously.

DM Backmann proposed a future joint meeting of the Communications, Health and Welfare and Environmental committees to delve deeper into these issues.

With no other questions or comments, the meeting was adjourned.

Henry Stewart

Respectfully submitted,
Henry Stewart

City of New York
Community Board #1, Queens

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March 1, 2023

Stacey Gardener,
Senior Director of External Affairs
New York City Office of Technology and Innovation
2 Metro-tech Center
Brooklyn, NY 11201

Dear Ms. Gardener,

Community Board 1, Queens Environmental and Transportation Committees met with the Office of Technology and Innovation (OTI) City of New York formerly known as Department of Information Telecommunication and Technology (DOITT). On January 25, 2023 the committees also invited several experts in 5G to discuss the health risks surrounding the installation of 5G services closest to homes, residential buildings, schools and spaces in direct contact with people. After the committees reviewed the PowerPoint presentation presented by OTI and later heard from the expert's rebuttals related to safety concerns the committee deliberated.

The Environmental Committee and Transportation Committee came to a consensus that there needed to be more information provided to prove the safety of 5G in the community. Therefore, they voted to recommend to Community Board 1, Queens Full Board a **denial** of the use of LinksNYC podiums for 5G towers until proof of safety was provided.

At the February 28, 2023 Full Board Meeting the Board voted in favor of this recommendation. Therefore, Community Board 1, Queens recommends **denial** of installations of any and all 5G antennas within the boundaries of the district until OTI can prove the health safety verification statistics of these monopoles for our residents. We seek documented follow up from your office with statistical information supporting the safety of the equipment used and installed by OTI.

Please provide this information to the District Office prior to any installations.

Thank you.

Sincerely,

Marie Torniali
Chairperson

Florence Koulouris
District Manger

Boundaries: North: East River, Bowery Bay – East: 82 St., Brooklyn-Queens Expressway – South: Queens Plaza No., Northern Blvd., LIRR Tracks – West: East River

COMMUNITY BOARD No. 1

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VACANT
DISTRICT MANAGER

HON. LINCOLN RESTLER
COUNCILMEMBER, 33rd CD

HON. JENNIFER GUTIERREZ
COUNCILMEMBER, 34th CD

March 21, 2023

Mr. Brett Sikoff
Executive Director, Franchise Administration
NYC Department of Information Technology & Telecommunications
15 Metro Tech Center, 18th Floor
Brooklyn, NY 11201

Re: Proposed New Link5G Pole & Cap Installations in Brooklyn Community District #1

Dear Mr. Sikoff,

Thank you for the information you and CityBridge provided to Brooklyn Community Board #1 and for participating in a presentation and discussion, regarding the proposed new Link5G transmission pole & cap installations in Brooklyn Community District #1.

On March 14, 2023, Brooklyn Community Board #1 voted 21 "YES"; 1 "NO", 3"ABSTENTIONS" to approve the following comments regarding the proposed Link5G installations to be performed and operated by CityBridge. The board does not sanction installing 6 new Link5G poles at the following locations:

Site ID	Street Address	Cross Street 1	Cross Street 2
BK-01-125285	640 MANHATTAN AVENUE	BEDFORD AVENUE	NASSAU AVENUE

Site ID	Street Address	Cross Street 1	Cross Street 2
BK-01-GF34896	21 INDIA STREET	WEST STREET	DEAD END
BK-01-GF34897	22 NORTH 6 STREET	NORTH 6TH STREET	DEAD END
BK-01-GF34906	419 KENT AVENUE	SOUTH 8TH STREET	BROADWAY
BK-01-GF34907	26 SOUTH 9TH STREET	KENT AVENUE	WYTHE AVENUE
BK-01-GF34908	26 SOUTH 10TH STREET	SOUTH 10TH STREET	SOUTH 11TH STREET

nor installing a cap on a lamppost located less than 10' from a building on the block of Lorimer Street between Scholes Street and Siegel Street (OTI #25821), until more extensive research is done to prove that these devices do not pose health safety hazards to residents. NYC OTI and CityBridge both deferred to the Federal Communications Commission (FCC) and the Food & Drug Administration (FDA) for supporting science related to safety. The FDA cites this study, *Wireless phone use in childhood and adolescence and neuroepithelial brain tumours: Results from the international MOBI-Kids study*, which on the one hands states "We have no evidence of a causal association between wireless phone use and brain tumours" while also noting "Because of likely biases we cannot rule out a small increased risk." The latter highlight we find to be very disconcerting.

Additionally, the following studies were presented to the board by the Environmental Health Trust, that raise major concerns regarding the potential health hazards of 5G technology: *"Electromagnetic fields, 5G and health: what about the precautionary principle?,* John William Frank; *"Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA,* Tarmo Koppel And Lennart Hardell; *"Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective,* Dominique Belpomme, Lennart Hardell, Igor Belyaev, Ernesto Burgio, David O. Carpenter; and *"Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads", T*armo Koppel, Mikko Ahonen, Michael Carlberg, Lennart Hardell. All of these authors state that more studies are needed.

It was further brought to the board's attention that US FCC standards for Wi-Fi, Cell Phones and Cell Towers have remained unchanged since 1996. In an August 2021 court decision the FCC ignored record evidence in *Environmental Health Trust et al. v. the FCC.* After reviewing 10,000+ pages of evidence, the United States Court of

Appeals for the D.C. Circuit ruled that the FCC's 2019 decision not to update 1996 wireless radiation limits was "arbitrary and capricious." The Court found that the FCC did not provide evidence of properly examining non-cancer harms such as:

- long-term exposure
- children's vulnerability
- testimony of persons injured
- Impacts to the developing brain and reproductive
- system
- "Complete failure" to address environmental effects

Until more extensive and substantial scientific, *and updated,* evidence is produced to create strong assurances that 5G technology is safe and non-hazardous to people, Brooklyn Community Board #1 does not sanction installation of these units in our district.

Furthermore, the board urges OTI and CityBridge to (re)locate new 5G units in locations in the district other than solely the wealthy waterfront area, to create equitable distribution and access to the newest technology, also avoid redundant installation locations such as S 9th St & S 10th St. Instead consider alternative locations such as Greenpoint Landing, Domino and River Ring, massive residential development and park projects that are in the process of bringing thousands of new residents and visitors to Williamsburg and Greenpoint.

Working for a Safer Williamsburg-Greenpoint.

Sincerely,

Dealice Fuller

Dealice Fuller
Chairperson

Cc: Congresswoman Nydia Velazquez
Senator Kristen Gonzalez
Assembly Member Emily Gallagher
Brooklyn Borough President Antonio Reynoso
Councilmember Lincoln Restler
Councilmemer Jennifer Gutierrez

Parks & Public Spaces

PRINT

January 2023, Parks & Public Spaces Committee

Review of NYC OTI; CityBridge proposal for a 5G Tower in CB5 District

At the regularly scheduled monthly Community Board Five meeting on Thursday, January 12, 2023, the following resolution passed with a vote of 34 in favor; 0 opposed; 1 abstaining:

WHEREAS, New York City, through its Office of Technology and Innovation (OTI), has contracted with

CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS, CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless

communications network intended to replace outdated public pay phones; and

WHEREAS, LinkNYC has provided free wireless internet connectivity using towers placed on sidewalks

throughout NYC, many of which include electronic display screens; and

WHEREAS, CityBridge is now in the process of upgrading its LinkNYC network to 5G infrastructure; and

WHEREAS, Link5G infrastructure is a 32' tall tower installed on sidewalks in the public right-of-way; and

WHEREAS, CityBridge and OTI stated that the 32' height of the towers is required to align with 5G

equipment already installed on NYC street lighting poles by commercial providers; and

WHEREAS, Link5G towers in commercial districts include electronic screens similar to those found on

LinkNYC kiosks that display advertising and public information; and

WHEREAS, Design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS, Link5G must adhere to siting requirements determined by NYC Department of City Planning,

and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS, CityBridge and OTI have proposed one (1) site at this time within Community Board Five for the installation of the new 5G Tower; and

WHEREAS, This location is on the northwest corner of 6th Avenue and West 53rd Street, in front of the Hilton Hotel, and will also have a bronze plaque imbedded into the sidewalk commemorating the location of the first cell phone call in history; and

WHEREAS, CityBridge and OTI stated that the location of the tower within CB5 was selected based on the commemoration of the first cell phone call; however, the plaque could be easily be imbedded without the new tower in place; and

WHEREAS, CityBridge and OTI stated that they currently do not have plans to install additional 5G towers in CB5 at this time but eventually they will be installed throughout the district replacing many of the 11' high existing 4G kiosks and that there was no master plan for installations within CB5; and

WHEREAS, The locations of these future 5G towers are not yet known but they will be spread throughout the district in order to provide 5G coverage and some towers will be located within CB5's Historic Districts impacting the historic character of those areas; and

WHEREAS, It is possible that future 5G towers are to be installed directly in front of residential apartments, and we believe that potentially 10' of distance from a tower to a residence is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS, Concerns were expressed regarding the locations of the 5G towers on public sidewalks in CB5's crowded midtown district given that the towers are infringing on the limited public space; and

WHEREAS, Concerns were also expressed regarding the aesthetic impacts of the towers given their height and visual prominence as shown in renderings; and

WHEREAS, It is not known, given the density of CB5, whether Link5G would even be necessary to address any digital deserts within CB5; and

WHEREAS, Suggestions were made to OTI and CityBridge for concealment of the 5G equipment and

exclusive use of existing light poles to mount equipment in lieu of new towers, which has other visual impacts as well, but OTI and CityBridge stated that this was not

deemed feasible to provide adequate 5G coverage; and

WHEREAS, New York City is in control of this process through its contract with the provider; and

WHEREAS, CB5 appreciates the need for ever evolving technology to serve its district and its visitors and wishes to be a partner with OTI to ensure that Manhattan has state-of-the-art connectivity and other

technology; and

WHEREAS, CB5 concludes that more time and information is required to review the 5G towers, their

locations within 5G, and the towers' impacts both visually and practically to the inhabitants of and visitors to CB5; and therefore be it

RESOLVED, that Community Board Five Manhattan disapproves the proposal as presented to install Link 5G towers at the northwest corner of 6th Avenue and 53rd Street, in front of the Hilton Hotel; and be it

FURTHER RESOLVED, that Community Board Five disapproves the installation of any Link 5G towers within the borders of CB5 until such time as all interested parties, including CB5, residents, business owners and community groups have a better opportunity to provide input and more information about locations of potential digital deserts be provided; and be it

FUTHER RESOLVD, Community Board Five requests that a moratorium be placed on construction and

At the regularly scheduled monthly Community Board Five meeting on Thursday, January 12, 2023, the following resolution passed with a vote of 34 in favor; 0 opposed; 1 abstaining:

WHEREAS, New York City, through its Office of Technology and Innovation (OTI), has contracted with

CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS, CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless

communications network intended to replace outdated public pay phones; and

WHEREAS, LinkNYC has provided free wireless internet connectivity using towers placed on sidewalks

throughout NYC, many of which include electronic display screens; and

WHEREAS, CityBridge is now in the process of upgrading its LinkNYC network to 5G infrastructure; and

WHEREAS, Link5G infrastructure is a 32' tall tower installed on sidewalks in the public right-of-way; and

WHEREAS, CityBridge and OTI stated that the 32' height of the towers is required to align with 5G

equipment already installed on NYC street lighting poles by commercial providers; and

WHEREAS, Link5G towers in commercial districts include electronic screens similar to those found on

LinkNYC kiosks that display advertising and public information; and

WHEREAS, Design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS, Link5G must adhere to siting requirements determined by NYC Department of City Planning,

and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS, CityBridge and OTI have proposed one (1) site at this time within Community Board Five for the installation of the new 5G Tower; and

WHEREAS, This location is on the northwest corner of 6 th Avenue and West 53 rd Street, in front of the Hilton Hotel, and will also have a bronze plaque imbedded into the sidewalk commemorating the location of the first cell phone call in history; and

WHEREAS, CityBridge and OTI stated that the location of the tower within CB5 was selected based on the commemoration of the first cell phone call; however, the plaque could be easily be imbedded without the new tower in place; and

WHEREAS, CityBridge and OTI stated that they currently do not have plans to install additional 5G towers in CB5 at this time but eventually they will be installed throughout the district replacing many of the 11' high existing 4G kiosks and that there was no master plan for installations within CB5; and

WHEREAS, The locations of these future 5G towers are not yet known but they will be spread throughout the district in order to provide 5G coverage and some towers will be located within CB5's Historic Districts impacting the historic character of those areas; and

WHEREAS, It is possible that future 5G towers are to be installed directly in front of residential apartments, and we believe that potentially 10' of distance from a tower to a residence is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS, Concerns were expressed regarding the locations of the 5G towers on public sidewalks in CB5's crowded midtown district given that the towers are infringing on the limited public space; and

WHEREAS, Concerns were also expressed regarding the aesthetic impacts of the towers given their height and visual prominence as shown in renderings; and

WHEREAS, It is not known, given the density of CB5, whether Link5G would even be necessary to address any digital deserts within CB5; and

WHEREAS, Suggestions were made to OTI and CityBridge for concealment of the 5G equipment and

exclusive use of existing light poles to mount equipment in lieu of new towers, which has other visual impacts as well, but OTI and CityBridge stated that this was not deemed feasible to provide adequate 5G coverage; and

WHEREAS, New York City is in control of this process through its contract with the provider; and

WHEREAS, CB5 appreciates the need for ever evolving technology to serve its district and its visitors and wishes to be a partner with OTI to ensure that Manhattan has state-of-the-art connectivity and other

technology; and

WHEREAS, CB5 concludes that more time and information is required to review the 5G towers, their

locations within 5G, and the towers' impacts both visually and practically to the inhabitants of and visitors to CB5; and therefore be it

RESOLVED, that Community Board Five Manhattan disapproves the proposal as presented to install Link 5G towers at the northwest corner of 6th Avenue and 53rd Street, in front of the Hilton Hotel; and be it

FURTHER RESOLVED, that Community Board Five disapproves the installation of any Link 5G towers within the borders of CB5 until such time as all interested parties, including CB5, residents, business owners and community groups have a better opportunity to provide input and more information about locations of potential digital deserts be provided; and be it

FUTHER RESOLVD, Community Board Five requests that a moratorium be placed on construction and planning of Link5G poles and devices in our district.

---

cb5 manhattan

Community Board Five
450 Seventh Avenue, Suite 2109
New York, NY 10123
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fax: 212-465-1628
email: office@cb5.org

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BROOKLYN COMMUNITY BOARD 9

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Dante B. Arnwine
District Manager

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Chair

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1st Vice Chair

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2nd Vice Chair

Linda Watson-Lorde
Executive Secretary

Mayna Legoute
Treasurer

Nicolas Almonor
Member-at-Large

Khyrie Alleyne
Member-at-Large

BROOKLYN COMMUNITY BOARD 9
5G TOWER MORATORIUM RESOLUTION

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and

WHEREAS; City Bridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free 4G wireless cellular connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 9 in Brooklyn and other communities through out the NYC and constituents of their districts have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32' tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI installed 5G towers without notification and input from the residents and Community Board 9 in Brooklyn; and

WHEREAS; City Bridge and OTI have proposed unknown number of sites across Community District 9; and

BROOKLYN COMMUNITY BOARD 9

WHEREAS; City Bridge and OTI have stated that the siting of proposed Link5G towers in Community District 9 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; where the currently proposed locations for 5G towers are not disclosed to residents and Community Board 9; and

WHEREAS; residents of Community District 9 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred on Bedford; and

WHEREAS; 1O' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; there are no reported issues by residents of Community District 9 of cellular gaps and frequent dropped calls that would justify Link5G being installed in the proposed locations; and

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 9; and

WHEREAS; OTI and City Bridge have not provided detailed plans regarding the full build-out of Link5G, both within Community District 9 and other parts of the Borough; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there have been questions raised by some residents as to whether sufficient research has been performed to fully assuage concerns that the radiation emitted by 5G infrastructure won't have any long-term impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants, and parks; and

WHEREAS: there has the 5G towers pose safety risk including combustion, accidents related to the falling over of the 5G towers; and

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 9 in Brooklyn at present and until many of the issues identified have been resolved; and

BROOKLYN COMMUNITY BOARD 9

WHEREAS; New York City is in control of this process through its contract with the provider.

THEREFORE BE IT RESOLVED, Community Board 9 Brooklyn disapproves the proposal as presented to install Link 5G towers in Community District 9; and

BE IT FURTHER RESOLVED, to a request for a moratorium on the installation and activation of any new towers in the community district 9 and that OTI, DCP, the Departments of Health and Environmental Protection and any other relevant agencies are requested to come to the district to address community concerns around the installation of new towers, and the towers that have already been erected; and

BE IT FURTHER RESOLVED, the existing 5G are deactivated and removed; and

BE IT FURTHER RESOLVED, to require the listed organizations and agencies affiliated with the 5G Towers to make a presentation to CB9 Genera Board and host a question and answer session following the presentation.

Adopted:
5/23/2023

Xavier A. Santiago
Chair

Angel D. Mescain
District Manager

April 26, 2023

Matthew C. Fraser
Chief Technology Officer
Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

Re: Proposed LinkNYC 5G Cell Tower Installations in East Harlem

Dear Mr. Fraser,

Community Board 11 is opposed to the proposed installations of LinkNYC 5G cell towers in Manhattan Community District 11.

The Office of Technology & Innovation (OTI), in franchise-agreement with CityBridge, aims to enhance wireless communication coverage throughout the city by installing and maintaining mobile telecommunications equipment on street poles.

Members of the public have iterated their concerns regarding the potential health and environmental implications of these installations, citing OTI's lack of transparency on potential impacts on residential quality of life. Further, the Federal Communications Commission (FCC) has levied a moratorium on the construction of LinkNYC 5G tower kiosk facilities, as they fall within the scope of the Commission's rules for implementation of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA) *letter enclosed*.

The need to expand network accessibility in underserved communities is recognized - however, until NYC OTI and CityBridge allay constituent health concerns, including satisfy the FCC's requirement to complete procedures pursuant to Section 106 of the NHPA, and the environmental review process pursuant to NEPA - Manhattan Community Board 11 cannot support the installations of the LinkNYC 5G cell towers.

If you have any questions, please contact Khalid Nixon, Assistant District Manager, at knixon@cb11m.org or 212-831-8929.

Sincerely,



Xavier A. Santiago
Chair

Cc: Hon. Mark D. Levine, Manhattan Borough President
Hon. Diana Ayala, Deputy Speaker, New York City Council
Hon. Kristin Richardson Jordan, New York City Council
Hon. Julie Menin, New York City Council
Hon. Keith Powers, New York City Council
Hon. Jose M. Serrano, New York State Senate
Hon. Cordell Cleare, New York State Senate
Hon. Eddie Gibbs, New York State Assembly
Hon. Inez Dickens, New York State Assembly
Judith Garcia, NYC OTI, Mobile Telecom Franchise Unit
Brett Sikoff, NYC OTI, Mobile Telecom Franchise Unit
Stacy Gardener, NYC OTI, External Affairs
Robert Sokota, President, CityBridge, LLC
Margaux Knee, General Counsel, CityBridge, LLC
Rafael Escano, NYC Department of Transportation
Jose Altamirano, Community Board 11
Michelle Wiltshire-Clement, Community Board 11

THE CITY OF NEW YORK
BRONX COMMUNITY BOARD 6
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Honorable Vanessa L. Gibson, Bronx Borough President
Honorable Oswald Feliz, New York City Council Member

MS. EVONNE CAPERS
Board Chairperson

MR. RAFAEL MOURE-PUNNETT
District Manager

March 16, 2023

Brett Sikoff
Executive Director, Franchise Administration
Judith Garcia
Assistant Director, Mobile Telecom Franchises
NYC Office of Technology and Innovation

Re: Notification of a proposed "5G" street pole attachment
Prospect Ave between E 185th Street and E 187th Street (OTI #25011)

Bronx Community Board 6 has reviewed proposed 5G street pole attachment #250111 and is in opposition. Board members are concerned about potential risks to families living in 2339 Prospect Avenue and 2347 Prospect Avenue, particularly those living on the 2nd and 3rd floor with windows facing the street. Community Board 6's District Manager requested information regarding radiation produced by the proposed installation on 2/28/23 and has yet to receive a response. The Board is not convinced that the FCC regulations on 5G installations are sufficient to protect the health of residents, who will be exposed to 24/7 radiation from the 5G pole.

In addition, the Board notes that there is a 4G street pole installation at the Southeast corner of Prospect and East 185th. It is the Board's understanding that 5G pole installations are necessitated by gaps in cell phone service. What demonstrated gap in cell phone service is this proposed installation addressing, if a 4G pole is across the street? It is the Board's understanding that per the judicial ruling in ExteNet Sys. v. Vill. of Flower Hill, local government has the burden of demonstrating gaps in service when authorizing 5G installations.

Bronx Community Board 6 rejects OTI's proposed 5G installation at East 185th and Prospect Avenue. We ask that OTI first address the questions raised by the Board, concerns about the 5G rollout process raised by Borough President Levine, and Manhattan Community Board 8's request for a moratorium on 5G installation. Without sufficient information from OTI on the risks and rewards of 5G, along with proper community engagement, moving forward with 5G installations - in particular those within 10 feet of residential buildings - is inappropriate and likely to draw more community opposition.

Regards,

Rafael Moure-Punnett
District Manager
Bronx Community Board 6

Evonne Capers
Chair
Bronx Community Board 6

Jeannine Kiely, *Chair*
Susan Kent, *First Vice Chair*
Valerie De La Rosa, *Second Vice Chair*
Mark Diller, *District Manager*

Antony Wong, *Treasurer*
Amy Brenna, *Secretary*
Ritu Chattree, *Assistant Secretary*

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February 1, 2023

Matthew C. Fraser
Chief Technology Officer & Commissioner
375 Pearl Street, 16th Floor
New York, NY 10038

Gregory Cala
Community and Intergovernmental Affairs Associate
1 Centre St., 9th Floor
New York, NY 10007

Dear Matthew C. Fraser and Gregory Cala:

At its Full Board meeting January 19, 2023, Community Board #2, adopted the following resolution:

1. Resolution highlighting community concerns around the construction of Link5G towers and calling for a moratorium on the construction of such towers in Community District 2.

Link5G Background

1. **Whereas,** New York City, through its Office of Technology and Innovation ("OTI"), has contracted with CityBridge to install and operate a citywide wireless communications network, subject to a Public Communications Structure Francise Agreement ("Franchise Agreement"); and

2. **Whereas**, under the Franchise Agreement, CityBridge is seeking to install up to 2,000 "Link5G" towers, along sidewalks throughout NYC, with these 32-foot-tall towers providing free Wi-Fi to surrounding areas, containing space that can be rented to wireless carriers that can enhance their 5G networks, and with some of these towers containing advertising space analogous to the advertising space on existing LinkNYC terminals; and

3. **Whereas,** CityBridge has already commenced installing Link5G towers in Industrial and Commercial districts, and is now looking to expand the rollout to include Residential districts and Landmarked Historic districts; and

4. **Whereas**, CityBridge is required to site 90% or more of new Link5G terminals outside of Manhattan below 96th Street in order to fulfill its mandate of providing broadband equity and closing the digital divide, with additional requirements to site a certain number of terminals in identified "equity community districts"; and

5. **Whereas**, the remaining 5G terminals outside of this equity mandate, which include those terminals proposed for Community District 2 ("CD2"), are, according to CityBridge, sited subject to various other criteria including where 5G service carriers have indicated the need for additional capacity, and the ability to generate advertising revenue; and

6. **Whereas**, potential siting locations are subject to a range of siting criteria, with additional criteria applying to those being sited within landmarked historic districts; and

7. **Whereas**, Link5G only represents one component of NYC's investment in 5G technology, with additional pole-top and roof-top 5G units under separate programs having already been rolled out and continuing to be rolled out extensively across the city; and

Initial Proposed Link5G Sites in CD2

8. **Whereas**, Representatives from OTI and CityBridge presented to Community Board 2's Quality of Life committee on Tuesday, January 17th, 2023, to share the plan for the initial siting of Link5G kiosks in CD2 and to hear questions and concerns from the community; and

9. **Whereas**, there are currently nine initial sites provided by CityBridge / OTI that will be part of the initial rollout of Link5G in CD2; and

10. **Whereas,** five of the proposed nine locations are located within landmarked historic districts within CD2, with two locations (820 Greenwich St. and 771 Greenwich St.) located within the Greenwich Village Historic District, two locations (568 Broadway and 110 Prince St.) located within the SoHo-Cast Iron Historic District, and one location (113 Horatio St.) located within the Gansevoort Market Historic District; and

11. **Whereas**, the other four locations, while not located within a landmarked historic district, are in close proximity to such districts may be located in close proximity to individual landmarks as well; and

12. **Whereas**, these nine sites only represent the initial round of proposed sites within CD2, and other sites are likely to be proposed by CityBridge in the future; and

13. **Whereas,** it does not appear that CityBridge / OTI are complying with the established siting criteria set forth in the Franchise Agreement for several of the locations, and specifically there appear to be no certifications that installation of the Link5G towers will in no way damage existing vault structures, which are widely prevalent in the proposed areas for such towers and where specific adjacent property owners have expressed concerns; and

Significant and Wide-Ranging Community Concerns

14. **Whereas**, numerous residents of CD2 and elsewhere attended CB2 meetings and/or submitted written testimony to CB2 to express opposition and concern regarding the installation of Link5G towers within CD2, with virtually no community members expressing support for the installation of these towers; and

15. **Whereas**, the specific points of concern and opposition expressed by the community were wide-ranging, touching on areas including design & aesthetics (including specifically in relation to towers in landmarked districts and in proximity to individual landmarks), safety, privacy, maintenance, equity, and economics; and

16. **Whereas**, from a design & aesthetics perspective, community and board members felt that the towers were out-of-scale with the streetscape in CD2, and particularly out-of-character with the landmarked historic districts within CD2, and there was a general consensus that if the Link5G towers could not be prevented from being sited with CD2, that they should at the very least be re-designed; and

17. **Whereas**, with particular regard to towers sited in landmarked historic districts or in proximity to individual landmarks, there was uncertainty and concern amongst board and community members as to the exact LPC approval process and the amount of oversight that LPC and other agencies would have over the placement of Link5G towers and if there would be consideration of other alternative infrastructure that might better suit and be less obtrusive within landmarked historic districts which could also meet the established objectives; and

18. **Whereas,** from a safety perspective, there was community concern around the potential health impacts of electromagnetic radiation emitted by 5G towers, particularly within residential and mixed use districts, and that relying solely on FCC regulations without additional state or local oversight was not adequate; and

19. **Whereas**, from a privacy perspective, despite CityBridge being subject to a privacy policy under the Franchise Agreement, there was community concern that this was not an adequate protection, and that the Link5G system may be vulnerable to cyber threats; and

20. **Whereas,** from an engineering design perspective, concerns were raised regarding engineering challenges, both for design and structural placement of the Link5G towers, it being apparent that many variable subsurface conditions exist throughout the older historic portions of the city, particularly in areas that precede the historic city grid system with extensive vaults underneath many of CD2s Sidewalks; and

21. **Whereas**, there was community concern regarding the future maintenance of these towers, and that despite CityBridge's obligation to maintain them, that they might fall into future disrepair; and

22. **Whereas**¸ there was confusion and concern expressed by community members regarding the stated equity goals of the Link5G program, that the towers being proposed for siting

in CD2 did nothing to advance these goals, as CD2 already has an extremely high level of broadband access, and that resources would be better spent siting Link5G terminals in areas where they would be more impactful; and

23. **Whereas**, there was opposition voiced regarding economic aspects of the Link5G program, which, while purportedly being installed at no cost to the taxpayer, would allow private entities to profit off of public space with the city receiving, according to some publications, minimal shared profits; and

24. **Whereas**, while CB2 appreciates that OTI and CityBridge have been conducting significant public outreach regarding the Link5G program, there clearly remain a large number of unanswered questions that span these various areas of concern; and

25. **Whereas**, seeing no immediate need for the installation of Link5G towers within CD2 given existing levels of cell carrier coverage and broadband access, CB2 members agreed that in the light of extensive community concerns and unresolved questions around the Link5G program, there is no reason to continue with installation of the proposed towers in CD2 at this time; now

Therefore Be It Resolved that CB2 Manhattan calls for a moratorium on installation of Link5G towers in Community District 2 within all residential districts and mixed use districts which contain residential zoning, as well as within all landmarked historic districts and areas in close proximity to individual landmarks.

Therefore Be It Further Resolved that should the city elect to proceed with installation of Link5G towers in CD2, CB2 Manhattan calls for a robust engagement with community stakeholders and significantly more extensive public education, public input and community review process to address the community's substantial range of questions and concerns.

Vote: Passed, 44 Board Members in favor, 1 against (C. Dignes)

Please advise us of any decision or action taken in response to this resolution.

Sincerely,

Jeannine Kiely, Chair
Community Board #2, Manhattan

William Benesh, Chair
Quality of Life Committee
Community Board #2, Manhattan

JK/em

cc: Hon. Jerrold Nadler, Congressman
Hon. Daniel Goldman, Congressman

Hon. Brad Hoylman-Sigal, State Senator
Brian Kavanaugh, State Senator
Hon. Deborah Glick, Assembly Member
Hon. Mark Levine, Man. Borough President
Hon. Erik Bottcher, City Council Member
Hon. Christopher Marte, City Council Member
Hon. Carlina Rivera, City Council Member
Brett Skioff, OTI
Robert Sokota, CityBridge
Margaux Knee, CityBridge

THE CITY OF NEW YORK
COMMUNITY BOARD 9
MANHATTAN

Morningside Heights
Manhattanville
Hamilton Heights

EXECUTIVE COMMITTEE

Ratification of Reso re: Disapproval of new Link5ZG Kiosks within MCB9

January 16, 2023

Edward F. Pincar
Manhattan Borough Commissioner
Department of Transportation
59 Maiden Lane, 37th Floor
New York, NY 10038

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

RE: Disapproval of new Link5G Kiosks within CB-9M

Dear CTO Fraser and Commissioner Pincar,

At its regularly scheduled Executive Committee meeting of Community Board 9 Manhattan held on January 12, 2023, the Executive Committee acting on behalf of the full board approved the following resolution by a vote of 15 in favor, 0 opposed, 0 abstentions and 1 not voting for cause; 2 other CB9 members who are not members of the Executive Committee present voting in favor:

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS; CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free wireless internet connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 9 and constituents of its district have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32’ tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI have proposed 4 sites across Community District 9;

WHEREAS; CityBridge and OTI have stated that the siting of proposed Link5G towers in Community District 9 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; 4 of the 18 sites proposed are either in or near the Morningside Historic District or the central Columbia University campus and the historic St. John the Divine Church, where renowned architecture and iconic streetscapes would be interfered with if Link5G structures were installed; and these addresses are:

- 2880 Broadway, *between* 112th Street and 113th Street, Residential
- 1060 Amsterdam Avenue, *between* 112th Street and 113th Street, Residential / *across from the* Cathedral of St. John the Divine
- 1125 Amsterdam Avenue, *between* 115th Street and 116th Street, Residential /St. Luke's Hospital
- 1181 Amsterdam Avenue near Columbia University, *between* 118th Street and 119th Street, Columbia University

WHEREAS; locations proposed along Broadway and Amsterdam Avenue would be in conflict with strict guidelines for illuminated storefronts and signage; and

WHEREAS; residents of Community District 9 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred in front of 520 East 90th Street in Manhattan Community District 8, and

WHEREAS; 10' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; Neither CityBridge nor the cellular network providers that Link5G service is intended to supplement have provided any evidence that dropped calls and limited capacity are present at the proposed Link5G locations;

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 9; and

WHEREAS; OTI and CityBridge have not provided detailed plans regarding the full build-out

of Link5G, both within Community District 9 and in areas north of 96th Street and in the outer Boroughs; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there has not been any information presented to Manhattan Community Board 9 that these street sites for Link5G poles are necessary to correct coverage gaps that could not otherwise be covered through normal wireless antenna placements on local structures, which is the routine method by which wireless carriers provide 5G and other wireless service coverage in an area; and

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 9 at present and until many of the issues identified have been resolved;

WHEREAS; New York City is in control of this process through its contract with the provider.

THEREFORE, BE IT RESOLVED, that Community Board 9 Manhattan disapproves the proposal as presented to install Link 5G towers in Community District 9; and

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G poles and devices in Community District 9 Manhattan.

Please advise us of any action taken on this matter.

If you have any questions and/or further information is needed, please do not hesitate contacting me or District Manager, Eutha Prince, at the board office (212) 864-6200.

Sincerely,



Barry Weinberg
Chair

cc: Honorable Eric L. Adams, Mayor of the City of New York
Honorable Jumaane Williams, Public Advocate of the City of New York
Honorable Jerrold Nadler, 12th Congressional District Representative
Honorable Adriano Espaillat, 13th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Cordell Cleare, NYS Senator, 30th Senatorial District
Honorable Daniel J. O'Donnell, NYS Assemblymember, 69th Assembly District
Honorable Inez Dickens, NYS Assemblymember, 70th Assembly District
Honorable Al Taylor, NYS Assemblymember, 71st Assembly District
Honorable Shaun Abreu, Member of the NYC Council, 7th Councilmanic District
Honorable Kristin Richardson Jordan, Member of the NYC Council, 9th Councilmanic District
Honorable Charles Schumer, U.S. Senator, State of New York
Honorable Kirsten Gillibrand, U. S. Senator, State of New York

February 9, 2023

COMMUNITY BOARD #14

Matthew C. Fraser,
Chief Technology Officer
NYC Office of Technology & Innovation
2 Metro Tech Center, P1
Brooklyn, NY 11201

COMMUNITY BOARD #14
City of New York
Borough of Queens

DOLORES ORR
Chairperson

JONATHAN GASKA
District Manager

Dear Technology Officer Fraser:

On behalf of the Community Board, the Executive Board of Community Board #14 un-conditionally opposes the following: all proposed locations for Link5G/cell towers that are near or in front of residential homes, houses of worship or mixed use commercial/residential locations.

We oppose the following:

1. 1400 Brunswick Avenue
2. 71-02 Beach Channel Drive
3. 66-03 Beach Channel Drive
4. 32-11 Beach Channel Drive
5. 67-19 Rockaway Beach Blvd.
6 .72-19 Rockaway Beach Blvd.
7. 88-07 Rockaway Beach Blvd.

The Board also opposes the placement of a tower in front of 112-01 Beach Channel Drive until and unless further study as to safety and local community input has occurred. We thank you in advance for support.

Sincerely,

Jonathan Gaska,
District Manager

1931 Mott Avenue, Room 311
Far Rockaway, NY 11691
Tel.: (718) 471-7300
Fax: (718) 868-2657
qn14@cb.nyc.gov—NEW
Www nyc gov/queenscb 14
FACEBOOK cb14rockaway

Cc:
Hon. Donovan Richards
Hon. Selvena Brooks-Powers
Hon. Joanne Airola
N. Garcia, Qns. DOT Comm.

APPENDIX B







May 5, 2023: Jumbo Tower on 2nd Avenue is activated, and the EMF warning buzzer sounds, both up close as well as 10 or 20 yards off.

APPENDIX C

June 25, 2020

National Telecommunications and Information Administration
U.S. Department of Commerce
1401 Constitution Avenue, NW
Washington, DC 20230

RE: The National Strategy to Secure 5G Implementation Plan
[Docket No. 200521–0144; RIN 0660–XC047]

The City of New York (City) appreciates the opportunity to comment on the development of an Implementation Plan for the National Strategy to Secure 5G. The following comments are based on New York City's own implementation plan (the NYC Internet Master Plan), released in January 2020, and the efforts of NYC Cyber Command (NYC3) to ensure strong cybersecurity practices for current and new technologies used by and within the city.

Affordable, reliable, and equitably distributed high-speed internet access is critical to the economic and personal well-being of the city's nearly 8.4 million residents. Currently, broadband services available from private companies continue to leave behind too many New Yorkers. While a majority of New Yorkers do have access to broadband, more than 1.5 million residents still have neither a connection at home nor on a mobile device.

Our city is committed to fighting income inequality and ensuring all New Yorkers have opportunities to succeed. That means every New Yorker should have affordable and reliable access to high-speed broadband so that they have access to quality educational opportunities, health care, and essential services. As the recent COVID-19 pandemic has laid bare, access to reliable broadband is now a prerequisite, similar to a public utility, to ensure personal safety, education, and opportunities for economic growth for New Yorkers.

As outlined in the NYC Internet Master Plan, 5G technology is uniquely well-suited to a dense urban environment such as New York and we recognize the importance of ensuring that 5G is deployed in a manner that contributes to closing the digital divide, not widening it.

While this new technology brings the potential for great opportunity, its deployment brings new risks and national security concerns. As a center of commerce with a gross domestic product that rivals many nations, New York City is a target for economic espionage by foreign governments. Our city is home to some of the largest corporations in the United States, as well as an innovative and thriving startup culture. Emerging technologies built in New York City drive over $70 billion in startup valuation and exits each year. 5G represents a new threat vector for nation-states and other foreign actors intent on stealing intellectual capital from our residents.

Beyond economic interests, there are political and cultural reasons our city is a high-profile target for adversaries that seek to undermine the integrity of our infrastructure for other nefarious purposes.

Technology components critical to the rollout of 5G in the U.S. will almost certainly require significant (if not critical) reliance on foreign technology firms, manufacturers, and their supply chain ecosystems—particularly China, who has historically sought to "access information about U.S. firms' proprietary operations and project-financing information, as well as steal IP and technology" through cyber espionage, according to the U.S.-China Economic and Security Review Commission. This creates a significant supply chain risk.

New York City is highly concerned about the threats created by a lack of coherent national vision and strategy for securing our nation's telecommunications infrastructure. This lack of federal leadership domestically and in coordination with allies internationally makes our city vulnerable to foreign adversaries who may seek to undermine us.

For these reasons, we urge you to consider: 1) funding for state and local testbeds, development, security controls and other factors necessary in furtherance of a secure 5G deployment; 2) national authorities and standards for rigorous, ongoing testing to secure 5G technology components, as well as the devices that utilize 5G networks; 3) federal regulatory structures that provide safeguards against the risk of the increased attack surface that is likely to arise along with mature 5G network development; and, 4) engagement with key international allies on this critical national security issue.

Line of Effort 1: Facilitating Domestic Rollout

To facilitate the domestic rollout of 5G technologies and the development of a robust domestic 5G commercial ecosystem (e.g., equipment manufacturers, chip manufacturers, software developers, cloud providers, system integrators, network providers), the City urges the federal government to consider and address security-related supply chain concerns. The City is troubled by disruptions to the 5G ecosystem that are likely to increase the cost and reduce the efficiency of any 5G technology deployment, but may prove necessary to curtail systemic security concerns. Private and public investment will be vital to ensuring affordable, reliable high-speed access is available across the five boroughs of our city, ensuring all New Yorkers have access to the economic, social, and civic power of the internet.

The City recognizes the critical role that advanced technologies play in national security. Investment in the research, development, testing, and evaluation of new technologies and architectures can launch mutually-beneficial public and private partnerships through federally-funded research projects. In the near term, New York recommends federal funding for local municipal investment in secure 5G network infrastructure in an effort to promote specific security requirements around 5G network equipment and infrastructure. We will discuss more about mitigating the significant equipment-related security concerns in our response to other Lines of Effort.

The City also invites meaningful research partnerships given that we maintain one of the most appropriate environments for 5G technologies. For instance, with funding from the National Science Foundation Platforms for Advanced Wireless Research and through partnerships with academic researchers and industry stakeholders, a wireless testbed in Upper Manhattan, named COSMOS, serves as a real-world research hub for new wireless technologies and applications in one of the most populated urban environments in the world. These kinds of testbeds are necessary to ensure the appropriate scientific and technical knowledge is developed to advance new and more secure products to the market that work in many environments, including environments like New York City that require consideration of security factors unique to densely populated and urban areas.

In addition, to increase domestic 5G research, development, and testing, New York City would invite an opportunity to serve as the site for an "X-Prize" or DARPA grand challenge-style scientific innovation investment opportunity that looks to foster a secure, domestically produced 5G commercial ecosystem. This would mirror other investment approaches that have brought the United States to the forefront of ingenuity and production in certain industries—perhaps most notably in the areas of autonomous vehicles and private sector spaceflight—with investments from public and private sector entities. New York City has served as host to federal pilots and partnerships to promote telecommunications technology, including our joint effort to improve the safety of travelers and pedestrians through the deployment of Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) connected vehicle technologies. We look forward to welcoming such innovation again.

Line of Effort Two: Assess Risks to and Identify Core Security Principles of 5G Infrastructure

5G's potential for higher speeds and other advantages also brings system complexities that may not have existed in previous generations of broadband technologies. The dynamics of 5G make this technology much less like a traditional

telecommunications platform and more like the multi-layered open environment we find on the internet. Such complex systems present more opportunities for security and privacy breaches. By moving away from firmware-based technology of 4G telecommunication components to software-based 5G telecommunication components that will need to be updated, the opportunity for manipulation exists within the supply chain. Furthermore, movement away from centralized network systems to decentralized network systems increases the attack surface of a network. That increased attack surface is amplified by the anticipated introduction of the increasing number and variety of connected devices (IoT) and big data industries.

Core security principles for 5G should be built upon existing foundational security principles and programs. For example, federal standards for supply chain risk analysis have been built by the National Institute for Standards and Technology (NIST), which should be highly leveraged on the federal level and made mandatory for access to grants for deploying new telecommunications platforms, such as the ones we discussed in Line of Effort One. It should also be foundational to federal investment in the technology more generally.

New York City Cyber Command has built an Internet of Things (IoT) Lab to rigorously test publicly-owned connected devices prior to citywide deployment. Our work confirms what is well known and evident: the risk inherent in these lightweight technologies. IoT risk profiles change with their environment and specific use case, and security has generally not been the primary focus of manufacturers of these technologies. We have identified dozens of critical and high risk vulnerabilities within proposed devices. Many have already been deployed elsewhere in the country and world prior to New York City's review. New York City Cyber Command has also identified "zero-day" (previously unknown) exploits that now have published common vulnerabilities and exposures (CVEs) associated with them. These vulnerabilities have been resolved by the vendors prior to deployment in our municipality, and ultimately benefits the public and private sector by improving security.

The problem of IoT vulnerabilities will only become exacerbated by the increased speeds of 5G and other future wireless broadband technologies.

Similarly, several significant vulnerabilities have been discovered by security researchers during initial 5G rollouts in test markets. As with any new technology, it is likely that additional, potentially critical, zero-day vulnerabilities exist within 5G technology components.

We recommend the federal government provide grants to localities and states for rigorous security testing of critical devices being considered for adoption by the public sector and critical infrastructure partners. This becomes vital with the anticipated expansion of IoT device use commensurate with the increased load and speed capabilities of 5G networks.

Additionally, New York City recommends federal testing and security requirements for consumer grade IoT devices. IoT protection is historically poor and malware distribution is easily scalable, which suggests that the creation of IoT botnets ("robot networks") for malicious purposes, including large-scale distributed denial of service (DDoS) attacks, is likely to increase as well. This poses a significant threat to vital digital infrastructure and resident services at all levels of government, as well as private sector enterprise.

New York City has dedicated itself to supporting our residents' secure connectivity as the cyber threat environment has continues to escalate. New York City Cyber Command, created in 2017, is charged with securing our public infrastructure and supporting the digital security of New Yorkers. New York City Cyber Command has built security-driven solutions into public Wi-Fi connectivity points and offers our residents mobile threat protection through NYC Secure, the first-of-its-kind free mobile security application from a public entity. In addition, the City has proposed baseline and additional security standards for a higher-level of service for users of public Wi-Fi on city streets in its Truth in Broadband: Public Wi-Fi in New York City report. Such consumer-facing initiatives at the local level should be supported through federal funding to

identify and raise best practices for raising cybersecurity support for the general public to meet the accelerating threat environment.

Finally, the federal government should require regular independent testing and certification of 5G telecommunication components. This testing will need to occur on a regular basis to ensure changing software does not create new vulnerabilities, and build processes for resolution when security concerns are identified.

Line of Effort Three: Address Risks to U.S. Economic and National Security during Development and Deployment of 5G Infrastructure Worldwide.

The passage of the Secure 5G and Beyond Act of 2020 by Congress is just one step in addressing the risks to economic and national security in the development and deployment of 5G infrastructure. We believe a lack of national strategy leads to inconsistent international engagement around our telecommunications infrastructure. While there have been specific instances where the federal government has pushed allies away from equipment associated with foreign adversaries, such activity is not a substitute for a proactive and comprehensive approach to a complex technology market. This dynamic creates a significant security risk to our city's critical infrastructure, as well as to the privacy and economic security of our residents.

In essence, New York City is executing on our security strategy in absence of the perspective of a comprehensive federal framework. While there is no scenario where governments lead the development and deployment of 5G and future telecommunications technologies, the public sector must play a critical role in its development and deployment. From international coordination among allies, to national leadership in the executive branch, to support for state and local deployment strategies, the required federal orchestration and influence has been largely absent.

The City shares the concerns outlined in the U.S. Senate Committee on Homeland Security and Governmental Affairs Permanent Subcommittee on Investigations staff report released earlier this month that pointed to a lack of authority and process at the federal level as key factors which undermine a cohesive telecommunications review of foreign actors, endangering our national security.

New York City urges the federal government to coordinate investment from federal and private sources into research and development of domestic telecommunications technologies at public and private institutions, while creating a coordinated effort among allied countries to do the same. Beyond attempting to gain primacy in domestic 5G manufacturing, efforts should be focused on accelerating the timeline and early production of other domestically nurtured next-generation telecommunication "6G" technologies in concert with key allied nations. The City also encourages the federal government to promote 5G vendor diversity and foster market competition, so long as these actions do not negatively impact or otherwise disrupt paramount security considerations and initiatives.

Line of Effort Four: Promote Responsible Global Development and Deployment of 5G.

An effective policy and regulatory framework which outlines equitable standards, incentives, and sufficient enforcement mechanisms is essential for promoting and facilitating global development and deployment of 5G. However, this framework should prioritize and support—not displace or disrupt—5G deployment and implementation initiatives at the state and local levels that provide for necessary security protections and public services that benefit city residents and businesses.

Continued disagreements and disarray among federal actors and telecommunications sector stakeholders on issues ranging from infrastructure security and supporting state and local broadband deployment efforts to confronting foreign

disinformation campaigns focused on undermining our democracy is ultimately allowing foreign governments to fill the void and set standards for security and privacy in the global tech industry. Widening the gap further are federal actions that favor large telecommunications companies at the expense of consumers and local governments, including the elimination of privacy protections, affordability programs and net neutrality requirements. We can only succeed through communicating American values of inclusiveness and digital rights nationally, promoting those values internationally through strong alliances with international partners, such as New York City's participation in Cities for Digital Rights, and ultimately constructing a common vision built upon mutual security.

To promote responsible global development and deployment of 5G, the federal government must stand up for our values by: 1) not impeding the abilities of states and localities to take necessary and appropriate actions, such as those discussed in the New York City Internet Master Plan, that promote and facilitate broadband services and enable affordable, equitable, reliable, secure high-speed broadband deployments within their communities; 2) providing funding, necessary authorization, and guidance to federal agencies tasked with monitoring foreign manufacturers and telecommunications carriers; and, 3) focusing on engaging our international allies to build standards that provide mutual security assurances.

Thank you for your dedication to this issue. We stand ready to work with our federal partners to secure our nation's vital telecommunications infrastructure and ensure the availability of secure high-speed, reliable, quality broadband service for all New Yorkers.

Sincerely,

Geoff Brown

Chief Information Security Officer
City of New York

John Paul Farmer

Chief Technology Officer
City of New York

APPENDIX D

MEETING WITH DEPUTY COMMISSIONER, RYAN BIRCHMEIER (OTI)
AND DEPUTY COMMISSIONER, CHANTAL SENATUS (OFFICE FOR LEGAL SERVICES)
MAY 17, 2023, 2-2:30PM

QUESTIONS FOR OTI

1. Is OTI viewing CityBridge's violations of NEPA and NHPA as a breach or material breach under the franchise agreement?
    a. See, e.g., Sections 15.6.1 (iii), (iv), (vi) and (vii)(a), 15.6.4 and 15.21.1 at https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf
    b. Has a notice of breach or default been issued to CityBridge?
2. Who's conducting the FCC environmental reviews that CityBridge was instructed by the FCC to conduct?
3. What is the extent of the NEPA checklist review—just NHPA and RF or the entire checklist? Which exclusions apply?
4. Is City Bridge submitting documentation of the NEPA review to OTI? To the FCC? On already built towers as well as unconstructed towers?
5. Will the documentation be made publicly available and if so, how and at what point in the process?
6. Is the review being done by tower? (yes) By antenna? (yes-collo agreement)
    a. And if by antenna, how is RF from multiple antennas in one kiosk taken into account?
    b. Will RF studies be made available to the public, and if so, when?
    c. How can we review the
        i. FCC NEPA and NHPA compliance reports on towers to be built
        ii. RF reports
    d. post-construction NEPA reviews
7. During the review or since the April 20, 2023 letter:
    a. Has all construction halted?
        i. Statement by CityBridge that they will continue construction
    b. Have any antennas been installed?
    c. Have antennas that were operational been turned off?
        i. Were antennas operational at the time of receipt of the April 20, 2023 letter?
        ii. Were antennas made operational after receipt of the April 20, 2023 letter?
8. On May 5, 2023, antennas were observed being installed at 2nd Ave & 1st St
    a. Did the underlying structure complete NEPA review?
    b. Did the antennas go thru review under the collocation NPA??

c. Were antennas made operational? When?

9. Which, if any, Link5G towers, has SHPO and Tribes declined to conduct post-construction 106 review on?
    a. Will we be able to see a list of what has been declined?
    b. How can we see the complete 106 review on those towers to ensure collocations on those towers have completed 106 review?
9. *Extenet v. Flower Hill* decision
    a. Federal law in NY (underscoring 2nd Circuit ruling): for federal pre-emption to apply, telecoms must show a gap in phone service and they are using the least intrusive means to fill that gap.
    b. There are no records of gaps, as confirmed by OTI and CityBridge at a community board meeting.
    c. Why then is OTI telling community boards that 5G is federally required?

APPENDIX E

Wired Broadband, Inc.
owilkens@wiredbroadband.org
Unanswered and New FOIL Requests
Regarding Jumbo 5G Kiosks / Monopoles

UNANSWERED FOIL REQUESTS
TO OFFICE OF TECHNOLOGY AND INNOVATION (OTI)[1]
REGARDING LINK5G CELL TOWERS
AS OF JUNE 7, 2023

	FOIL #	Date Submitted to DoITT	Subject
1	2021-858-00282	10-27-21	Electrical and Engineering Drawings/Specifications of the Wireless Facilities (Link 5G) Please provide, with respect to the proposed wireless facilities, public communications structures (Link 5G) recently presented at the Public Design Commission (PDC) hearing held on October 18, 2021, all electrical and engineering drawings, specifications, wavelength, frequency, antenna gain, antenna length, power potential of the wireless antennas, and the companies who will manufacture and install them. See for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf.
2	2021-858-00283	10-27-21	Correspondence with Government Agencies on Link 5G Please provide any correspondence (email, mail or otherwise) between DoITT and any other city, state or federal agency (including, without limitation, the Federal Communications Commission (FCC) and Federal Food & Drug Administration (FDA)) regarding or concerning the proposed wireless facilities, public communications structures (Link 5G) recently presented at the Public Design Commission (PDC) hearing held on October 18, 2021. See for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf.
3	2021-858-00285	10-27-21	Correspondence Among DoITT, City Bridge and ZenFi Networks on Link 5G Please provide any correspondence (email, mail or otherwise) among DoITT and City Bridge and ZenFi Networks (including, without limitation, the Federal Communications Commission (FCC) and Federal Food & Drug Administration (FDA)) regarding

[1] Other agencies may also be included.

			or concerning the wireless facilities, public communications structures (Link 5G) recently presented at the Public Design Commission (PDC) hearing held on October 18, 2021. See for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf.
4	2021-858-00287	10-29-21 OTI RESPONDED - NO RECORDS	Link 5G Antenna Manufacturer and Model No. With respect to each of the wireless facilities, public communications structures (Link 5G) recently the subject of consideration at the Public Design Commission (PDC) hearing held on October 18, 2021 (see for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), please provide the model number and manufacturer of each antenna being used and how many antennas will be placed or installed in each such wireless facility or structure.
5	2021-858-00308	11-24-21 OTI RESPONDED NO RECORDS	FCC Frequency Band and Corresponding Carriers of 5G Link With respect to the proposed wireless facilities recently presented at the Public Design Commission (PDC) hearing held on October 18, 2021, please identify all FCC frequency bands in which the wireless antennas will be operating and the wireless carriers who are providing wireless service in those frequency bands. Please identify each wireless carrier and their corresponding frequency band. See for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf.
6	2021-858-00331	12-21-21	Link 5G and Jumbo 5G Antennas - Borough Wide Plans With respect to the wireless facilities, public communications structures (Link 5G) recently the subject of consideration at the Public Design Commission (PDC) hearing held on October 18, 2021 (see for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf) and updated presentation of 12-13-21 accessible at https://www1.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf), please provide each of the borough-wide plans provided, or to be provided, by DoITT to each

			of the Borough Presidents as referenced here on p.33 of the 12-13-21 report cited above. The relevant portion is quoted here from p.33: "DoITT provides borough presidents' offices with proposed borough-wide plan and specific maps for community districts."
7	2021-858-00332	12-21-21	Link 5G and Community Review Documentation With respect to the wireless facilities, public communications structures (Link 5G) recently the subject of consideration at the Public Design Commission (PDC) hearing held on October 18, 2021 (see for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf and updated presentation of 12-13-21 accessible at https://www1.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf), please provide all documentation regarding or concerning the following quoted from p.33 of the 12-13-21 presentation: "Both pay phone replacement and Greenfield sites receive more community review thanks to DoITT's management approach." Please provide documentation, correspondence or otherwise regarding who DoITT solicited or requested community review from (specific community district boards, borough presidents, and others, the names of persons contacted, and information requested and communicated) and all responses from community district boards, borough presidents, city council members, and others, names of persons responding and the information and documentation that they communicated.
8	2022-858-00004	1-7-22 DOI RES PONSE -NO RECORDS	5G Buildout Documentation by CityBridge, LLC and Other Entities Please provide all buildout documentation (proposed, draft and final versions) being provided to DoITT regarding or concerning the Public Communications Structures referred to in the proposed Amendment #3 to the Franchise Agreement dated as of March 21, 2020 ("Amendment #3") with CityBridge, LLC, as well as any buildout documentation (proposed, draft and final versions) being provided to DoITT by any other entity, either under Amendment #3 with CityBridge or any other agreement with any other entity regarding or concerning Public Communications Structures (or any other wireless technology structures). See the following link of proposed Amendment #3

			https://www1.nyc.gov/assets/doitt/downloads/pdf/franchise-agreements/citybridge-fcrc-proposed-amendment-052721.pdf.
9	2022-858-00008	1-7-22	DoITT Approvals of Public Communications Structures by CityBridge, LLC Please provide all documentation regarding and concerning consultations and approvals between CityBridge, LLC and DoITT, and any and all DoITT approval documentation and consents provided to CityBridge, LLC, in each instance with respect to the Public Communications Structures referred to in the Franchise Agreement dated as of December 19, 2014, and its Amendment No. 1 (dated as of October 9, 2015), Amendment No. 2 (dated as of June 20, 2018), and its proposed Amendment No. 3 (dated as of March 21, 2020).
10	2022-858-00107	4-18-22 OTI RESPONDED -NO RECORDS	Landmarks and NYCLink 5G: Request Description Please provide all data, documentation and correspondence with DoITT, the Public Design Commission (Art Commission), Dept of Buildings or any other agency regarding or concerning any impact on landmarks in NYC with respect to the location of proposed wireless facilities, public communications structures (Link 5G) (approximately 4000) recently the subject of consideration at the Public Design Commission (PDC) hearing held on October 18, 2021. See for reference https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf.

	FOIL #	**Date Submited to OTI**	**Subject**
11	2023-858-00001	1-1-23	Applications Submitted by CityBridge for Link5G With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request the following: all applications and documentation submitted by CityBridge for the planning, siting, construction, installation or operation of Link5G facilities and equipment (including without limitation wireless antennas and facilities) in New York City and all attachments and documentation

			pertaining to or concerning such applications, including, without limitation, visual impact studies and analyses, real estate reports, appraisals, propagation maps (whether actual, proposed or projected), drive-by tests to determine gaps in phone coverage, site plans, surveys, FCC compliance reports, environmental assessments, engineering reports (including radio frequency engineering reports), legal memoranda, and all other documentation regarding or concerning the planning, construction and installation of such Link5G facilities and equipment.
12	2023-858-00002	1-1-23	Permits, Authorizations and Approvals for CityBridge and telecom carriers With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request all permits, authorizations and approvals issued by any New York City agency, committee or entity (e.g., the Public Design Commission, the Franchise Concessions and Review Committee, the Office of Technology and Innovation) regarding or concerning CityBridge or any of the telecommunications carriers (whose equipment will be housed in the Link5G) to plan, site, construct, install or operate the Link5G facilities or equipment (including without limitation wireless antennas and facilities).
13	2023-858-00003	1-1-23	Applications Submitted by Telecom Carriers for Link5G With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request the following: all applications submitted (whether directly to OTI or indirectly to CityBridge or otherwise submitted) by the telecommunications carriers for the planning, siting, construction, installation or operation of wireless antennas and facilities relating to Link5G in New York City and all attachments and documentation pertaining to or concerning such applications, including, without limitation, visual impact studies and analyses, real estate reports, appraisals, propagation maps (whether actual, proposed or projected), drive-by tests to determine gaps in phone coverage, site plans, surveys, FCC compliance reports, environmental assessments, engineering reports (including radio frequency engineering reports), legal memoranda and all other documentation regarding or

			concerning the planning, construction and installation of such Link5G facilities and equipment.
14	2023-858-00004	1-1-23	Correspondence between CityBridge and any NYC Agency for Link5G With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request all correspondence regarding or concerning the planning, siting, construction, installation and operation of Link5G in New York City (including without limitation, letters, emails and faxes) between CityBridge, or any of its subcontractors, agents or otherwise, and OTI or any other New York City agencies regarding or concerning such planning, siting, construction, installation and operation.
15	2023-858-00005	1-1-23	Correspondence between OTI and Community Boards for Link5G With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request all correspondence (including without limitation, letters, emails and faxes) between OTI and community boards in NYC regarding or concerning Link5G.
16	2023-858-00006	1-1-23	Exhibits Submitted by OTI to PDC for Link5G Referenced in PDC Certificate # 28200 With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request the exhibits submitted by OTI to PDC referenced in Certificate 28200, dated Aug 8, 2022: Exhibits 6816-IY, IZ & JA.
17	2023-858-00007	1-1-23	Detailed Pilot Proposal(s) Submitted by OTI to PDC for Link5G With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-

			2021-pres-DoITT-p-Link-5G.pdf), we respectfully request any "detailed pilot proposal[s]" submitted by OTI to PDC as required under PDC Certificate 28200, dated Aug 8, 2022, "which will include a specified cap on the number of installations as well as location as soon as possible or on an ongoing basis when known, and siting guidelines of the poles."
18	2023-858-00012	1-7-23 OTI RESPONDED - NO RECORDS	Link5G Kiosks – Telecom Denial of Service Reports With respect to the Link5G kiosks / cell towers ("Link5G"), the subject of OTI's presentation at the Public Design Commission (PDC) hearing held on October 18, 2021 (see https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf), we respectfully request all reports, correspondence and otherwise in whatever form or medium regarding or concerning denial of service (phone service, broadband service, or otherwise) whether submitted by CityBridge, by the telecommunications carriers or by their respective agents or representatives.

	FOIL #	**Date Submited**	**Subject**
19	2023-858-00101	3-31-23 to OTI	NYC Dept of City Planning Letters of 3-1-18 and 5-20-21 Please provide the NYC Dept of City Planning letter of March 1, 2018 referred to in the franchise agreement of April 9, 2020 between Extenet Systems, Inc. (Extenet II) and the City in the third "Whereas" clause on p.1 (see https://www.nyc.gov/assets/oti/downloads/pdf/mobile-telecom-franchises/extenet-systems-2-mtf-agreement-2020.pdf). Please also provide the NYC Dept of City Planning letter of May 20, 2021 referred to in the franchise agreement of between Extenet Systems, Inc. and the city in the second "Whereas" clause on p.1 (see https://www.nyc.gov/assets/oti/downloads/pdf/information-services-franchises/extenet-systems-info-services-franchise-agreement.pdf).
20	2023-858-00102	3-31-23 to OTI	NYC Dept of City Planning letter of April 28, 2014 Please provide the NYC Dept of City Planning letter of April 28, 2014 referred to in the franchise agreement between CityBridge, LLC and the City in the third paragraph after the preamble on p.9. Please also provide a copy of the executed franchise agreement between CityBridge, LLC

			and the City. (see https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf).
21	2023-858-00103	3-31-23 to OTI	City Council Authorizing Resolutions No. 2309 of 12-21-09 and No. 191 of 8-25-10 Please provide the City Council Authorizing Resolution No. 2309 adopted by the City Council on December 21, 2009 and City Council Authorizing Resolution No. 191 adopted by the City Council on August 25, 2010, as set forth on p.9 of the franchise agreement between CityBridge, LLC and the City (see https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf).
22	2023-858-00104	3-31-23 to OTI	HR&A Advisors Studies Please provide all studies, surveys, impact analysis, economic impact analysis and other analyses, including without limitation all backup documentation, performed or provided by HR&A Advisors as referenced on, e.g., p.4 of the "Link5G Design Proposal, Dec 13, 2021 at https://www.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf, and on, e.g., pp. 3, 11 and 38 of "Link5G in Residence Zoning and Historic Districts PDC Preliminary/Final Review August 8, 2022" at https://chtrust.org/wp-content/uploads/New-York-City-OTI-Link5G-DigitalEquityppt.pdf.
23	2023-858-00105	3-31-23 to OTI	Growth from Knowledge Studies Please provide all studies, surveys and analyses, including without limitation all backup documentation, performed or provided by Gfk (Growth from Knowledge) as referenced on, e.g., pp.3, 10 and 13 of "Link5G in Residence Zoning and Historic Districts PDC Preliminary/Final Review August 8, 2022" at https://chtrust.org/wp-content/uploads/New-York-City-OTI-Link5G-DigitalEquityppt.pdf.
24	2023-030-00073	3-31-23 to NYC Dept of	NYC Dept of City Planning Letters of 3-1-18, 5-20-21 and 4-28-14

		City Planning	Please provide the NYC Dept of City Planning letter of March 1, 2018 referred to in the franchise agreement of April 9, 2020 between Extenet Systems, Inc. (Extenet II) and the City in the third "Whereas" clause on p.1 (see https://www.nyc.gov/assets/oti/downloads/pdf/mobile-telecom-franchises/extenet-systems-2-mtf-agreement-2020.pdf). Please also provide the NYC Dept of City Planning letter of May 20, 2021 referred to in the franchise agreement between Extenet Systems, Inc. and the city in the second "Whereas" clause on p.1 (see https://www.nyc.gov/assets/oti/downloads/pdf/information-services-franchises/extenet-systems-info-services-franchise-agreement.pdf). Please provide the NYC Dept of City Planning letter of April 28, 2014 referred to in the franchise agreement between CityBridge, LLC and the City in the third paragraph after the preamble on p.9. Please also provide a copy of the executed franchise agreement between CityBridge, LLC and the City. (see https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf).
25	2023-030-00075	3-31-23 to NYC Dept of City Planning	NYC Dept of City Planning letter of April 28, 2014 Request Description: Please provide the NYC Dept of City Planning letter of April 28, 2014 referred to in the franchise agreement between CityBridge, LLC and the City in the third paragraph after the preamble on p.9. Please also provide a copy of the executed franchise agreement between CityBridge, LLC and the City. (see https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf).
26	2023-030-00078	4-3-23 DCP	RFP / Solicitation Submitted to DCP on Feb 2, 2018 on Telecom Equipment and Facilities Please provide the draft RFP or solicitation submitted to the Dept of City Planning (DCP) on February 2, 2018, as referenced in the March 1, 2018 letter from DCP (Office of the Counsel) to the Dept of Information Technology and Telecommunications (Stanley Shor, Asst Commissioner). The subject heading on the letter reads: "Draft RFP for Proposals for Franchises for the Installation and Use of Telecommunications Equipment and Facilities, including Base Stations and Access-Point Facilities, on City-Owned Street Light Poles and

			Traffic Light Poles, and Certain Utility Poles and Other Facilities Located on City Streets, in connection with the provision of Mobile Telecommunications Services."
	2023-858-00108	4-3-23 to OTI	RFP / Solicitation Submitted to DCP on Feb 2, 2018 on Telecom Equipment and Facilities Please provide the draft RFP or solicitation submitted to the Dept of City Planning (DCP) on February 2, 2018, as referenced in the March 1, 2018 letter from DCP (Office of the Counsel) to the Dept of Information Technology and Telecommunications (Stanley Shor, Asst Commissioner). The subject heading on the letter reads: "Draft RFP for Proposals for Franchises for the Installation and Use of Telecommunications Equipment and Facilities, including Base Stations and Access-Point Facilities, on City-Owned Street Light Poles and Traffic Light Poles, and Certain Utility Poles and Other Facilities Located on City Streets, in connection with the provision of Mobile Telecommunications Services."
	2023-030-00079	4-3-23 DCP	RFP / Solicitation Submitted to DCP for LinkNYC and Link5G Kiosks Please provide any requests for proposal (RFP) or solicitations, whether in draft or final form, submitted to the Dept of City Planning (DCP) for the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.
	2023-858-00109	4-3-23 to OTI	RFP / Solicitation Submitted to DCP for LinkNYC and Link5G Kiosks Please provide all requests for proposal (RFP) or solicitations, whether in draft or final form, submitted to the Dept of City Planning (DCP) for the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.
	2023-030-00080	4-3-23 to DCP	Final RFPs for Telecom Equipment and Facilities Please provide the final versions of the requests for proposal (RFP) or solicitations, from 2010 to the present, for the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services, including without limitation (a) the final version of the RFP or solicitation referenced in the Dept of City Planning's March 1, 2018 letter to the Dept of Information Technology and Telecommunications (Stanley Shor, Asst Commissioner) as set forth

			in FOIL 2023-858-00108 and (b) the final version of the requests for proposal (RFP) or solicitations in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.
	2023-858-00110	4-3-23 to OTI	Final RFPs for Telecom Equipment and Facilities Please provide the final versions of the requests for proposal (RFP) or solicitations, from 2010 to the present, for the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services, including without limitation (a) the final version of the RFP or solicitation referenced in the Dept of City Planning's March 1, 2018 letter to the Dept of Information Technology and Telecommunications (Stanley Shor, Asst Commissioner) as set forth in FOIL 2023-858-00108 and (b) the final version of the requests for proposal (RFP) or solicitations in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.
	2023-858-00111	4-3-23 to OTI	Dept of City Planning Determinations on RFPs for Telecom Eqpt and Facilities Please provide documentation regarding determinations made by the Dept of City Planning on requests for proposal or solicitations regarding the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.
	2023-030-00081	4-3-23 to DCP	Dept of City Planning Determinations on RFPs for Telecom Eqpt and Facilities Please provide documentation regarding determinations made by the Dept of City Planning on requests for proposal or solicitations regarding the installation and use of telecommunications equipment and facilities, including base stations and access-point facilities, in connection with the provision of mobile telecommunications services for the approximately 9-½ foot LinkNYC kiosks and the approximately 32 foot Link5G kiosks.

	2023-858-00113	4-7-23 to OTI	Reports of RF Tests Conducted in NYC From 2018 onwards, please provide all and complete reports, memoranda, analyses, measurements, notes, and any other writings regarding or concerning radio-frequency or electro-magnetic frequency readings, measurements or tests taken of wireless antennas in NYC, which identify, including without limitation, the antenna locations, the type of antennas, their frequency band, telecom carriers, who took the readings, measurements or tests and their qualifications, and the distance and the angle from the antenna where the readings, measurements or tests were taken.
	2023-858-00120	4-13-23 to OTI	Fiber Optics Buildout in NYC Please provide documentation showing the fiber buildout in NYC, including without limitation (a) the fiber buildout by Verizon; (b) the fiber buildout by CityBridge, (c) identifying the entities which installed and deployed the fiber and the locations where each entity's fiber has been installed, (d) in which locations is the fiber "lit up;" and (d) in which locations is the fiber dark.
	2023-858-00139	4-23-23 to OTI	Work Permits for Link5G kiosks / cell towers Please provide all work permits relating to or regarding the Link5G kiosks / cell towers.

Odette J. Wilkens
Wired Broadband, Inc.
501(c)(3) non-profit
Focusing on safe technology for the public

Position Paper on NYC Link5G "Kiosks" / Cell Towers
By Wired Broadband, Inc.
Submitted to the Committee on Technology
June 7, 2023

Community boards are increasingly rising in opposition to the Link5G cell towers. Sixteen community boards to date have either disapproved or called for moratoria on these towers. This represents up to 800 community board members,[1] and an average of about 2 million residents.[2] That is more than a quarter of the NYC population.[3] Elected officials are hearing increasingly from their constituents that they are opposed to these towers in their neighborhoods.[4] The message has been clear, they:

Do Not Need Link5G Cell Towers and
Do Not Want Them.

Moreover, the Federal Communications Commission (FCC) notified CityBridge, the NYC franchisee and site developer for the Link5G cell towers, of its **failure to comply** with environmental and historic preservation reviews otherwise required under federal law – under the National Environmental Policy Act (NEPA) and under Section 106 of the National Historic Preservation Act (NHPA). Those reviews are required prior to construction.

However, CityBridge has already constructed and installed 107 towers throughout the City,[5] and as to those towers, post-construction reviews must also be conducted. CityBridge's failure to comply with federal law would mean that they are in material breach of their franchise agreement. Despite these failures, it has been reported that there is no moratorium on current installations.[6]

Community boards have expressed **serious problems** with these installations that range from aesthetic blight, ill placement in historic districts, lack of privacy and security, rat infestations,

[1] "[E]ach [community board] consists of up to 50 unsalaried members." https://www.nyc.gov/site/cau/community-boards/about-commmunity-boards.page.
[2] "Community districts range in … population from a little more than 50,000 residents to more than 200,000." https://www.nyc.gov/site/planning/community/community-portal.page#:~:text=Community%20districts%20range%20in%20size,residents%20to%20more%20than%20200%2C000. Two million is based on an average between 50,000 and 200,000 = 125,000; 125,000 x 16 community boards = 2,000,000.
[3] In 2023, NYC population is 7,888,121, https://worldpopulationreview.com/us-cities/new-york-city-ny-population.
[4] Overview of community board actions in New York City, https://ehtrust.org/5g-in-new-york/.
[5] CityBridge CEO Nick Colvin's presentation to the Landmarks Committee of Manhattan Community Board 7 on 5-30-23.
[6] Reported by Andrew Heineman of Rep. Jerrold Nadler's office at 5-30-23 meeting of the Landmarks Committee of Manhattan Community Board 7.

adverse health impacts and adverse environmental impacts to birds, bees and trees. Several community boards whose districts have been designated as equity districts are bristling at the branding and the accompanying mandate of an exorbitant number of cell towers, currently, up to 117 in a single district.

These are 32' or 3-story towers with **no setback requirement** on how close they can be to any structure, be it a home, school, hospital or business, or how close they can be to vehicular or pedestrian traffic. That means that in the event of structural failure, the towers may collapse onto nearby structures or onto the street, risking serious property damage and personal injury.

The Office of Technology and Innovation (OTI), the lead city agency in charge of these installations,[7] has been providing presentations to community boards, but many of the CBs and residents have **complained that OTI has not been transparent in providing complete or accurate information** regarding, e.g., the complete build-out plan, surveillance and contracts with service providers**.** Indeed, many FOIL requests asking for antenna specifications, frequencies and bandwidths have gone unanswered with perpetual extensions of time to respond, when that information should be publicly available prior to any permits for installation. A FOIL request had been submitted in October 2021 for FCC compliance reports which relate to radiation levels; OTI recently responded that it does not have those reports. How, then, can OTI monitor compliance with the franchise agreement?

This position paper corrects OTI's assertions of safety, federal oversight, digital equity and privacy and provides a comprehensive analysis of the many adverse implications of the Link5G cell towers, e.g., insufficient fall zones, failure to meet the legal threshold of a gap in phone service to justify imposing these towers in our neighborhoods, and incidents of adverse impacts on first responders from wireless exposure.

This position paper also shows that, if the Link5G deployment can be viewed as a **proof of concept, it has failed** and should be abandoned for a better plan for NYC residents. That plan would require meaningful community input and approval at the inception of any ideas well before any decisions are made or formal agreements entered into, not after the fact, which residents are already concluding has been an attempt to minimize community pushback and input.

NYC officials have been **misled to believe that their "hands are tied,"** and must accept 5G deployment as a matter of federal preemption. That is incorrect. A 2022 case in **federal district court in New York struck down an FCC rule that strips local authority** over the placement of cell towers, underscoring the federal Second Circuit standard that places the burden of proof on the telecom carrier to prove a gap in phone service. CityBridge has admitted in a community board meeting that they do not have any reports showing a gap in phone service.[8]

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[7] LinkNYC New Site Permit Applications (Data): https://data.cityofnewyork.us/SocialServices/LinkNYC-NewSite-Permit-Applications/xp25-gxux
LinkNYC New Site Permit Applications (Map): https://data.cityofnewyork.us/SocialServices/LinkNYC-New-Site-Permit-Applications-Map/tdt4-7qzu.

[8] Manhattan Community Board 8, Transportation Committee meeting of Dec 7, 2023.

OTI has also claimed that the carriers need to add capacity for future demand and that NYC is federally required to give them access. The same **federal court struck down a similar claim** in New York as not protected under federal law. The court upheld local authority to determine and deny the placement of cell towers. ***Therefore, under either scenario – no evidence of a gap in phone service and adding capacity for future demand – there is no federal preemption for imposing 5G in NYC.***

In conflict with federal law in New York, the Link5G deployment has effectively stripped local communities from any meaningful participation in determining whether they need or want them. OTI has stated that they are only interested on where to site the towers, not whether they are wanted.

"Is 5G safe?" is a common refrain heard from constituents focusing on health and environmental risks of cumulative exposure to different frequencies, including hi-powered 5G frequency, in extreme proximity to people's windows, homes, businesses and schools. There has been **no pre-market safety** testing for 5G. However, **three recent 5G studies showed harm**.[9] Wireless exposure limits set by the FCC are a safe harbor for industry to provide immunity from liability for personal injury, but are not safety limits to protect the public.[10]

The marketing of 5G shows a trend towards planned, built-in obsolescence. Telecom carriers are already sunsetting prior generations, such as 3G, by design. This is forcing underserved communities **to buy new phones and equipment** with each new generation of wireless service as their old phones and equipment become obsolete and unusable. Therefore, the trend of ever-new generations of wireless networks (5G and beyond) with planned, built-in obsolescence of each generation of wireless **will perpetuate the digital divide**.

The issues covered in this paper are listed below:

- FCC Notifies CityBridge of Failure to Comply with Federal Law
- Link5G Cell Towers, Not "Kiosks"

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[9] Feb 2023 study of two previously healthy men rapidly developed typical "microwave syndrome" symptoms shortly after a 5G cell tower was installed on the roof of their office: headaches, joint pain, tinnitus, abnormal fatigue, sleep disturbances, burning skin, anxiety and trouble concentrating. https://www.anncaserep.com/open-access/development-of-the-microwave-syndrome-in-two-men-shortly-after-9589.pdf.
Jan 2023 study of a previously healthy man and woman developed similar "microwave syndrome" symptoms soon after a 5G tower was installed on top of their apartment. https://www.gavinpublishers.com/assets/articles_pdf/Case-Report-The-Microwave-Syndrome-after--Installation-of-5G-Emphasizes-the-Need-for--Protection-from-Radiofrequency-Radiation.pdf.
April 2023 study of a 52 year old woman whose apartment was 60 meters from a 5G base station who developed "microwave syndrome" symptoms, https://acmcasereport.com/pdf/ACMCR-v10-1926.pdf?fbclid=IwAR2J-mE3XeBxqaXPQdFxslf9Q23bMCer9vgUBHnCvJXBrgBv-w7YdRUDwF0;
The studies show that non-ionizing radiation from 5G — well below levels allowed by authorities — can cause health problems in individuals who had no prior history of electromagnetic sensitivity (EMS).

[10] See also a comprehensive briefing, https://ehtrust.org/wp-content/uploads/Setbacks-Ordinances-Health-Liability-for-Wireless-Facilitites-.pdf and https://ehtrust.org/wp-content/uploads/5G-Health-and-Policy-New-York-City-March-15-2023-.pdf.

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- FCC's Lack of Oversight and Regulatory Gap
    - FCC Does Not Measure Wireless Emissions
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    - Telecom Carriers' Propagation Maps are Not Reliable
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- FCC Loses Two Cases on Wireless Emissions and Environmental Review
- Telecoms Characterize Wireless Emissions as a Pollutant
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    - Wireless is Not Green
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- Adverse Health and Environmental Impacts
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Addendum A – Photo from OTI's Presentation to PDC, p.40
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Addendum C – OTI's Letter to Community Board 8 Manhattan
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Addendum E – Take Action to Remove 5G Antenna from 520 E. 90th Street
Addendum F – Letter Jan 6, 2023, from Dr. Kent Chamberlin, Chair Emeritus Dept of Electrical and Computer Engineering, Univ of NH, former NH Commissioner

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FCC Notifies CityBridge of Failure to Comply with Federal Law

CityBridge has been found to have violated federal law. The FCC notified CityBridge on April 20, 2023, that environmental and historic preservation reviews were required for each Link5G cell tower prior to construction under two federal laws – the National Historic Preservation Act, and the National Environmental Policy Act (NEPA).[11] CityBridge has already constructed and installed 107 towers throughout the City.[12] As to those towers already constructed, post-construction reviews must also be conducted. The FCC in footnote 14 of the notice did not preclude enforcement actions against CityBridge. [13]

Given that these huge, free-standing structures will house wireless antennas otherwise subject to federal licenses under which the telecom carriers are required to operate, the Link5G cell towers have triggered historic preservation review as a federal "undertaking" and environmental review as a "major Federal action."[14] The New York State Historic Preservation Office (SHPO) would also be involved in the review.

CityBridge's failure to comply with federal law would mean that they are in material breach of their franchise agreement. CityBridge had made representations that it had the "power and authority" to perform under the agreement, that it would not be in material breach with any "statute [or] regulation," and "no material misrepresentation has been made … intentionally or negligently." CityBridge had also covenanted that it "shall comply with all laws."[15] Although there is a cure period so long as the default is susceptible to cure, and the franchisee is diligently working to cure the default, there are "termination defaults" that may allow OTI to terminate the franchise, including

[11] https://www.dropbox.com/preview/Jumbo%205G/Politicians/FCC%20Letter%20to%20CityBridge%204-20-23.pdf?role=personal.
[12] See Landmarks Committee of Manhattan Community Board 7 hearing, comments of Nick Colvin, CEO of CityBridge, 5-30-23.
[13] Id., ftnt 14.
[14] Id, see also, https://parks.ny.gov/shpo/environmental-review/preservation-legislation.aspx; and https://www.achp.gov/sites/default/files/documents/2017-01/CitizenGuide.pdf.
[15] See Sections 15.6.1 (iii), (iv), (vi) and (vii)(a), 15.6.4 and 15.21.1 at https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf.

claims of misrepresentation. However, OTI would need to serve notice of breach or default to CityBridge, which, to date, has not yet been confirmed by OTI.[16]

Despite these failures and breaches, it has been reported that there is no moratorium on current Link5G installations.[17] There was an eye witness who saw and photographed workers installing antennas into a Link5G tower at 2nd Avenue and 1st Street on May 5, 2023, after the FCC letter of April 20, 2023 to CityBridge notifying it of its failure to comply with federal law.

Link 5G Cell Towers, Not "Kiosks"

OTI's branding of 5G public communications structures as "Link5G kiosks" is inaccurate and misleading. The definition of a kiosk is a small structure or cubicle in a public area used for providing newspapers, tickets, displaying ads or having interactive screens.[18]

The Link5G structures are not small. They are giant, free-standing, towers about 32' tall, or 3 stories in height, with housing for multiple 4G/5G antennas being almost 20' high (see attached Addenda A and B).[19] This is part of a plan to install a minimum of 2000 5G cell towers in the entire city.[20] Therefore, they should be called what they really are – "Link5G Cell Towers."

OTI claims that these Link5G cell towers or "kiosks" are simply replacing the old phone booths, as well as adding new structures. The **FCC does not agree**, and called each of the Link5G cell towers a federal "undertaking" under the National Historic Preservation Act and a "major federal action" under the National Environmental Policy Act, requiring review under both of those federal laws.[21]

Locations of the sites for Link5G cell towers are on Open Data at:

- LinkNYC New Site Permit Applications (Data): https://data.cityofnewyork.us/SocialServices/LinkNYC-NewSite-Permit-Applications/xp25-gxux
- LinkNYC New Site Permit Applications (Map):

[16] The author, along with others, were in an online meeting with OTI representatives on May 17, 2023, where the question was posed but not answered.
[17] Reported by Andrew Heineman of Rep. Jerrold Nadler's office at 5-30-23 meeting of the Landmarks Committee of Manhattan Community Board 7.
[18] Google Dictionary, https://www.google.com/search?q=definition+kiosk&oq=definition+kiosk&aqs=chrome..69i57j0i15i22i30j0i22i30l8.3085j1j7&sourceid=chrome&ie=UTF-8.
[19] Renditions can be seen in the links for footnote 4 below and at https://manhattanneighbors.org/jumbo-5g-antennas-nyc/.
[20] Link5G ppt presentation to NYC's Public Design Commission by Dept of Info Technology and Telecommunications (DoITT) now called Office of Technology and Innovation (OTI) 10-18-21 at pp. 54-55. https://www1.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf; updated presentation, 12-13-21 at https://www1.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf.
[21] FCC letter to CityBridge, April 20, 2023.

https://data.cityofnewyork.us/SocialServices/LinkNYC-New-Site-Permit-Applications-Map/tdt4-7qzu

- LinkNYC approved and installed (includes LinkNYC kiosks and Link5G cell towers): https://data.cityofnewyork.us/Social-Services/LinkNYC-Map/tgrn-h24f

- **Inadequate Environmental Review**

Why is the issue of size important? Based on a search of the City Environmental Quality Review (CEQR) determinations for mobile telecommunications, it appears that OTI did not conduct an adequate environmental review. Instead, OTI piggybacked on the CEQR done on the smaller, 9' LinkNYC kiosks to make a determination of no environmental impact for the 32' Link5G towers. [22]

LinkNYC kiosks were designed to provide public Wi-Fi. Instead, Link5G structures are cell towers designed to house multiple 4G/5G antennas from multiple carriers for private customers, in addition to Wi-Fi. OTI also conducted a CEQR environmental assessment on 5G "small" cells in 2020, and concluded no environmental impact.[23] But that assessment was based on 5G structures being much smaller in size (the size of a large backpack) and would be placed on pre-existing structures (co-locations) like streetlights and light poles.

The Link5G assessment was also based on the incorrect assumption of no significant energy consumption, even though the 5G network requires an exorbitant amount of energy.[24] That means there has been no assessment of the Link5G cell towers on adverse impacts on energy consumption. In fact, telecom carriers have been advising their customers to turn off 5G to save battery life on their devices.[25]

Moreover, because Link5G cell towers are huge, free-standing structures (rather than co-locations), whether they rise to the level of federal undertakings otherwise requiring environmental review on the federal level also warrants further examination. Because the telecom carriers are operating under federal licenses, Link5G cell towers may require prior review under the National Environmental Policy Act.

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[22] Technical Memorandum, CEQR No. 15DIT001Y, Citywide Public Communications Structures, undated, https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAxNVwxNURJVDAwMVlcdGVjaF9tZW1vXDE1RElUMDAxWV9UZWNobmljYWxfTWVtb3JhbmR1bV9fMDUyNjIwMjEucGRm0&signature=7bff46e8f4492ec7ca05ec25ebaaf6462822bfde.

[23] Technical Memorandum 001, CEQR No. 20DIT001Y, New York City Department of Information Technology and Telecommunications, Mobile Telecommunications Franchises, May 7, 2020, https://a002ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAyMFwyMERJVDAwMVlcdGVjaF9tZW1vXDIwRElUMDAxWV9UZWNobmljYWxfTWVtb3JhbmR1bV9fMDUwODIwMjAucGRm0&signature=cb5e38710e4a95b771ea454efb5ce1b45e767a65; CEQR Environmental Assessment Statement Short Form, Dec 10, 2019, https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAyMFwyMERJVDAwMVlcZWFzXDIwRElUMDAxWV9FQVNfMTIxMDIwMTkucGRm0&signature=9efc336372ffb4f803d59f76fe9fd0b815651005.

[24] https://ehtrust.org/report-5g-to-increase-energy-consumption-by-61-times/.

[25] "Why are Carrriers Telling Us to Turn Off 5G?" PC Magazine, March 5, 2021, https://www.pcmag.com/opinions/why-are-carriers-telling-us-to-turn-off-5g.

Therefore, a more thorough CEQR analysis would be required for Link5G Cell Towers before its continued deployment.

Opposition

- **Community Board Actions in Opposition**

Sixteen community boards to date have disapproved or voted for moratoria on Link5G installations. This represents up to 800 community board members,[26] and an average of about 2 million residents.[27]

The number of community boards in opposition to the Link5G Cell Towers is rising, and elected officials are hearing increasingly from their constituents that they are opposed to these towers in their neighborhoods (see also opposition to 5G pole-top antennas in Addendum E).[28] Community boards' concerns about these installations range from aesthetics and out of character with the neighborhood, ill placement in historic districts, lack of privacy and security, rat infestations on current LinkNYC kiosks, and health issues related to exposure to wireless radiation.

Community boards should have received written notice from OTI of proposed installations in their districts, similar to the notice received by Community Board 8 in Manhattan (MCB8)[29] (see attached notice in Addendum C). There is a comment period of 60 days to reply to OTI.

The community boards in opposition, to date, are listed below:

- Manhattan
  - CB2 covering Greenwich Village, SoHo, NoHo, Little Italy and Chinatown – moratorium
  - CB5 covering Times Square and Union Square – moratorium
  - CB8 covering the Upper East Side – moratorium
  - CB9 covering Morningside Heights, Harlem and Columbia University – disapproval and moratorium[30]
  - CB10 covering East Harlem – disapproval and questions submitted to OTI
  - CB11 covering East Harlem – disapproval
- Brooklyn
  - CB1 covering Greenpoint and Williamsburg – disapproval

[26] "[E]ach [community board] consists of up to 50 unsalaried members." https://www.nyc.gov/site/cau/community-boards/about-commmunity-boards.page.
[27] "Community districts range in … population from a little more than 50,000 residents to more than 200,000." https://www.nyc.gov/site/planning/community/community-portal.page#:~:text=Community%20districts%20range%20in%20size,residents%20to%20more%20than%20200%2C000. Two million is based on an average between 50,000 and 200,000 = 125,000; 125,000 x 16 community boards = 2,000,000.
[28] Overview of community board actions in New York City, https://ehtrust.org/5g-in-new-york/; see also, uproar at Manhattan Community Board 12 in the video embedded in the article, https://patch.com/new-york/washington-heights-inwood/5-more-uptown-5g-tower-sites-revealed-plans-leaving-pol-livid.
[29] https://www.cb8m.com/wp-content/uploads/2022/11/Manhattan-CB8-Greenfields-Nov-2022.pdf.
[30] Moratorium at 2:21:12, https://www.facebook.com/watch/live/?ref=watch_permalink&v=1238972740308898.

    - CB4 covering Bushwick - disapproval and moratorium, including those already installed
    - CB9 covering Crown Heights – disapproval and moratorium, including those already installed
    - CB10 covering Bay Ridge and Hamilton Heights – disapproval
- Bronx
    - CB6 covering Crotona, Belmont and West Farms - disapproval
- Queens
    - CB1 covering Astoria – disapproval (see also 1-25-23 meeting of the Environment/Sanitation Cmte for comments by experts and by a police lieutenant severely injured from a wireless antenna placed outside of his house)[31]
    - CB3 covering East Elmhurst, Jackson Heights and North Corona – partial disapproval (4 out of 5 installations rejected because they were close to residences)
    - CB6 covering Forest Hills and Rego Park – moratorium on future installations a/o 5-9-23
    - CB12 covering Jamaica – disapproval and moratorium
    - CB14 covering Far Rockaway - disapproval

As an example, MCB8 sent the city a clear message that they do not need these towers and they do not want them. MCB8's passed resolutions disapproving the towers and voting on a moratorium on the planning and construction of Link5G Cell Towers in their district (see Addendum D).[32] MCB8 was slated to have 18 towers installed, 15 in historic districts. The resolution cited many reasons for disapproval, some of which include:

1. A distance of 10' from buildings is an insufficient distance,
2. "Renowned architecture and iconic streetscapes would be interfered with,"
3. Illuminated advertising on these towers do not comply with certain historic preservation rules prohibiting such advertising (e.g., see Addendum B),
4. There are no reported gaps in phone or internet service,
5. "Impacts on sidewalk clearances, and rat infestation,"
6. The desire to have telecommunications infrastructure underground for more service reliability and "to minimize visual impacts," and
7. "Long-term health impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants and parks."[33]

[31] See presentation by a police lieutenant who was injured from exposure to wireless radiation from an antenna placed just feet away from his house and from which he has had to evacuate, starting at about 00:54:00, https://www.youtube.com/watch?v=OGxADW9tp8E.

[32] MCB8's moratorium resolution https://www.cb8m.com/wp-content/uploads/2022/11/1222-Link-5G-Resolution.pdf (see also, resolutions of the Transportation Committee and Landmarks Committee, attached as Addendum D reformatted into Word).

[33] Id.

For the public hearings at MCB8, see the Transportation Committee hearing with over 130 attendees and about 30 commenters in unanimous opposition,[34] the Landmarks Committee hearing[35] and the full Board hearing and vote passing the moratoria.[36]

- **Officials in Opposition**

Manhattan Borough President, Mark Levine, issued a letter to OTI to pause its deployment in order to address the concerns of his constituents.[37] Assembly member Seawright and former member of Congress Maloney sent letters to the city opposing the Link5G cell towers in their districts and calling for a moratorium.[38] Seawright introduced NYS Assembly bill A06633 to establish a temporary commission to study the environmental and health effects of evolving 5G technology.[39] Senator Lanza introduced NYS Senate bill S5123 requiring a setback requirement of 250' from any structure, environmental review, and placement within 250' only with prior approval of owners and community boards.[40]

The following elected officials sent a joint letter on Jan 23, 2023 to the Landmarks Preservation Commission to pause the review of any Link5G installations proposed for historic districts: Council Members Powers and Menin, Assembly members Seawright and Bores, State Senator Krueger, Congressman Nadler, joined by Manhattan Borough President Levine.[41] Individual letters were sent to the Mayor or to OTI by former Congresswoman Maloney,[42] and City Council members Menin[43] and Powers.[44]

Nadler urged the FCC to require a review under the National Historic Preservation Act (NHPA) (Sec 106) for Link5G cell towers proposed in historic districts.[45] A week later, on April 20, 2023, the FCC notified CityBridge that reviews are required prior to construction not only under the NHPA, but also under the NEPA.[46] As to those towers already constructed, post-construction reviews must also be

[34] https://www.cb8m.com/event/24978/.
[35] https://www.cb8m.com/event/24983/.
[36] https://www.cb8m.com/event/24871/ (starting at about 28:00).
[37] https://ehtrust.org/wp-content/uploads/January-16-2023-Letter-on-5G-Poles-from-New-York-Manhattan-Borough-President-to-Matthew-C.-Fraser-Chief-Technology-Officer-Office-of-Technology-Innovation-of-The-NYC-Office-of-Technology-Innovation.pdf.
[38] https://www.carnegiehillneighbors.org/community-board-8-response.
[39] https://nyassembly.gov/mem/Rebecca-A-Seawright/sponsor/.
[40] https://www.nysenate.gov/legislation/bills/2023/S5123.
[41] https://nylc.wpenginepowered.com/wp-content/uploads/2023/01/Joint-Electeds-Link-5G-Letter-to-LPC-1-23-2023-1.pdf; see also, Rep. Nadler letter at , City Council Member Menin letter at https://www.carnegiehillneighbors.org/_files/ugd/02baf5_e1841418e98243d4bf31287bba2f700b.pdf.
[42] https://www.carnegiehillneighbors.org/_files/ugd/02baf5_f7c4ca2a58af437b9ef4932d12e32a44.pdf.
[43] https://www.carnegiehillneighbors.org/_files/ugd/02baf5_e1841418e98243d4bf31287bba2f700b.pdf.
[44] https://www.dropbox.com/home/Jumbo%205G/Politicians?preview=Keith+Powers+Letter+to+OTI+12-21-22.pdf.
[45] https://nadler.house.gov/news/documentsingle.aspx?DocumentID=394982.
[46] FCC Letter to CityBridge, April 20, 2023, https://www.dropbox.com/search/personal?path=%2FJumbo+5G&preview=id%3AuIbvgJN6khUAAAAAAAAH5Q&query=fcc+letter+bridge&search_token=jwuzsoC%2FG68HRntmUo8G0hoFmcQ42jb4WVKpLGsYFyo%3D&typeahead_session_id=271081629562923783203325519873 01.

conducted.[47] The FCC notice should serve to halt Link5G construction and installation while the reviews are being conducted, however, it has been reported that CityBridge intends to continue construction despite the FCC letter.[48] In fact, it has been recentlyn reported that there is no moratorium on current Link5G construction and installations.[49]

- **Historic Preservation Societies in Opposition**

Link5G cell towers do not belong in historic districts. Many historical preservation societies in NYC have opposed their installation. An online petition by Carnegie Hill Neighbors in CB8-Manhattan has already garnered over 3000 signatures under the banner "Don't Sell Our Streets to 5G Towers." [50] Another online petition by Village Preservation in CB2-Manhattan has a letter writing campaign to local representatives under the banner "Stop the Siting of Oversized and Unnecessary 5G Towers in Our Neighborhood!" [51]

Eight historic preservation societies voiced their opposition jointly in a Jan 12, 2023 letter to First Deputy Mayor Sheena Wright and Deputy Mayor Maria Torres-Springer requesting more transparency on the city's process of choosing and siting locations, particularly in historic districts, and expressing their dismay at the potential "severe, negative and permanent impacts" if they were to be placed in historic districts. [52]

Friends of the Upper East Side, an historical preservation society, issued a December 23, 2022 letter to the Mayor, the Public Design Commission, the Office of Technology and Innovation and the Landmarks Preservation Commission, expressing that the Link5G Cell Towers would conflict with a master plan not to have flash-screen advertising on Madison Avenue, and would contribute to congestion and the uneven clustering of cell towers, for example, 5 cell towers on one block.[53] Others have also expressed opposition, e.g., Save Chelsea[54] and Save Gansevoort.[55]

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[47] Id.

[48] https://www.nydailynews.com/news/politics/new-york-elections-government/ny-nyc-5g-towers-have-not-undergone-federal-reviews-20230426-v7waeeraozd2xcllibzb7ckmfe-story.html; see also, https://childrenshealthdefense.org/defender/fcc-behemoth-5g-towers-new-york-city/.

[49] Reported by Andrew Heineman of Rep. Jerrold Nadler's office at 5-30-23 meeting of the Landmarks Committee of Manhattan Community Board 7.

[50] Carnegie Hill Neighbors petition, https://www.carnegiehillneighbors.org/; see also, https://www.carnegiehillneighbors.org/5g-opposition.

[51] Greenwich Village Society for Historical Preservation petition, https://p2a.co/cebw5as.

[52] http://friends-ues.org/wp-content/uploads/2023/01/Preservation-Group-Request-to-Deputy-Mayors-on-5G-Towers.pdf?emci=4a0975a4-0698-ed11-994c-00224832eb73&emdi=fa3fe730-0f98-ed11-994c-00224832eb73&ceid=6757961; see also, https://www.mas.org/news/link5g-towers-spark-concern/.

[53] http://friends-ues.org/wp-content/uploads/2023/01/FRIENDS-Link5G-towers-letter-122322.pdf?emci=4a0975a4-0698-ed11-994c-00224832eb73&emdi=fa3fe730-0f98-ed11-994c-00224832eb73&ceid=6757961.

[54] In testimony at the PDC, at 2:38:25, https://www.youtube.com/watch?v=nTBM95YcdF8.

[55] By letter on April 10, 2023 to the FCC and State Historical Preservation Office.

- **Lack of Compliance with NYC Rules and Federal Laws**

Link5G cell towers do not comply with the Rules of the NYC Landmarks Preservation Commission. According to the Rules, public communications structures, such as the Link5G cell towers, must have "an exterior dimension no greater than 11" wide x 35" deep x 122.9" high."[56] At 32 feet high and a width of 18 inches,[57] the Link5G cell tower exceeds the allowable dimensions.

Link5G cell towers have been constructed and installed in violation of federal law. On April 20, 2023, the FCC notified CityBridge that reviews are required prior to construction under the federal National Historic Preservation Act (NHPA), and under the National Environmental Policy Act (NEPA), essentially halting Link5G construction and installation while the reviews are being conducted.[58] As to those towers already constructed, post-construction reviews under NHPA and NEPA must also be conducted.[59] The FCC did not preclude enforcement actions against CityBridge for having constructed and installed Link5G without prior reviews.[60]

The FCC notice came on the heels of a letter which Congressman Nadler sent to the FCC requesting a Section 106 review under the NHPA in historic districts.[61]

OTI and CityBridge

- **Proof of Concept Has Failed**

OTI entered into an agreement with a vendor, CityBridge, LLC, to install 4000 (which can approach 7500) Link5G Cell Towers without first engaging the community for input on the entire project prior to entering into a franchise agreement with CityBridge. CityBridge's assertion that there was overwhelming support for the Link5G towers was only based on a survey of 1303 people.[62] That is hardly a large enough sample to represent almost 8 million New Yorkers.[63] OTI is now attempting to retrofit communities into an ill-conceived plan. Given the growing opposition by community boards,

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[56] Rules of the New York City Landmarks Preservation Commission, Title 63, §2-23(c)(2)(iv), https://www1.nyc.gov/assets/lpc/downloads/pdf/Rules/Rules%20of%20the%20NYC%20Landmarks%20Preservation%20Commission_01.22.2019.pdf.

[57] CityBridge presentation to CB6-Queens Executive Committee, 2-15-23.

[58] FCC Letter to CityBridge, April 20, 2023, https://www.dropbox.com/search/personal?path=%2FJumbo+5G&preview=id%3AuIbvgJN6khUAAAAAAAAH5Q&query=fcc+letter+bridge&search_token=jwuzsoC%2FG68HRntmUo8G0hoFmcQ42jb4WVKpLGsYFyo%3D&typeahead_session_id=271081629562923783203325519873 01.

[59] Id.

[60] Id., ftnt 14.

[61] Congressman Nadler's letter to the FCC requesting a Section 106 review of the Link5G cell towers in historic districts: https://nadler.house.gov/uploadedfiles/nadler_letter_to_fcc_re_section_106_review_of_link5g_towers.pdf; see also, press release, https://nadler.house.gov/news/documentsingle.aspx?DocumentID=394982.

[62] Link NYC – Link5G in Residential Zoning and Historic Districts, PDC Preliminary/Final Review, Aug 8, 2022, see footnote referencing GfK Independent survey of 1303 New Yorkers at 10, https://www.nyc.gov/assets/designcommission/downloads/pdf/08-08-2022-pres-OTI-f-Link%205G.pdf.

[63] See Manhattan Community Board 8, Transportation Committee hearing where OTI and CityBridge presented on Dec 7, 2022, where this issue arose.

historic preservation societies, elected officials and others, Link5G deployment, if viewed as a **proof of concept, has failed** and should be abandoned for a better plan for NYC residents.

- **Public Design Commission Requirements for OTI's Pilot Program**

The Public Design Commission (PDC) reviewed the Link5G proposal.[64] The PDC approved a pilot program of 200 Link5G Cell Towers in order to gauge community reaction, specifically, to "provide details on the community reception of the poles, including the design and provisioning of service."[65] Instead, OTI is already proposing over 300 towers which may be more than what OTI has been authorized to do,[66] although it is not clear whether the 200 limit only applies to residential neighborhoods. The PDC pointed to OTI's obligation to gauge the community's reaction on the design, which has been largely negative.[67]

- **FOIL Requests for Link5G Specifications Outstanding for Over One Year**

Many community boards and residents have complained of a lack of transparency in providing the public with information related to the Link5G program. OTI has failed to respond to requests for information under numerous Freedom of Information Law requests (FOILs) dating as far back as October of 2021, with perpetual monthly extensions to respond,[68] and, more recently, from the Environmental Health Trust, a scientific think tank.[69]

OTI has yet to provide: FCC compliance reports, FCC frequency bands of the antennas, antenna model number, antenna gain, power potential, antenna manufacturers, antenna installers, electrical and engineering drawings, correspondence with any other city, state or federal agency, correspondence with City Bridge, the borough-wide plans being provided to the borough presidents, documentation related to the build-out, approvals, impacts on historic districts, visual impact

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[64] PDC Meetings and Minutes:
PDC Meeting 10-18-21 Video (starts at 1:38), https://www.youtube.com/watch?v=Nr4IWCYATAg
PDC Meeting 10-18-21 Minutes (no mention of Link5G),
https://www.nyc.gov/assets/designcommission/downloads/pdf/Meeting%20Minutes%2010-18-21.pdf
PDC Meeting 12-13-21 Video (starts at 2:00), https://www.youtube.com/watch?v=nTBM95YcdF8
PDC Meeting 12-13-21 Minutes (see Certificate 27973, p.26),
https://www.nyc.gov/assets/designcommission/downloads/Meeting%20Minutes%2012-13-21.pdf
PDC Meeting 8-8-22 Video (starts at 0:24:00), https://www.youtube.com/watch?v=Bc9U5pLWI2I
PDC Meeting 8-8-22 Minutes (see Certificate 28200, p.24),
https://www.nyc.gov/assets/designcommission/downloads/pdf/Meeting-Minutes-8-8-22-REVISED.pdf
PDC Meeting 9-12-22 Video (starts at 0:33:25), https://www.youtube.com/watch?v=K-pUkQAivGI
PDC Meeting 9-12-22 Minutes (see Certificate 28229),
https://www.nyc.gov/assets/designcommission/downloads/pdf/minutes-9-12-22-rev-2.pdf

[65] PDC Meeting 9-12-22 Minutes (see Certificate 28229),
https://www.nyc.gov/assets/designcommission/downloads/pdf/minutes-9-12-22-rev-2.pdf

[66] See, NYC Open Data portal for "Link5G New Site Permit Applications," https://data.cityofnewyork.us/Social-Services/LinkNYC-New-Site-Permit-Applications/xp25-gxux.

[67] PDC Meeting 9-12-22 Minutes (see Certificate 28229),
https://www.nyc.gov/assets/designcommission/downloads/pdf/minutes-9-12-22-rev-2.pdf.

[68] E.g., FOIL #s 2021-858-00282, 283, 285, 331, 332; 2022-858-00008; 2023-858-00001, 002, 003, 004, 005, 006, 007, 024.

[69] Letter to NYC requesting information regarding Link5G cell towers https://ehtrust.org/wp-content/uploads/Letter-RF-Reports-New-York-City-Office-of-Technology-and-Innovation-11.pdf.

studies, real estate reports, propagation maps, drive-by tests, denial of service reports, detailed pilot proposals submitted by OTI to the Public Design Commission, and more.[70] Other cities require applications for each tower accompanied by radio frequency and FCC compliance reports, among other requirements, and are publicly available; see. e.g., applications in Takoma Park, MD.[71]

OTI recently responded and confirmed that it does not have records relating to:

- FCC and radio frequency (RF) compliance reports, which certify telecom carriers' compliance with FCC emission limits
- Model number and manufacturers of the antennas
- Any correspondence with the Public Design Commission (PDC) or any other city agency regarding impact on landmarks
- Denial of service
- Frequency bands under which the antennas would be operating
- Build-out plans for the towers.

On appealing OTI's response, the question asked of OTI was, if OTI does not have those records, then how does OTI know that CityBridge is in compliance with all laws or licenses under which it operates, and how does OTI know that CityBridge is in compliance with the franchise agreement? OTI did not answer any of those questions in its response to the appeal.

- **4G/5G is Already Installed on Existing Structures**

There are already 13,580 reservations by the city's franchisees for the installation of 4G antennas and 5G "small" cells on existing structures, such as light poles and streetlights, and pole-top installations.[72] Their statuses are either installed, approved or proposed:

- 7,487 already installed,[73]
- 2,992 additional approved,[74] and

[70] E.g., FOIL #s 2021-858-00282, 283, 285, 331, 332; 2022-858-00008; 2023-858-00001, 002, 003, 004, 005, 006, 007, 024.
[71] https://takomaparkmd.gov/initiatives/project-directory/small-cell-antennas-in-the-citys-rights-of-way/.
[72] Mobile Telecommunications Franchise Pole Reservations, https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6; see also photos of 4G/5G installations in NYC, https://ourtownourchoice.org/ny/wtf/.
[73] https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6/explore/query/SELECT%0A%20%20%60id%60%2C%0A%20%20%60reservation_date%60%2C%0A%20%20%60franchisee%60%2C%0A%20%20%60status%60%2C%0A%20%20%60installation_date%60%2C%0A%20%20%60pole_type%60%2C%0A%20%20%60borough%60%2C%0A%20%20%60x_coord%60%2C%0A%20%20%60y_coord%60%2C%0A%20%20%60latitude%60%2C%0A%20%20%60longitude%60%2C%0A%20%20%60zone%60%2C%0A%20%20%60on_street%60%2C%0A%20%20%60cross_street_1%60%2C%0A%20%20%60cross_street_2%60%2C%0A%20%20%60park_advisory%60%2C%0A%20%20%60historic_advisory%60%2C%0A%20%20%60scenic_landmark_advisory%60%2C%0A%20%20%60bid_advisory%60%2C%0A%20%20%60school_advisory%60%2C%0A%20%20%60zipcode%60%2C%0A%20%20%60community_board%60%2C%0A%20%20%60council_district%60%0ASEARCH%20%27installed%27/page/filter.

[74] https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6/explore/query/SELECT%0A%20%20%60id%60%2C%0A%20%20%60reservation_date%60%2C%0A%20%20%60franchisee%60%2C%0A%20%20%60status%60%2C%0A%20%20%60installation_date%60%2C%0A%20%20%60pole_type%60

- 3,010 proposed.[75]

Since most – 10,379 – have already been installed or approved, the sheer number of these should obviate the need for any Link5G Cell Towers for wireless services.

- **NYC Comptroller's Negative Report on Existing LinkNYC Kiosks**

The NYC Comptroller conducted an audit of the existing LinkNYC kiosk program by a consortium of providers, including CityBridge, and found little accountability by OTI in terms of the moneys owed to the city and the upkeep of the kiosks. [76] OTI neglected to collect almost $70 million due to the city and neglected in ensuring equitable distribution of broadband to the city's underserved areas.

The audit also found the consortium's failure to maintain the kiosks in proper order. The kiosks were to be inspected twice a week to ensure they worked, were free of grime and graffiti, and that "any broken or damaged parts were to be repaired or replaced within 24 hours." The audit found that 76% sampled had "grimy screens, physical damage, and defective screens, icons, telephones and charging ports."

This does not instill confidence that CityBridge will now comply with its obligations or that OTI will sufficiently oversee, rather than deflect responsibility for, CityBridge's operations in connection with the Link5G program.

- **Lack of ULURP Review**

The Uniform Land Use Review Procedure (ULURP) requires that if there are any land use "implications," the project must be subject to review and approval by the community boards. Those

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%2C%0A%20%20%60borough%60%2C%0A%20%20%60x_coord%60%2C%0A%20%20%60y_coord%60%2C%0A%20%20%60latitude%60%2C%0A%20%20%60longitude%60%2C%0A%20%20%60zone%60%2C%0A%20%20%60on_street%60%2C%0A%20%20%60cross_street_1%60%2C%0A%20%20%60cross_street_2%60%2C%0A%20%20%60park_advisory%60%2C%0A%20%20%60historic_advisory%60%2C%0A%20%20%60scenic_landmark_advisory%60%2C%0A%20%20%60bid_advisory%60%2C%0A%20%20%60school_advisory%60%2C%0A%20%20%60zipcode%60%2C%0A%20%20%60community_board%60%2C%0A%20%20%60council_district%60%0AWHERE%20%60status%60%20IN%20%28%27Approved%27%29%0ASEARCH%20%27approved%27/page/filter

[75] https://data.cityofnewyork.us/City-Government/Mobile-Telecommunications-Franchise-Pole-Reservati/tbgj-tdd6/explore/query/SELECT%0A%20%20%60id%60%2C%0A%20%20%60reservation_date%60%2C%0A%20%20%60franchisee%60%2C%0A%20%20%60status%60%2C%0A%20%20%60installation_date%60%2C%0A%20%20%60pole_type%60%2C%0A%20%20%60borough%60%2C%0A%20%20%60x_coord%60%2C%0A%20%20%60y_coord%60%2C%0A%20%20%60latitude%60%2C%0A%20%20%60longitude%60%2C%0A%20%20%60zone%60%2C%0A%20%20%60on_street%60%2C%0A%20%20%60cross_street_1%60%2C%0A%20%20%60cross_street_2%60%2C%0A%20%20%60park_advisory%60%2C%0A%20%20%60historic_advisory%60%2C%0A%20%20%60scenic_landmark_advisory%60%2C%0A%20%20%60bid_advisory%60%2C%0A%20%20%60school_advisory%60%2C%0A%20%20%60zipcode%60%2C%0A%20%20%60community_board%60%2C%0A%20%20%60council_district%60%0ASEARCH%20%27installed%27/page/filter.

[76] DiNapoli Examines Faltering LinkNYC Program, press release, July 20, 2021, https://www.osc.state.ny.us/press/releases/2021/07/dinapoli-examines-faltering-linknyc-program; see also, Comptroller's Report, July 2021, https://www.osc.state.ny.us/files/state-agencies/audits/pdf/sga-2021-19n5.pdf.

"implications" need not rise to the level of a significant impact.[77] The franchise agreement between CityBridge and OTI references a letter from the Dept of City Planning (DCP) dating back to April 28, 2014 that there would be no land use impacts or implications, thereby not requiring ULURP review: "a franchise consistent with the RFP would not have land use impacts or implications and that review under Section 197-c of the Charter would not be necessary."[78]

This poses a number of problems related to Link5G installations.

1. The original franchise agreement related to the smaller 9-1/2' LinkNYC kiosks, well before Amendment No. 3 which introduced the giant 32' Link5G towers, dated March 21, 2020.
2. Amendment No. 3 to the franchise agreement between with CityBridge substantially revised the franchise, e.g., with towers 3-1/3 times taller than the original structures, so that the revised franchise no longer matches the original RFP.
3. The Link5G towers should have been subject to ULURP since the threshold for review is simply "land use implications"; that would otherwise require community board approval. [79]
4. Based on the text in Amendment No. 3, there was no recitation of a new RFP being issued for the larger towers or a new determination by the DCP. This would run counter to the NYC Charter which would require a new RFP and a new determination by the DCP.[80]
5. The 60-day comment period provided by OTI to the community boards is not a substitute for a full ULURP review.

Therefore, the Link5G towers should have been subject to ULURP.

- **What Does CityBridge Have to Hide?**

On May 30, 2023, the Landmarks Committee of Manhattan Community Board 7, held a public hearing with Nick Colvin, CEO of CityBridge. CityBridge requested that the hearing not be recorded, and where the public was asked to submit questions ahead of time so that OTI would sift through and determine which questions CityBridge would answer.[81] The public was not allowed to ask questions during the hearing. Indeed, none of the questions that the author and others posed to CityBridge was answered. What does CityBridge have to hide?

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[77] See, Uhlfelder v. Weinshall, 10Misc.sd 151, 810 N.Y.S.2d 275, 2005 NY Slip Op 25349 (N.Y. Sup. Ct. 2005).
[78] See Section entitled "Background and Authority," Franchise Agreement at 9, https://www.nyc.gov/content/oti/pages/franchises/linknyc-franchises.
[79] See, Uhlfelder v. Weinshall, 10Misc.sd 151, 810 N.Y.S.2d 275, 2005 NY Slip Op 25349 (N.Y. Sup. Ct. 2005).
[80] The NYC Charter Chapter 14 (Franchises …) Sec 363(e) states in relevant part: "Pursuant to an authorizing resolution adopted by the council, the responsible agency may issue one or more requests for proposals or other solicitations of proposals, provided that … (2) no such request or solicitation shall be issued unless … the department of city planning has determined that the proposed franchise would not have land use impacts or implications … "
[81] CityBridge CEO Nick Colvin's presentation to the Landmarks Committee of Manhattan Community Board 7 on 5-30-23, where the author and a constituent were present. There is no recording of the 5-30-23 meeting because, as the district manager stated to the constituent, CityBridge did not want the meeting recorded, and "we committed to CityBridge to not record and archive for the public."

In addition, Mr. Colvin stated that while he didn't think that the towers would collapse, he did mention that the top was made of light plastic which could easily fall off. But he gave his assurance that it would not hurt anyone. As the saying goes, "from his lips to God's ears." Even light plastic hurtling from 3 stories can cause injury or property damage, just based on Newtonian physics of gravity and velocity. Another factor is that the aesthetic that has been promoted by CityBridge would be marred, with the towers likely taking on the appearance of having missing teeth.

Public Safety

- **Privacy Vulnerabilities**

There was concern at MCB8 that 5G towers would track their children's locations. 5G uses a beam-forming technology that tracks your cell phone.[82] Will our children's locations be tracked?

The privacy policy in the City's franchise agreement with CityBridge states that CityBridge does not support a "do not track" function,[83] therefore, users' (and children's) online activities can be tracked. CityBridge also states that, although they "do not collect information about your precise location," they "can determine your general location" when you are using their services.

OTI had stated that personal information would not be exploited by CityBridge,[84] but the privacy policy states that third party providers would be managing email addresses without a stated obligation that those providers would maintain confidentiality and would also not exploit personal information.[85] In addition, CityBridge states that it "cannot guarantee against access" to personal information by unauthorized third parties, and that "[t]he security of your data transmitted" using their services "is at your own risk."[86]

CityBridge in its presentation to CB8 Manhattan denied that it had any affiliation with Google. But there was an association with Alphabet (parent of Google with its massive personal data collection[87]), an investor in one of the companies that formed a consortium with CityBridge for the

[82] RF Coherency technology drives 5G RAN innovation, June 22, 2022, https://www.rcrwireless.com/20220622/5g/rf-coherency-technology-drives-5g-ran-innovation-reader-forum; see also, What is 5G?, https://cdn.shopify.com/s/files/1/0266/5411/3837/files/5G_White_Paper_-_EMR_Australia.v1.1.pdf?v=1613734363.
[83] CityBridge Privacy Policy, Exhibit 2 to Franchise Agreement between Department of Information Technology and Innovation (DoITT) and CityBridge, LLC, undated and unexecuted version, p. 4, https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-exhibit-2.pdf.
[84] See, e.g., Public Design Commission Meeting 12-13-21 Video (starts at 2:00), https://www.youtube.com/watch?v=nTBM95YcdF8.
[85] CityBridge Privacy Policy, Exhibit 2 to Franchise Agreement between DoITT and CityBridge, LLC, undated and unexecuted version, pp. 3-4, https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-exhibit-2.pdf.
[86] Id.
[87] Google faces $5 billion lawsuit in U.S. for tracking 'private' internet use, June 2, 2020, https://www.reuters.com/article/us-alphabet-google-privacy-lawsuit/google-faces-5-billion-lawsuit-in-u-s-for-tracking-private-internet-use-idUSKBN23933H.

buildout of LinkNYC, the predecessor to Link5G. Although this was a prior association, there is still the concern over the potential tracking and commodification of our locations and our personal data.[88]

The New York Civil Liberties Union (NYCLU) had warned that the LinkNYC network has significant privacy vulnerabilities, with its collection of personal information including e-mail addresses, browsing data and camera surveillance.[89] Although changes were made to ameliorate those concerns for the LinkNYC network, it is not clear that those changes apply to the Link5G network.[90]

- **Security Vulnerabilities**

Although Link5G cell towers have been touted to provide free services, including free public charging stations for cell phones, the FBI is warning against using free public charging stations as bad actors have been infecting devices with malware through these stations.[91]

Security vulnerabilities are inherent in 5G architecture and, while 5G is being deployed, these vulnerabilities have not been resolved. As to 5G's hackability, "5G networks are much more vulnerable to cyberattacks than their predecessors," as noted by former FCC Chairman, Tom Wheeler.[92] Whereas the 4G network is a centralized, hardware-based switching network with hardware choke points to quarantine any security breach events, 5G is a distributed, software-based network of digital routers with thousands of nodes and access points that a hacker can exploit; there is no choke point control.[93] If a hacker gains control of the 5G software managing the networks, the hacker can also control the 5G network.[94]

Even NYC's Chief Technology Officer and Chief Security Officer spotlighted 5G's security vulnerabilities in a letter to the National Telecommunications and Information Administration (NTIA) in 2020 (emphasis added):

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[88] CityBridge, a consortium with Google, https://www.politico.com/states/new-york/albany/story/2020/03/03/city-hall-calls-google-backed-linknyc-consortium-delinquent-1264966; CityBridge affiliated with Alphabet (Google's parent), https://www.theverge.com/2020/3/5/21166057/linknyc-wifi-free-kiosk-google-new-york-sidewalk-labs-payments-revenue. See also, NYCLU Privacy Conference which gives the history of LinkNYC and its corporate affiliations, https://livestream.com/internetsociety/hopeconf/videos/130816888.

[89] NYCLU Privacy Conference: gives the history of LinkNYC, along with privacy issues https://livestream.com/internetsociety/hopeconf/videos/130816888.

[90] https://www.nyclu.org/en/press-releases/city-strengthens-public-wi-fi-privacy-policy-after-nyclu-raises-concerns.

[91] https://www.theepochtimes.com/fbi-warns-against-free-public-charging-stations-for-phones-citing-hacking-risks_5184153.html?utm_source=share-btn-copylink.

[92] Why 5G Requires New Approaches to Cybersecurity, Tom Wheeler and David Simpson, Brookings Institute, Sept 3, 2019, https://www.wita.org/nextgentrade/why-5g-requires-new-approaches-to-cybersecurity/.

[93] *Why 5G Requires New Approaches to Cybersecurity*, Tom Wheeler and David Simpson, Brookings Institute, Sept 3, 2019, https://www.wita.org/nextgentrade/why-5g-requires-new-approaches-to-cybersecurity/; see also, *Why 5G Networks Are Disrupting The Cybersecurity Industry*, Oct 29, 2021, https://www.forbes.com/sites/forbestechcouncil/2021/10/29/why-5g-networks-are-disrupting-the-cybersecurity-industry/?sh=5186fc041fe9.

[94] *Why 5G Requires New Approaches to Cybersecurity*, Tom Wheeler and David Simpson, Brookings Institute, Sept 3, 2019, https://www.wita.org/nextgentrade/why-5g-requires-new-approaches-to-cybersecurity/.

> Such complex systems [5G] present ***more opportunities for security and privacy breaches***. By moving away from firmware-based technology of 4G telecommunication components to ***software-based 5G telecommunication components that will need to be updated, the opportunity for manipulation exists*** within the supply chain. Furthermore, movement away from centralized network systems to decentralized network systems ***increases the attack surface of a network***. That increased attack surface is ***amplified*** by the anticipated introduction of the increasing number and variety of connected devices (IoT) and big data industries. (top of p.3)
>
> The problem of IoT vulnerabilities will only become ***exacerbated by the increased speeds of 5G*** and other future wireless broadband technologies. (middle of p.3)
>
> IoT protection is historically poor and ***malware distribution is easily scalable***, which suggests that the creation of IoT botnets ("robot networks") for malicious purposes, including ***large-scale distributed denial of service (DdoS) attacks***, is ***likely to increase*** as well. This poses a ***significant threat*** to vital digital infrastructure and resident services at all levels of government, as well as private sector enterprise. (penultimate paragraph on p.3)[95]

To further amplify the last point, it has been reported that:

> "***Botnet and denial of service (DdoS) type attacks can bring down whole portions of the network simply by overloading a single [5G] node.***"[96]

- **<u>Fire Hazards</u>**

Cell towers have been known to catch on fire. Industry commentary admits that 5G runs hot. That means that heat builds up at the cell tower because it is tightly packed with lots of equipment required to do digital to analog conversions, and they are "power-hungry" requiring a large amount of energy consumption.[97] In fact, wireless antennas from various carriers may be tightly packed in the Link5G Cell Towers, with housing for multiple 5G antennas at 5 circular bay stations surrounding the pole being almost 20' high (see Addendum A).[98]

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[95] Letter from Chief Security Officer, Geoff Brown, and Chief Technology Officer, John Paul Farmer, to National Telecommunications Information Administration of the U.S. Chamber of Commerce, June 2, 2020.
[96] Why 5G Networks Are Disrupting The Cybersecurity Industry, Oct 29, 2021, Forbes, https://www.forbes.com/sites/forbestechcouncil/2021/10/29/why-5g-networks-are-disrupting-the-cybersecurity-industry/?sh=5186fc041fe9.
[97] 5G Heats Up Base Stations, https://semiengineering.com/5g-heats-up-base-stations/.
[98] Renditions can be seen in the links for footnote 4 above and at https://manhattanneighbors.org/jumbo-5g-antennas-nyc/.

A side effect of the 5G array of antennas is that the circuits are inefficient and "[t]hey get hot."[99] A lot of heat needs to be dissipated because of the amount of equipment, conversions and inefficiencies.[100]

Cell towers are, essentially, electrical installations and should require compliance with strict electrical building codes.[101] There were four notable fires in California that were started in whole or in part by failures or overload of telecommunications equipment. The Guejito Fire in San Diego in 2007, [102] the Malibu Canyon Fire in 2007,[103] the Silverado Fire in 2020, and the Woolsey Fire in 2018 being the worst in California history.[104] The Guejito Fire in San Diego in 2007 was started by a Cox Communications
lashing wire. This fire merged into the Witch Creek Fire which became the largest and deadliest in San Diego history, and also forced the largest mass evacuation in California history.[105]

In 2021 in Brooklyn, the cause of fire on an apartment building rooftop was reported to be caused by an "electrical malfunction of a cell tower on the roof of a building."[106] In Hanover, VA in 2020, a cell tower was engulfed in flames which officials believed to have been caused by electrical/mechanical issues.[107]

Exacerbating the problem is that cell site developers tend to construct monopole cell towers as quickly and as cheaply as possible, meaning that any quality control over their manufacture, construction or maintenance is probably close to non-existent.

- **<u>Insufficient Fall Zone</u>**

At 3 stories high and placed as close as 10.6' to buildings, Link5G Cell Towers do not have a sufficient fall zone in case the tower collapses. "Fall zone means the area, defined as the furthest distance

[99] 5G Heats Up Base Stations, https://semiengineering.com/5g-heats-up-base-stations/.
[100] Id.
[101] Guest Commentary: Is 5G a Potential Fire Hazard?, Tony Simmons, P.E., The Aspen Times, June 13, 2021, https://www.aspentimes.com/opinion/guest-commentary-is-5g-a-potential-fire-hazard/.
[102] PROTECTING LA COUNTY'S FUTURE: HOW FIRE RISKS FROM TELECOMMUNICATIONS EQUIPMENT, CLIMATE CHALLENGES & A DANGEROUS SHIFT AWAY FROM ENVIRONMENTAL REVIEW THREATEN LOS ANGELES COUNTY'S FUTURE, Susan Foster, November 15, 2022, p. 11.
[103] *California Public Utilities Commission, Incident Investigation Report*, 10/21/2008, at 6, http://file.lacounty.gov/SDSInter/bos/bc/115889_ReportBack-BoardMotion60A-SessionWildfireReport.pdf.
[104] *City of Los Angeles, After Action Review of the Woolsey Fire Incident*, Citigate Associates, LLC, Nov. 17, 2019, at 4, http://file.lacounty.gov/SDSInter/bos/supdocs/144968.pdf; Guest Commentary: Is 5G a Potential Fire Hazard?, Tony Simmons, P.E., The Aspen Times, June 13, 2021, https://www.aspentimes.com/opinion/guest-commentary-is-5g-a-potential-fire-hazard/.
[105] PROTECTING LA COUNTY'S FUTURE: HOW FIRE RISKS FROM TELECOMMUNICATIONS EQUIPMENT, CLIMATE CHALLENGES & A DANGEROUS SHIFT AWAY FROM ENVIRONMENTAL REVIEW THREATEN LOS ANGELES COUNTY'S FUTURE, Susan Foster, November 15, 2022, p. 11.
[106] *Fire on Rooftop With Cell Antennas in Brooklyn New York*, Apr 19, 2021, https://ehtrust.org/firecell-tower-brooklyn-new-york/.
[107] *Hanover cell tower catches fire*, NBC 12 Newsroom, June 26, 2020, https://www.nbc12.com/2020/06/26/cell-phone-tower-hanover-catches-fire/.

from the tower base, in which a tower will collapse in the event of a structural failure."[108] The fall zones would generally be at least 110% of the height of the cell tower.[109]

At 3 stories high, that would mean a clearance would be required with a circumference of more than 3 stories around the tower from any nearby structure, traffic and pedestrian sidewalks. Instead, these Link5G towers can be placed in extreme proximity, as close as 10.6' to buildings, although it could be closer upon notice to the community board. That means that in the event of their collapse, they could crash into people's windows and injure people in their homes and on the street. In the case of towers being proposed close to schools or playgrounds, they could crash into the school or onto the playgrounds and injure the children.

- **Protecting our First Responders**

Ensuring that our first responders are protected and are not adversely affected by cell towers, including Link5G Cell Towers, would be important elements in securing the public's safety. There are instances of fire fighters and a police lieutenant who were injured from wireless antennas where they work and where they live.

Fire fighters in California were injured after a cell tower was installed on their station house property. They experienced headaches, and memory, sleeping and neurological disorders. SPECT brain scans found abnormalities associated with wireless radiation. Testing results showed delay in reaction time and difficulty in mental focus.[110] During actual fire calls, they had become disoriented and could not find the fire.

> "Firefighters have reported getting lost on 911 calls in the same community they grew up in, and one veteran medic forgot where he was in the midst of basic CPR on a cardiac victim and couldn't recall how to start the procedure over again…Prior to the installation of the tower on his station, this medic had not made a single mistake in 20 years."[111]

Consequently, the International Association of Fire Fighters published a resolution opposing, and calling for a moratorium, on the placement of cell towers near fire stations.

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[108] https://www.lawinsider.com/dictionary/fall-zone.

[109] See, e.g., Board of Zoning Appeals Denies Cell Tower Requests, July 31, 2020, (requiring a 160 foot cell tower to have a fall zone of an additional 25 feet above the tower's height, and rejecting Verizon's "engineered" fall zone of less than the cell tower height), https://www.greenevillesun.com/news/local_news/board-of-zoning-appeals-denies-cell-tower-requests/article_45d979ac-7b14-5749-af48-b237fe67dee3.html.

[110] https://www.iaff.org/cell-tower-radiation/; International Association of Firefighters (IAFF) Votes To Study Health Effects of Cell Towers on Fire Stations, Call for Moratorium on New Cell Towers on Fire Stations Until Health Effects Can Be Studied, https://ehtrust.org/wp-content/uploads/pr_iaff_vote-1.pdf.

[111] Letter by Dr. Beatrice Golomb, Professor of Medicine, UC San Diego School of Medicine, Aug. 22, 2017, https://mdsafetech.org/wp-content/uploads/2017/09/golomb-sb649-5g-letter-8-22-20171.pdf.

A police lieutenant living in Queens, NY has suffered injuries by a pole-top antenna installed just feet away from his house.[112] He was otherwise healthy before exposure to radiation from the wireless antenna, which caused him to suffer from heart arrhythmias and sleep deprivation. He underwent invasive medical cardiac procedures where the doctors found his condition could not be replicated in their offices away from the source of radiation. When he realized that his condition improved away from his home, he was compelled to evacuate his own home, along with his sister, while still shouldering the financial burden of a substantial mortgage on a house which has now become toxic and likely unmarketable.

His sister, who had just completed chemotherapy, became very sick after the antenna installation, and was advised by her oncologist that if she stayed, she would have a recurrence of the cancer.

In his own words:

> For the first time in my life, I went from being perfectly healthy, to suffering from heart arrhythmias, headaches, and not being able to sleep, out of nowhere … The lack of empathy from city officials, and the lack of resident control – like all of our freedoms are taken away with these towers – is like nothing I've ever seen before. It doesn't make any sense.
>
> I've been a public servant all my life. I was a full paramedic at 19 – the youngest in New York City. A police officer at 20. I worked my way up doing every beat that you can do. I was at ground zero after 9/11 with my partner. We took turns going into the World Trade Center to pull people out. As I would pull a person out to safety, my partner would run back in. We'd switch. It was during one of those switches, as I was pulling a person to safety, my partner ran back in and then the tower collapsed. My partner was later found in the rubble.[113]

Note: OTI executives, Stacey Gardener and Brett Sikoff, were present when the police lieutenant recounted his heart-wrenching story at the Queens CB1 meeting of the Environment & Sanitation Committee on January 25, 2023.[114] They did not respond and offered no assistance in moving the antenna away from his home.

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[112] See CB1-Queens, Joint Environmental/Sanitation and Transportation Committees, 1-25-23 starting at about 00:54:00.

[113] Written comments submitted by the police lieutenant in connection with presentation to CB1 Queens on 1-25-23; Id.

[114] See CB1-Queens, Joint Environmental/Sanitation and Transportation Committees, 1-25-23 starting at about 00:54:00.

Digital Equity

- **"Digital Divide" – 5G Unlikely to Remedy**

It has been reported by the US Government Accountability Office (GAO) that 5G deployment is likely to exacerbate disparities in accessing telecommunications services.[115] The GAO is the highest audit institution of the federal government.[116] Moreover, the National Digital Inclusion Alliance testified in Congress that "5G will not solve the digital divide" and 5G service will require 5G capable cell phones, which the underserved, low income households, will likely not be able to afford.[117] In fact, telecom carriers have been advising their customers to turn off 5G to save battery life on their devices.[118]

5G deployment in NYC has been marketed as bridging the "digital divide" for underserved communities[119] when, in fact, only one bay will be for public Wi-Fi, while four out of the five bays will be 4G/5G services for paying customers. 5G deployment is largely a private enterprise with a minimum of free Wi-Fi. Will one bay be sufficient to service thousands of users for free, simultaneously? In contrast, fiber optics, wired to the home, can handle an exponentially greater broadband capacity.

OTI's "digital divide" justification begs the question of whether the situation is due to lack of affordable broadband, lack of infrastructure (e.g., lack of fiber optics connection to the home), lack of affordable computers or lack of digital literacy. And how do we know that wireless services will actually connect the unconnected? Although this and other questions were posed by the Environmental Health Trust in a letter to OTI in January, 2023, they remain unanswered.[120]

OTI overstates the number of New Yorkers lacking broadband as 3.4 million by referring to those without home ***and*** mobile broadband" [emphasis added].[121] Does that mean that homes otherwise having only cable/fiber broadband are considered "underserved?" In fact, those homes would have exponentially greater broadband capacity than wireless, particularly if they are serviced by fiber.

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[115] US Government Accountability Office 2020 Report "FCC Needs Comprehensive Strategic Planning to Guide Its Efforts," https://www.gao.gov/products/gao-20-468 (p.3). Full report https://www.gao.gov/assets/gao-20-468.pdf (p.14).

[116] https://en.wikipedia.org/wiki/Government_Accountability_Office.

[117] Testimony of Angela Siefer, Executive Director, National Digital Inclusion Alliance, before the U.S. House of Representatives, Subcommittee on Communications and Technology, Committee on Energy and Commerce, Jan 29, 2020, https://www.congress.gov/116/meeting/house/110416/witnesses/HHRG-116-IF16-Wstate-SieferA-20200129.pdf; video of testimony at https://givingcompass.org/nonprofit/national-digital-inclusion-alliance?gclid=CjwKCAjw67ajBhAVEiwA2g_jEMPJ3ET3xWZhbc8lBCH9_FIuP4nXRASue_6oPyMDyvxO9uysvJfELRoC5XgQAvD_BwE at 2:27 and 2:50.

[118] "Why are Carrriers Telling Us to Turn Off 5G?" PC Magazine, March 5, 2021, https://www.pcmag.com/opinions/why-are-carriers-telling-us-to-turn-off-5g.

[119] https://www.techdirt.com/2022/11/22/nycs-new-5g-linknyc-towers-dont-actually-fix-the-digital-divide-and-theyre-ugly-as-hell/.

[120] Letter to NYC requesting information regarding Link5G cell towers https://ehtrust.org/wp-content/uploads/Letter-RF-Reports-New-York-City-Office-of-Technology-and-Innovation-11.pdf.

[121] Link5G ppt presentation to NYC's Public Design Commission by Dept of Info Technology and Telecommunications (DoITT) now called Office of Technology and Innovation (OTI), 12-13-21, p.4 at https://www1.nyc.gov/assets/designcommission/downloads/pdf/12-13-2021-pres-DoITT-p-Link-5G-1.pdf.

OTI claims that these Link5G towers will solve the digital divide, as if providing free Wi-Fi in the 5th bay is assured; however, their claim appears to be speculative. There is no transparency as to what contracts CityBridge has entered into with the telecom carriers, and whether contracts are even in place to provide free Wi-Fi in the 5th bay of all proposed towers. The only requirement in the pilot program by the Public Design Commission was that there would be at least one wireless contract for each pole that is constructed, and that one contract may or may not be for Wi-Fi.[122] Unless there is evidence of contracts to provide the promised Wi-Fi to underserved communities, it means that OTI's assertions are speculative, at best.

- **Devaluation of Property Values and Digital Equity**

The U.S. Department of Housing and Urban Development (HUD) classifies cell towers under "Hazards and Nuisances," and requires real estate appraisers report if a property is within the fall zone of the cell tower.[123] HUD prohibits the Federal Housing Administration from underwriting mortgages for homes within the fall zone of a cell tower.[124] Therefore, installing these giant 5G Cell Towers under purported "digital equity" to underserved communities may undermine the ability of these communities to obtain federal mortgage and home ownership assistance.

There are potential buyers who do not want to live near cell towers, and in some areas that have cell towers, property values have gone down by as much as 20%.[125]

Residents in other cities have expressed their concern over the devaluation of their homes in close proximity to cell towers. For example, in the Town of Islip, on Long Island, the zoning board denied the application for the siting of a cell tower based, among other things, on the potential devaluation of their homes, corroborated by experts."[126]

- **The Built-In Obsolescence of Wireless will Perpetuate the Digital Divide**

There is a planned, built-in obsolescence with wireless. For instance, the major telecom carriers are shutting down their 3G networks, by design, so that 3G-enabled only phones will become obsolete

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[122] Link5G_PDC_Deck_Residential_Historic_Phase1_8_19_22.pptx at 3.
[123] Hazards & Nuisances: Overhead High Voltage Transmission Towers and Lines
Chapter 1: Appraisal & Property Requirements (Page 1-18f)
https://archives.hud.gov/offices/hsg/sfh/ref/sfh1-18f.cfm.
[124] *Powerlines and Cell Antennas Lower Property Values*, https://ehtrust.org/cell-phone-towers-lower-property-values-documentation-research/; see also online commentary, https://www.city-data.com/forum/mortgages/577383-fha-loans-cellphone-towers-did-you.html.
[125] *The Electrifying Factor Affecting Your Property's Value*, Wall Street Journal, Aug 15, 2018, https://www.wsj.com/articles/the-electrifying-factor-affecting-your-propertys-value-1534343506. A study spanning 1984 to 2002 found that the prices for 4,283 residential sales in 4 suburbs were reduced by about 21% (see, *Cell Towers and Our Real Estate Values*, October 4, 2014, https://dscelltower.wordpress.com/2014/10/04/cell-towers-and-our-real-estate-values/).
[126] *T-Mobile Northeast LLC v. Town of Islip*, 893 F. Supp. 2d 338, 359 (E.D.N.Y. 2012), https://casetext.com/case/tmobile-ne-llc-v-town-of-islip.

and consumers will be forced to buy a new cell phone for the new network.[127] It would also apply to other 3G-enabled equipment, such as "medical devices, tablets, smart watches, vehicle SOS services, home security systems," etc. [128] This is artificially creating demand for 4G and 5G services as people are forced to buy 4G and 5G-enabled cell phones and equipment, and soon 6G and beyond. This is a trend, as reported by an industry publication, where "companies have turned to planned obsolescence to artificially render older products obsolete."[129] It is a tactic used to ensure that tech companies "can consistently turn a profit every time they launch new products."

Buying into the 5G rhetoric is relegating people to a perpetual cycle of obsolescence, apparently for corporate profit. This cycle will become exacerbated with future generations of wireless as it becomes necessary for more devices to be connected to ever-new generations of wireless in order for the devices to work. Those who cannot afford new devices will be left behind, further exacerbating the digital divide.

Moreover, wireless equipment and facilities have a much shorter life span, and require continuous periodic maintenance and replacement. Fiber has been federally prioritized as the superior choice to implement broadband nationwide to bridge the "digital divide." There is no planned, built-in obsolescence with fiber, and is therefore more cost effective for underserved communities.

FCC Lack of Oversight and Regulatory Gap

- **FCC Does Not Measure Wireless Emissions**

Although the FCC regulates the limits of allowable wireless emissions, unfortunately, the FCC does not measure wireless emissions to determine if telecom carriers are in compliance with the FCC's emission limits. The FCC's own website states in its FAQ section in response to "Does the FCC Routinely Monitor Radiofrequency Radiation from Antennas?": "The FCC does not have the resources or the personnel to routinely monitor the exposure levels due at all of the thousands of transmitters that are subject to FCC jurisdiction."[130]

Moreover, the FCC typically does not track or require that a cell tower less than 200 feet be registered with the FCC,[131] unless the tower is subject to an Environmental Assessment (EA) under NEPA or NHPA, in which event the tower will be tracked and registered (along with an EA submission).[132] Indeed, the need for tracking all towers and having a database was underscored by

[127] https://www.fcc.gov/consumers/guides/plan-ahead-phase-out-3g-cellular-networks-and-service.
[128] Id.
[129] https://cellularnews.com/mobile-phone/planned-obsolescence/.
[130] RF Safety FAQ, https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety#Q24 (accessed 7-28-22).
[131] Cell Tower Mapping, https://www.waveform.com/a/b/guides/cell-tower-mapping, "Unfortunately, there's no government regulation requiring carriers to publicize their 4G or 5G tower locations. The Federal Communications Commission (FCC) is the body that regulates cell carriers like AT&T, Verizon, and T-Mobile ... Their rules only require those carriers to register towers that are over 200 feet tall."
[132] See Instructions for filing FCC Form 854 Item 48.

the safety and health director of the Mechanical Workers Association of America representing 270,000 workers requesting such a database of the FCC as far back as 2014.[133]

Since the FCC has notified CityBridge of its lack of compliance with NEPA and NHPA, those towers that trigger an EA would be registered. However, there is a catch. The determination of whether an NEPA and NHPA is triggered is determined by the applicant, in this case CityBridge. That means an indeterminate number of 5G towers will still not be tracked by the FCC for compliance.[134] Furthermore, EAs no longer need to be filed if the parties (the applicant, FCC, tribes and the State Historical Preservation Office – SHPO) sign a memorandum of Agreement addressing NHPA issues.

- **OTI Claims to Measure Wireless Emissions**

The onus usually falls on residents and local governments to measure emissions to determine compliance and to pay for those measurements. OTI has said that the telecoms are required to measure their own emissions, that an independent company is taking measurement, and that they have been in compliance.[135] But, there are a number of questions:

- Where are the reports and who is verifying the results?
- Why are these reports not readily available to the public for inspection?
- Do the reports measure the emissions from one antenna or the cumulative emissions of multiple antennas slated for the Link5G cell towers?

OTI should be measuring emissions on a random, unannounced basis to verify compliance, otherwise, it is seemingly a case of the fox guarding the henhouse. There should also be projected measurements of the cumulative exposure of multiple antennas on a Link5G tower, and at different distances. In fact, it was reported in 2014 that tests performed by independent radio-frequency engineers on 9,000 sites nationwide found that 10% of cell towers exceeded FCC limits.[136]

- **Telecom Carriers' Propagation Maps are Not Reliable**

Although OTI has stated that these towers are to fill a gap in telecommunications service and that the telecommunications carriers have identified these gaps, when asked, neither OTI nor CityBridge had any reports documenting evidence of any such gaps in service and they confirmed that they had no such reports.[137] OTI is also saying that a gap may not exist now, but that the carriers are anticipating a future gap so they want to add 5G antennas for capacity.[138] The problem is that there are no reports showing how those anticipated gaps were identified. Apparently, OTI used a firm,

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[133] *Cellphone Boom Spurs Antenna Safety Worries*, Wall Street Journal, Oct 2, 2014, https://www.wsj.com/articles/cellphone-boom-spurs-antenna-safety-worries-1412293055.
[134] *Cellphone Boom Spurs Antenna Safety Worries*, Wall Street Journal, Oct 2, 2014, https://www.wsj.com/articles/cellphone-boom-spurs-antenna-safety-worries-1412293055.
[135] See, PDC Meeting 12-13-21 Video, Q&A with DoITT (now OTI) Commissioner Tisch (starts at 2:00), https://www.youtube.com/watch?v=nTBM95YcdF8
[136] Id.
[137] CB8-Manhattan Transportation Committee video of OTI presentation and public comments, https://www.cb8m.com/event/24978/.
[138] CB6-Queens Executive Committee meeting 2-15-23 with OTI presenting.

HR&A Advisors, but no reports have been forthcoming when the Environment Committee of CB1 Queens specifically asked for those reports.[139] OTI responded that they would only provide a "sample report," which also has not been provided.

Moreover, the telecoms use computer-generated propagation maps that purport to show gaps in phone service, but these are largely inaccurate and of little use. The FCC Enforcement Bureau found their accuracy rates at best 64.3% and at worst 16.2%.[140] FCC field agents had performed drive-by tests to physically determine gaps in phone service across 12 states, driving more than 10,000 miles, and conducting 24,649 tests. They performed an additional 5,916 stationary speed tests at 42 locations in 9 states. As a result, FCC staff has recommended that computer-generated propagation maps no longer be accepted, without actual drive-test data to back them up, and also recommended penalties for inaccurate or false propagation map filings as they would violate federal law.[141]

- **No Gap in Service, No Federal Preemption**

OTI has tried to justify the Link5G program by saying that telecom carriers need to add capacity (5G) to their systems to handle potential future demand. That, however, is not a sufficient justification to impose Link5G Cell Towers on the residents of NYC who do not need them or want them.

NYC officials have been misled to believe that their "hands are tied," and must accept 5G deployment as a matter of federal preemption. That is incorrect. In a sweeping decision in NY in 2022, a senior federal district court judge, in ruling against a telecommunications carrier, struck down the FCC rule that strips local authority over the placement of cell towers,[142] and upheld local authority to determine the number and placement of cell towers and deny the irresponsible placement of cell towers.[143]

In fact, OTI incorrectly stated at CB3-Queens that the federal government does not allow the city to remove 5G antennas.[144] To be clear, no federal law, rule or regulation, under NY jurisdiction, requires us to give carriers access to our streets to add capacity to their systems. That would include

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[139] CB1 – Queens, 1-25-23, Joint Environmental/Sanitation and Transportation Committees.

[140] "FCC Mobility Fund Phase II, Coverage Maps Investigation, Staff Report," GN Docket No. 19-367, "… the Commission launched an ***investigation*** into whether one or more major mobile providers violated the requirements of the one-time collection of coverage data … Commission staff initially requested information directly from several providers in order to understand providers' mapping processes, and later ***issued subpoenas to Verizon and U.S. Cellular."*** One of the recommendations was that "the Commission should release an Enforcement Advisory on broadband deployment data submissions, including ***a detailing of the penalties associated with filings that violate federal law*** … Providers should be required to submit actual on-the-ground evidence of network performance (e.g., speed test measurement samplings, including targeted drive test and stationary test data) that validate the propagation model used to generate the coverage maps." https://docs.fcc.gov/public/attachments/DOC-361165A1.pdf.

[141] Id.

[142] 33 FCC Rcd 9088, 9104-05 (2018) (FCC Doc # 18-133), https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g.

[143] ExteNet Sys. v. Vill. of Flower Hill, No. 19-CV-5588-FB-VMS, 9 (E.D.N.Y. Jul. 29, 2022), 2022 WL 3019650, https://casetext.com/case/extenet-sys-v-vill-of-flower-hill; see also, https://ehtrust.org/flowerhillny/.

[144] See, e.g., OTI's presentation to Community Board 3 in Queens on Jan 19, 2023, starting at about 0:40:00, https://www.youtube.com/watch?v=N_6c81RaAlM.

either installing 5G antennas or removing them. The Telecommunications Act of 1996 (TCA) has given local government the explicit authority on the number and the placement of cell towers.[145]

Moreover, the court did not agree with the FCC ruling that interpreted the TCA to provide preemption for telecom carriers to add capacity without evidence of a gap in service,[146] that, quoting from precedent, "[I]t is not up to the FCC to construe the [Act] to say something it does not say … "[147]

Therefore, the court ruled that cell tower installations to add capacity rather than ensuring phone service connection are not federally protected and consequently there is no federal preemption or imprimatur to install them.[148] In summary, the court clarified that:

1. The FCC's 5G Order in trying to strip local government of its control for regulating the placement of towers[149] ***is not binding within the NY jurisdiction,***

2. Wireless carriers have the burden of showing that there is ***a gap in phone service, and that they are using the least intrusive means possible to fill that gap*** *and*

3. "Improved capacity and speed are desirable (and, no doubt, profitable) … ***but they are not protected by the [TCA].***" [150]

ExteNet Sys. v. Vill. of Flower Hill, No. 19-CV-5588-FB-VMS, 9-10 (E.D.N.Y. Jul. 29, 2022)

The court ruled that, under the TCA, local governments have authority over the number and placement of wireless facilities, and to deny the irresponsible placement of wireless facilities. [151]

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[145] See 47 U.S.C. §332(c)(7)(A) entitled "general authority" shows how Congress has preserved to state and local governments the general authority to regulate the siting, placement, construction and maintenance of wireless facilities (cell towers, small cells, etc.) within their respective jurisdictions, https://www.law.cornell.edu/uscode/text/47/332.

[146] 33 FCC Rcd 9088, 9104-05 (2018) (FCC Doc # 18-133), https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g.

[147] Clear Wireless LLC v. Bldg. Dep't of Vill. of Lynbrook, 2012 WL 826749, at *9 (E.D.N.Y. Mar. 8, 2012) ("[I]t is not up to the FCC to construe the [Act] to say something it does not say, nor up to the Court to find broadband communication encompassed by the law." (internal quotation marks omitted)).

[148] ExteNet Sys. v. Vill. of Flower Hill, No. 19-CV-5588-FB-VMS, 9 (E.D.N.Y. Jul. 29, 2022), 2022 WL 3019650, https://casetext.com/case/extenet-sys-v-vill-of-flower-hill; see also, https://ehtrust.org/flowerhillny/.

[149] 33 FCC Rcd 9088, 9104-05 (2018) (FCC Doc # 18-133), https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g.

[150] ExteNet Sys. v. Vill. of Flower Hill, No. 19-CV-5588-FB-VMS, 9 (E.D.N.Y. Jul. 29, 2022), 2022 WL 3019650, https://casetext.com/case/extenet-sys-v-vill-of-flower-hill; see also, https://ehtrust.org/flowerhillny/.

[151] Id, Extenet had sued the Village of Flower Hill, Nassau County, New York because its wireless facility application for 18 4G installations was denied and claimed that the denial was an effective prohibition in providing telecom services in violation of the TCA – basically, that Extenet was entitled to install them to add capacity to their systems because of federal preemption. The Court disagreed because Extenet failed to meet its burden of proof to show a significant gap in phone service and the use of the least intrusive means to fill that gap; see also, 47 U.S.C. §332(c)(7)(A), https://www.law.cornell.edu/uscode/text/47/332.

Therefore, the FCC rule that makes the deployment of 5G automatically preemptible under the TCA[152] is erroneous, does not comply with the TCA and does not apply to NY jurisdictions.

- **FCC, Captured Agency: Safe Harbor for Industry, Not Safety for the Public**

The FCC is an agency influenced and "captured" by the very industry that it is charged by law to regulate. Formerly with the FCC as a NEPA attorney in the FCC's Wireless Telecommunications Bureau, Erica Rosenberg within the FCC's National Environmental Policy Act (NEPA) department, recently published an article on how the FCC is a captured agency.[153] The Center for Ethics at Harvard also published an article that underscored this issue.[154] It is also alleged that FCC employees own telecom stock in the very companies that the FCC is regulating, which does not imbue confidence that the FCC is working in the public interest.[155] Many articles have proliferated on the subject of FCC capture and inaction.[156]

Whenever residents ask OTI if 5G is safe, OTI's scripted answer is that the telecom industry is contractually required by NYC to comply with the FCC emission limits. But those limits are a **safe harbor for industry** – if the industry is within those limits, **they are immune from liability for personal injury**. **The industry is protected, no matter how many people are injured.** Therefore, the FCC limits are not safety limits to protect the public.[157]

In fact, the FCC was ordered by a federal appeals court in 2021 to re-evaluate its limits in light of many scientific studies showing harm from radiation below those limits, especially for children. [158] To date, the FCC has failed to do so.

FCC Loses Two Cases on Wireless Emissions and Environmental Review

The FCC which sets the wireless emission limits for the U.S. lost a major case in federal court in 2021 when the court called into question, and remanded, the FCC's outdated 1996 emission limits because the FCC failed to consider the accounts of personal injuries and 11,000 pages of scientific studies showing harm below those limits.[159]

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[152] 33 FCC Rcd 9088, 9104-05 (2018) (FCC Doc # 18-133), https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g.
[153] https://doi.org/10.1080/00139157.2022.2131190.
[154] "Captured Agency" by Norm Alster, https://ethics.harvard.edu/files/center-for-ethics/files/capturedagency_alster.pdf.
[155] https://arstechnica.com/tech-policy/2023/03/fcc-let-employees-own-stock-in-comcast-and-other-top-isps-watchdog-says/?comments=1&comments-page=1; see also, 47 USC 154.
[156] See, e.g., "The FCC is Supposed to Protect the Environment. It Doesn't." ProPublica, May 2023, https://www.propublica.org/article/fcc-environment-cell-towers-failures?emci=9360893b-ebe8-ed11-8e8b-00224832eb73&emdi=8448fcc6-f1e8-ed11-8e8b-00224832eb73&ceid=8208674.
[157] "How the FCC Shields Companies from Safety Concerns," ProPublica, Nov 2022, https://www.propublica.org/article/fcc-5g-wireless-safety-cellphones-risk?utm_source=sailthru&utm_medium=email&utm_campaign=dailynewsletter&utm_content=feature
[158] Appeals Court Tells FCC to Address Non-Thermal Health Impacts of Radiation from Wireless Technology on Children, the Public, and the Environment, Aug. 25, 2021, https://ehtrust.org/appeals-court-tells-fcc-to-address-non-thermal-health-impacts-of-radiation-from-wireless-technology-on-children-the-public-and-the-environment/.
[159] Id.

The same court ruled against the FCC in 2019 for violating the Administrative Procedures Act (APA) when the FCC determined that it was in the public interest to not consider its licensing of small cells a major federal action that would otherwise warrant environmental review.[160] Therefore, 5G "small" cells are subject to NEPA review, albeit mostly limited to NHPA and radio-frequency reviews.[161] Unfortunately, 5G continues to be deployed without such review, for the most part, in contravention of the court's ruling.

Studies have shown that the FCC's 1996 emission limits are not protective of the public.[162] Those limits would be illegal in other countries whose limits are thousands of times lower, e.g., in Switzerland, Italy and Russia.[163] Several NYC residents have already been injured or disabled from wireless radiation, including a police lieutenant (who spoke about his experience at QCB1),[164] and an 84 year-old elderly woman in subsidized housing.

Telecoms Characterize Wireless Emissions as a Pollutant

The telecom industry characterizes wireless radiation as a pollutant in their device protection plans and disclaims any injuries arising from wireless radiation.[165] Insurance companies such as Lloyd's of London and Swiss Re will not insure for personal injury from this radiation because of the high risk of claims, which may leave the city exposed for these injuries.[166]

5G is Unsustainable

- **5G is Not Green**

Energy consumption from "5G" infrastructure "is expected to increase 61x between 2020 to 2030 due to its energy demands."[167] NYC's assessment of no environmental impact of 5G "small cells" (a

[160] Keetoowah Tribe of Cherokee Indians v. FCC (D.C. Cir 2019).
[161] Note 1 at 47 CFR 1.1306.
[162] See, e.g., Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G, https://icbe-emf.org/wp-content/uploads/2022/10/ICBE-EMF-paper-12940_2022_900_OnlinePDF_Patched-1.pdf; Fact Sheet: Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G, https://icbe-emf.org/wp-content/uploads/2022/10/fact-sheet-221009-v2.pdf.
[163] See chart of countries' emission limits at 11, https://ehtrust.org/wp-content/uploads/5G-Health-Effects-and-Policy-Issues-April-2023.pdf.
[164] See presentation by a police lieutenant who was injured from exposure to wireless radiation from an antenna placed just feet away from his house and from which he has had to evacuate, starting at about 00:54:00, https://www.youtube.com/watch?v=OGxADW9tp8E.
[165] Verizon https://ehtrust.org/wp-content/uploads/device-protection-brochure-nationwide.pdf;
AT&T https://ehtrust.org/wp-content/uploads/ATT-Multi-Device-Protection-Pack-Insurance.pdf;
Sprint https://ehtrust.org/wp-content/uploads/Sprint-Insurance-Terms-and-Conditions-Downloaded-2019.pdf.
[166] https://ehtrust.org/key-issues/electromagnetic-field-insurance-policy-exclusions/.
[167] https://ehtrust.org/report-5g-to-increase-energy-consumption-by-61-times/; see also "Reinventing Wires: The Future of Landlines and Networks," at 73, National Institute for Science, Law and Public Policy, authored by Timothy Schoechle, PhD; https://electromagnetichealth.org/wp-content/uploads/2018/02/ReInventing-Wires-1-25-18.pdf.

"negative declaration") was based on the incorrect assumption that 5G would have no significant change on the consumption of energy even though the 5G network requires an exorbitant amount of energy; additionally, it was based on 5G being much smaller in size ("small" cells) and would be placed on pre-existing structures.[168] In fact, telecom carriers have been advising their customers to turn off 5G to save battery life on their devices.[169]

A thorough environmental review would need to be done to determine if 5G infrastructure even complies with New York State's requirements for energy conservation. Therefore, Link5G Cell Towers would require a CEQR and SEQRA environmental assessment to determine compliance with NYC and NYS environmental standards.

Moreover, NYS adopted a constitutional amendment on environmental rights of residents to clean water and air and a healthful environment, also known as the "Green Amendment." [170] The amendment is enforceable against the government and does not require exhaustion of administrative remedies. In Dec. 2022, a trial court in NY ruled for plaintiffs in upholding their rights to a healthful environment against government action and inaction.[171] Wireless radiation, as an acknowledged pollutant by the telecom and insurance industries and by scientists, would appear to fall under the harms for which the Green Amendment was conceived.

New York State recently passed the most climate protective law in the country, and is focusing on the "decarbonization of New York" with emphasis on fossil fuels.[172] However, New York's climate change goals cannot be reached without also requiring the decarbonization of energy consumption by telecommunications infrastructure, and that means moving away from wireless to fiber optics.

- **Fiber Optics – the Superior and Greener Service**

It's easy to move away from wireless to fiber optics because 4G and 5G depend on fiber optics. Fiber optics are already running up the pole to supply energy to wireless antennas. The greener alternative would be to extend fiber a few feet or yards to the premises – to homes, businesses, schools, medical facilities, in short, to all locations. Keeping telecommunications infrastructure underground would be without any visual impacts.

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[168] Technical Memorandum 001, CEQR #20DIT0014, NYC Dept of Information Technology and Telecommunications, Mobile Telecommunications Franchises, May 7, 2020, https://a002ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAyMFwyMERJVDAwMVlcdGVjaF9tZW1vXDIwRElUMDAxWV9UZWNobmljYWxfTWVtb3JhbmR1bV9fMDUwODIwMjAucGRm0&signature=cb5e38710e4a95b771ea454efb5ce1b45e767a65; CEQR Environmental Assessment Statement Short Form, Dec 10, 2019, https://a002-ceqraccess.nyc.gov/Handlers/ProjectFile.ashx?file=MjAyMFwyMERJVDAwMVlcZWFzXDIwRElUMDAxWV9FQVNfMTIxMDIwMTkucGRm0&signature=9efc336372ffb4f803d59f76fe9fd0b815651005.

[169] "Why are Carrriers Telling Us to Turn Off 5G?" PC Magazine, March 5, 2021, https://www.pcmag.com/opinions/why-are-carriers-telling-us-to-turn-off-5g.

[170] §19 Art.I, NYS Constitution, effective as of Jan. 1, 2022 ("[e]ach person shall have a right to clean air and water, and a healthful environment)."

[171] *Fresh Air for the Eastside, Inc. v. State*, 2022 N.Y. Slip Op. 34429 (N.Y. Sup. Ct. 2022), https://casetext.com/case/fresh-air-for-the-eastside-inc-v-state?

[172] Climate Leadership and Community Protection Act, https://climate.ny.gov/.

Underscoring the importance of fiber over wireless, former FCC Chairman, Tom Wheeler, in his March 2021 Congressional testimony, described fiber as "future proof," and prioritized a "fiber first" policy for the nation. Wheeler's statements point to the fact that wireless and fiber are not equivalent broadband media, [173] and that wireless should be used only as a last resort. "Fiber is unmatched in its speed, performance [and] reliability … "[174] far exceeding those of 5G. Fiber's life span far exceeds that of wireless, at 25-50 years.

Moreover, wireless equipment has a much shorter life span, and requires continuous periodic maintenance and replacement, and who will pay for its upkeep over time? Fiber has been federally prioritized as the superior choice to implement broadband nationwide, including for bridging the "digital divide."

OTI has asserted that CityBridge will be building out the fiber optic network for free. However, there is already a fiber optic network built out by Verizon, apparently, to many parts of the City, and CityBridge has been reported trying to connect to Verizon's already existing fiber.[175] Moreover, Verizon is laying out additional fiber to half a million homes in NYC as part of a recent settlement agreement with the City.[176]

Fiber optics to and through the premises (FTTP) is the preferred and superior method of providing telecommunications connectivity. "Fiber has a minimal ecological impact, reduces waste, consumes very little energy and helps decrease greenhouse gas emissions."[177] Fiber optics has "[l]ower energy consumption, reduced waste and sustainable architecture, characteristics that make fiber infrastructure an environmentally advantageous choice."[178]

FTTP provides the best capacity for remote learning for children and students and more reliable access to medical and other services for the elderly and disabled during emergencies or severe weather when wireless service is more likely to be interrupted.

The Fiber Broadband Association (FBA), the largest fiber optics trade association in the U.S., has shown that consumers prefer the higher upload and download symmetrical speeds that fiber

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[173] "Reinventing Wires: The Future of Landlines and Networks," National Institute for Science, Law and Public Policy, authored by Timothy Schoechle, PhD; https://electromagnetichealth.org/wp-content/uploads/2018/02/ReInventing-Wires-1-25-18.pdf.

[174] Id.

[175] https://www.thecity.nyc/2020/3/3/21210474/city-hall-may-pull-plug-on-linknyc-owner-over-missing-kiosks-and-75m-owed

[176] Verizon fails to fulfill its obligation to provide fiber to every household in the five boroughs, https://www.nyc.gov/office-of-the-mayor/news/415-15/de-blasio-administration-releases-audit-report-verizon-s-citywide-fios-implementation; https://www.nyc.gov/office-of-the-mayor/news/807-20/mayor-de-blasio-holds-verizon-accountable-connect-half-million-new-york-city-households-to; see also, https://arstechnica.com/tech-policy/2020/11/verizon-wiring-up-500k-homes-with-fios-to-settle-years-long-fight-with-nyc/.

[177] Fiber Optic Broadband, A Greener Internet Solution, https://www.otelco.com/a-greener-internet-solution/.

[178] https://www.cablinginstall.com/cable/fiber/article/16465844/how-fiber-can-help-make-your-network-greener.

provides (which wireless cannot provide)[179] hence, ***"If it isn't fiber, it isn't broadband."*** [180] The FBA also shows the preference for superior technology of fiber in its report, "The Market Has Spoken."[181]

Fiber can also be an economic boon.[182] For example, Chattanooga, TN used fiber optics to spring into a clean energy economy and create a vibrant workforce, earning it the accolade of "Gig City," with the fastest broadband network in the U.S. The economic value of its fiber infrastructure over a 10-year period from 2011 to 2020 exceeded $2.69 billion and produced 9,516 jobs.[183]

The National Telecommunications and Information Administration ("NTIA") is implementing the federal Infrastructure Investment and Jobs Act by prioritizing fiber optics over wireless in creating a future-proof technology grid.[184] New York City should do the same, or be left behind.

- **Fiber Already Promised to New Yorkers**

City Bridge is being touted by OTI as building out fiber optics networks in NYC for free. However, NYC residents have already paid for fiber to the premises for every home in NYC. Verizon promised it would do so with its surcharges on NYC telephone bills since the 1990s.[185] However, Verizon has not built out the entire network as promised and as paid. NYC does not need free services from CityBridge; it needs Verizon to comply with its obligations.

Adverse Health and Environmental Impacts

- **Public Health**

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[179] https://s3.amazonaws.com/files.fiberbroadband.org/download/3555.4237?AWSAccessKeyId=AKIAIZGD7FMLIYLBZNIA&Expires=1650065068&Signature=CfFGHmOkZaAovAfuGmXXs2hDpKo%3D.

[180] https://www.broadbandworldnews.com/document.asp?doc_id=773546.

[181] https://www.fiberbroadband.org/p/cm/ld/fid=978.

[182] *How Blazing Internet Speeds Helped Chattanooga Shed its Smokestack Past,* Cnet.com, August 20, 2015, https://www.cnet.com/tech/services-and-software/how-blazing-internet-speeds-helped-chattanooga-shed-its-smokestack-past/; *Why Chattanooga Has the Fastest Internet in the US*, https://tech.co/news/chattanooga-fastest-internet-usa-2018-08.

[183] "Ten Years of Fiber Optic and Smart Grid Infrastructure in Hamilton County, Tennessee," Bento J. Lobo, Ph.D., CFA First Tennessee Bank Distinguished Professor of Finance, The University of Tennessee at Chattanooga, August 31, 2020, https://www.researchgate.net/publication/352221978_Ten_Years_of_Fiber_Optic_and_Smart_Grid_Infrastructure_in_Hamilton_County_Tennessee;
See also, *How Blazing Internet Speeds Helped Chattanooga Shed its Smokestack Past*, Cnet.com, August 20, 2015, https://www.cnet.com/tech/services-and-software/how-blazing-internet-speeds-helped-chattanooga-shed-its-smokestack-past/; *Chattanooga Mayor Pushes Back on 5G as Smart Cities Cure All*, MeriTalk, February 13, 2019, https://www.meritalkslg.com/articles/chattanooga-mayor-pushes-back-on-5g-as-smart-cities-cure-all/.
See also, for economic benefits of fiber deployment, In Kansas, Rural Chanute Built Its Own Gigabit Fiber and Wireless Network," Christopher Mitchell 10-2-21, https://ilsr.org/chanute-rural-gigabit/; and https://www.soar-ky.org/prtc/.

[184] *NTIA Official Acknowledges Clear Preference for Fiber in Infrastructure Deployment Program*, June 13, 2022, https://broadbandbreakfast.com/2022/06/ntia-official-acknowledges-clear-preference-for-fiber-in-infrastructure-deployment-program/.

[185] See, e.g., "New York City Must Call for a Halt to the Billion + Dollars of Cross-Subsidies and Overcharging by Verizon NY, the Public Telco Utility," https://kushnickbruce.medium.com/new-york-city-must-call-for-a-halt-to-the-billion-dollars-of-cross-subsidies-and-overcharging-by-27fad87186f0; see also, http://irregulators.org/.

There have been serious concerns for public health and safety, including risk of cancer, as well as other medical conditions, from wireless radiation (also referred to as radio-frequency (RF) radiation):

1. There has been no pre-market testing of 5G for public health or safety, as confirmed by US Sen. Blumenthal (CT) during a hearing of telecom executives. "We're kind of flying blind here as far as health and safety is concerned." [186]
2. Three studies since Jan 2023 show adverse health impacts from exposure to 5G towers. Previously healthy individuals developed typical "microwave syndrome" symptoms shortly after the towers were installed: headaches, abnormal fatigue, heart arrythmia, burning skin, trouble concentrating.[187] The significance of these reports is that non-ionizing radiation[188] from 5G — well below levels allowed by authorities — can cause health problems in individuals who had no prior history of electromagnetic sensitivity.[189] Dr. Lennart Hardell, lead author of the reports and a world-renowned scientist on cancer risks from radiation, affirms these reports as "groundbreaking" because they serve as the "first warning of a health hazard."[190]
3. The WHO'S International Agency for Research on Cancer classified wireless radiation (2G and 3G) as a possible human carcinogen back in 2011,[191] similar to lead, diesel fuel and gasoline engine exhaust. OTI incorrectly presented to CB8 that the WHO said 5G is safe.
4. The National Toxicology Program, commissioned by the Food and Drug Administration to conduct a $30 million study, in 2018 found clear evidence of cancer;[192] NTP is one of the most prestigious institutions in the world in toxicology.
5. A study in 2000 commissioned by one of the major telecom carriers found links to cancer, leukemia, neurological disorders and cognitive impairment, with special caution for children and an acknowledgement of those already disabled from the radiation.[193]

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[186] https://ehtrust.org/health-effects-of-5g-wireless-technology-confirmed-at-us-senate-hearing-after-senator-blumenthal-questions-industry/; see also, https://mdsafetech.org/2019/02/13/no-research-on-5g-safety-senator-blumenthal-question-answered/.

[187] Jan 2023 study of 63 year old man and 62 year old woman where 5G antennas were installed on the rooftop of their home, https://www.gavinpublishers.com/assets/articles_pdf/Case-Report-The-Microwave-Syndrome-after--Installation-of-5G-Emphasizes-the-Need-for--Protection-from-Radiofrequency-Radiation.pdf and https://childrenshealthdefense.org/defender/5g-radiation-microwave-syndrome-symptoms/; Feb 2023 study of two previously healthy men where 5G antennas were installed on the rooftop of their business, https://www.anncaserep.com/open-access/development-of-the-microwave-syndrome-in-two-men-shortly-after-9589.pdf; April 2023 study of 52 year old woman whose apartment was 60 meters from a 5G base station, https://acmcasereport.com/pdf/ACMCR-v10-1926.pdf?fbclid=IwAR2J-mE3XeBxqaXPQdFxslf9Q23bMCer9vgUBHnCvJXBrgBv-w7YdRUDwF0; see also, The microwave syndrome or electro-hypersensitivity: historical background https://pubmed.ncbi.nlm.nih.gov/26556835/.

[188] https://childrenshealthdefense.org/emr/emf-key-terms-descriptions/.

[189] https://childrenshealthdefense.org/emr/emf-wireless-health-impacts/.

[190] https://www.stralskyddsstiftelsen.se/two-studies-show-that-5g-caused-the-microwave-syndrome-in-healthy-persons/.

[191] https://www.iarc.who.int/wp-content/uploads/2018/07/pr208_E.pdf.

[192] *Environmental Health Trust, et al v. FCC*, Motion for Leave to File Brief of Amicus Curiae Joseph Sandri in Support of Petitioners Urging Reversal, Aug. 5, 2020, https://ehtrust.org/wp-content/uploads/20-1025-Amicus-Brief-Joe-Sandri.pdf.

[193] T-Mobil Deutsche Telekom commissioned study by the Ecolog-Institute, April 2000, "Mobile Telecommunications and Health Review of the Current Scientific Research in View of Precautionary Health Protection," https://ehtrust.org/wp-content/uploads/ecolog2000.pdf.

6. One hundred sixty scientists worldwide submitted in 2015 The International Scientists' Appeal to the United Nations to Protect Humans and Wildlife from the unconstrained proliferation of wireless radiation.[194]
7. Thousands of scientific and medical studies show neurological disorders; increased risk of cancer and brain tumors; DNA damage; oxidative stress; immune dysfunction; cognitive processing effects; altered brain development, sleep and memory disturbances, ADHD, abnormal behavior, sperm dysfunction, and damage to the blood-brain barrier.[195]
8. New Hampshire Commission that studied the health impacts of wireless radiation found that levels below the FCC emission limits can be harmful (see Addendum F, a letter from Dr. Kent Chamberlin to CB9 Manhattan).[196]
9. The Board of Health of Pittsfield, MA issued an emergency order to turn off a 4G cell tower that injured 17 residents most of whom evacuated their homes.[197] Children were found vomiting in their beds, pets were vomiting and residents were becoming ill.[198]

- **Up to 30% of Population Experiencing Symptoms**

There may be adverse implications for the economy and workforce as more NYC residents become affected by exposure to wireless radiation. With each new "generation" of wireless technology, including 5G, people are being further exposed to wireless radiation which they cannot avoid.[199]

The U.S. Access Board (which advises the Justice Department and other state and federal agencies under the Americans with Disabilities Act) notes that a U.S. National Institute of Building Sciences survey of a representative region found that 2-6% of the population are sensitive to electro-magnetic fields, referring to wireless radiation.[200] Based on a population of 8.468 million people in NYC,[201] the numbers would range from 169,360 to 508,080 people.

A 2019 Bevington study[202] analyzed the prevalence of symptoms from radiation sickness within the population. Based on the same number, the results are also high:

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[194] Dr. Martin Blank, PhD, Dept of Physiology and Cellular Biophysics, Columbia University, announcing the appeal and warning on wireless radiation, https://www.youtube.com/watch?v=HgECRrabuZQ.

[195] A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation, 2022, https://bioinitiative.org/conclusions/; see also, Adverse health effects of 5G mobile networking technology under real-life conditions, May 1, 2020, https://pubmed.ncbi.nlm.nih.gov/31991167/; Wireless Radiation (RFR) – Is U.S. Government Ignoring Its Own Evidence for Risk? March, 28, 2019, https://electromagnetichealth.org/electromagnetic-health-blog/u-s-gov-ignoring-own-evidence/; Oxidative Mechanisms of Biological Activity of Low-Intensity Radiofrequency Radiation, Electromagnetic Biology and Medicine, 35(2), 186-202, Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., & Kyrylenko, S. (2016), https://pubmed.ncbi.nlm.nih.gov/26151230/.

[196] http://www.gencourt.state.nh.us/statstudcomm/committees/1474/reports/5G%20final%20report.pdf.

[197] https://ehtrust.org/cease-and-desist-order-against-verizon-cell-tower-by-board-of-health-pittsfield-ma/.

[198] https://ehtrust.org/family-injured-by-cell-tower-radiation-in-pittsfield-massachusetts/.

[199] Letter by Dr. Beatrice Golomb, Professor of Medicine, UC San Diego School of Medicine, Aug. 22, 2017, https://mdsafetech.org/wp-content/uploads/2017/09/golomb-sb649-5g-letter-8-22-20171.pdf.

[200] U.S. Access Board – Advancing Full Access & Inclusion for All - "Indoor Environmental Quality Project," https://www.access-board.gov/research/building/indoor-environmental-quality/.

[201] https://www.google.com/search?q=number+of+people+in+NYC&oq=number+of+people+in+NYC&aqs=chrome..69i57.9654j1j7&sourceid=chrome&ie=UTF-8.

[202] The Prevalence of People with Restricted Access to Work in Manmade Electromagnetic Environments,

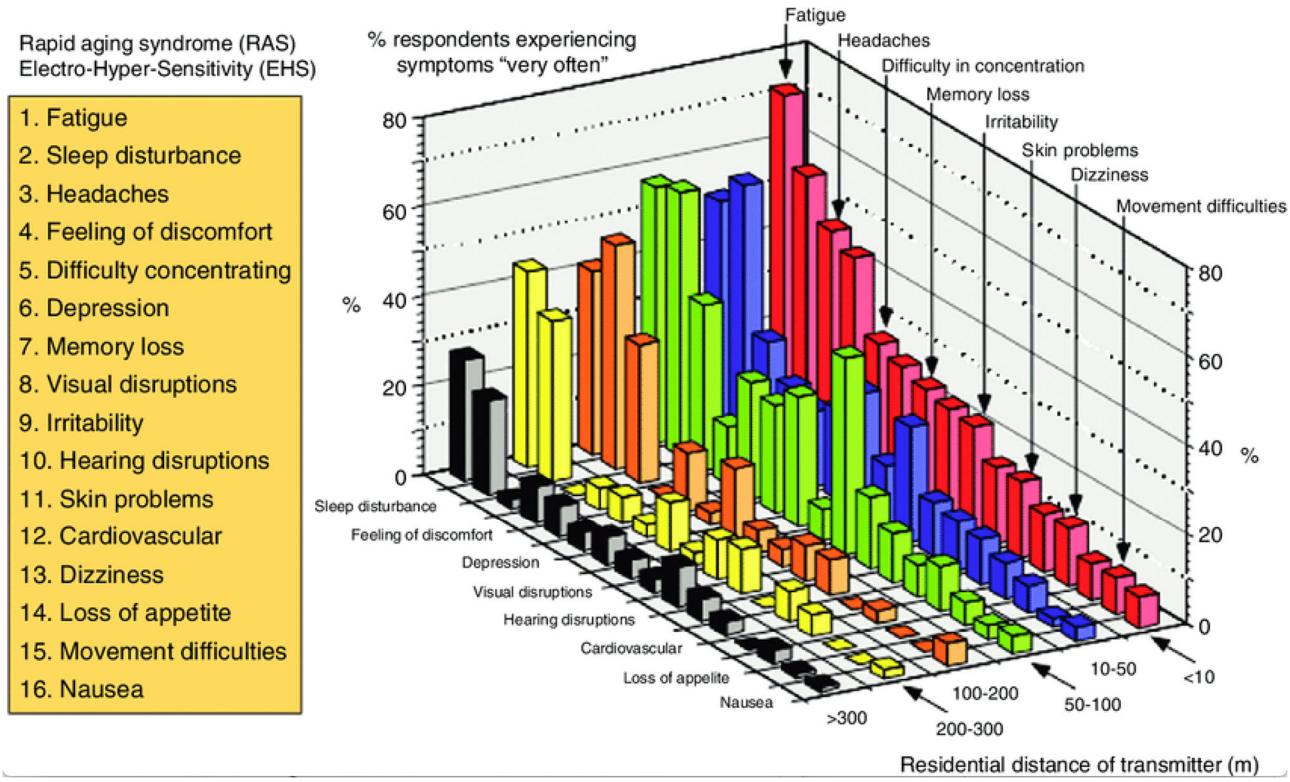
Percentages	Projected Number of Affected NYC Residents
Can't work – 0.65%	55,042
Severe symptom – 1.5%	127,020
Moderate symptoms – 5%	423,400
Mild symptoms – 30%	3,399,882

[Intentionally left blank]

https://mdsafetech.files.wordpress.com/2019/10/2018-prevalence-of-electromagnetic-sensitivity.pdf.

- **Neurobehavioral Symptoms Near Cell Towers**[203]

The following chart shows a worsening of symptoms when closer to a cell tower but a lessening of symptoms when farther away from a cell tower.



Symptoms experienced by people near cellular phone base stations; RF radiation affects the blood, heart and autonomic nervous system.[204] Source: Santini, et al (France): Pathol Biol. 2002;50:S369-73.

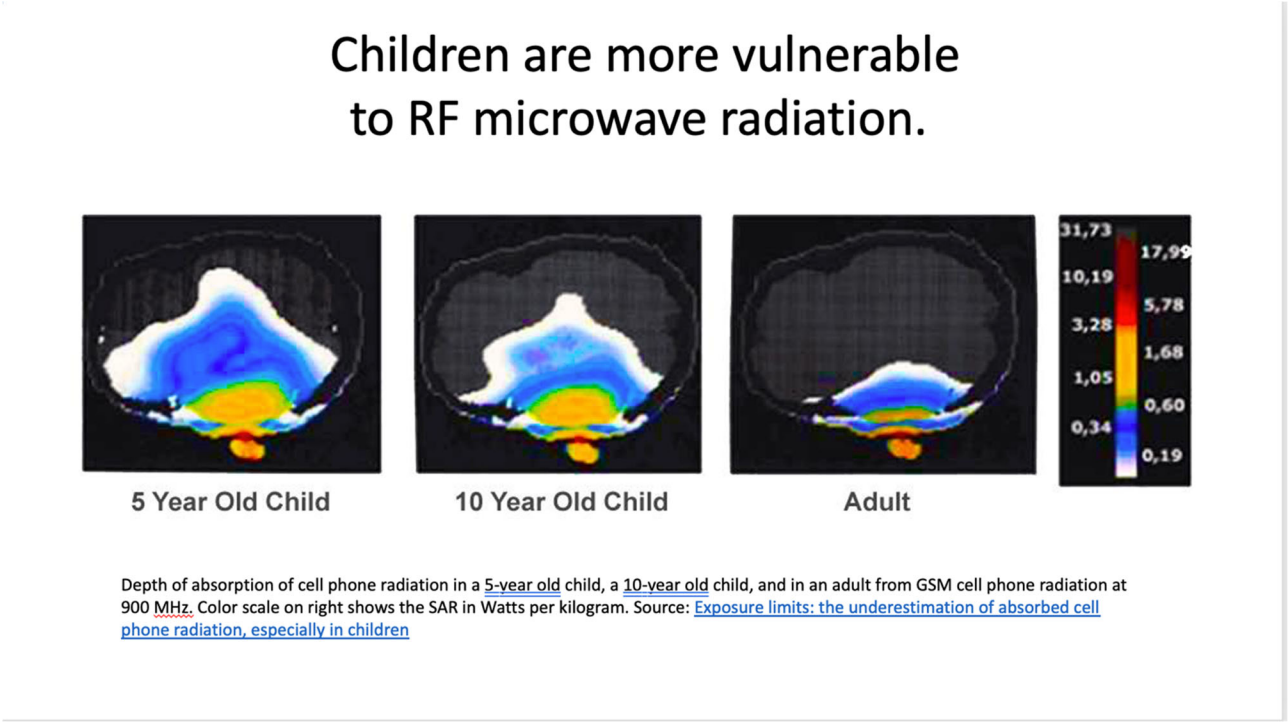
- **Adverse Impacts on Children**

Children are particularly vulnerable and are adversely affected by RF radiation in their environment, homes and schools.[205] A special risk factor has been identified for children "due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known

[203] *Cell Tower Health Effects*, Physicians for Safe Technology, https://mdsafetech.org/cell-tower-health-effects/.
[204] Dr. Magda Havas, https://www.researchgate.net/figure/Symptoms-experienced-by-people-near-cellular-phone-base-stations-based-on-the-work-of_fig2_258313941.
[205] *Children and Wireless Radiation,* https://ehtrust.org/educate-yourself/children-and-wireless-faqs/.

carcinogens, including radiation."[206] The American Academy of Pediatrics has pointed out that children are disproportionately affected by cell phone radiation due to their lower bone density and amount of fluid in the brain allowing for absorption of greater quantities of RF radiation than in adults.[207]

Children absorb more RF radiation than adults, and fetuses are at even greater risk.[208] Children's "brain tissues are more absorbent, their skulls are thinner and their relative size is smaller."[209] RF radiation penetrates more deeply into the skulls of children compared to adults,[210] as shown below in cell phone usage.[211]



Source: Exposure limits: the underestimation of absorbed cell phone radiation, especially in children, Gandhi, Morgan, Augusto de Salles, Han, Heberman, Davis, October 14, 2011.[212]

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[206] *Key Scientific Evidence and Public Health Policy Recommendations*, Supplement 2012, at 21, David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, Cindy Sage, MA, Sage Associates, https://bioinitiative.org/wp-content/uploads/pdfs/sec24_2012_Key_Scientific_Studies.pdf.https://bioinitiative.org/.

[207] *Key Scientific Evidence and Public Health Policy Recommendations*, Supplement 2012, at 21, David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, Cindy Sage, MA, Sage Associates, https://bioinitiative.org/wp-content/uploads/pdfs/sec24_2012_Key_Scientific_Studies.pdf.https://bioinitiative.org/.

[208] *Why children absorb more microwave radiation than adults: The consequences,* Morgan, Kesar and Davis, Journal of Microscopy and Ultrastructure, Vol. 2, Issue 4, December 2014, 197-204, https://www.sciencedirect.com/science/article/pii/S2213879X14000583.

209 Id.

[210] See, Dr. Melnick, London 5G Conference at 39:00, https://www.youtube.com/watch?v=zSx_yDzxvM8&t=2295s; https://ehtrust.org/research-on-childrens-vulnerability-to-cell-phone-radio-frequency-radiation/ and https://ehtrust.org/science/scientific-imaging-cell-phone-wi-fi-radiation-exposures-human-body/.

[211] *Exposure limits: the underestimation of absorbed cell phone radiation, especially in children,* Gandhi, Morgan, Augusto de Salles, Han, Heberman, Davis, October 14, 2011, https://pubmed.ncbi.nlm.nih.gov/21999884/.

[212] Id.

Exposure to RF radiation "can result in degeneration of the protective myelin sheath that surrounds brain neurons" and "[d]igital dementia has been reported in school age children."[213] It also increases the risk of childhood leukemia.[214]

There are also neurological implications to RF radiation exposure for children.[215] Cell towers near schools and Wi-Fi in schools are potentially hazardous to children.[216]

- Elementary school children who were exposed to high levels of RF radiation generated from mobile phone base stations 200 meters from their schools "had a significantly higher risk of type 2 diabetes mellitus" than those exposed to lower RF radiation.[217]

- Adolescent school children who were exposed to high levels of RF radiation generated from mobile phone base stations within 200 meters from their schools had "delayed fine and gross motor skills, spatial working memory and attention" than those exposed to lower RF radiation.[218]

- A ten-year old child testified of his cardiac condition being caused by exposure to RF radiation in a library where he was being tutored.[219]

RF radiation "… has toxic effects in pregnancy, to the fetus and subsequent offspring … and is tied to developmental problems in later life, including attention deficit and hyperactivity."[220]

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[213] *Why children absorb more microwave radiation than adults: The consequences,* Morgan, Kesar and Davis, Journal of Microscopy and Ultrastructure, Vol. 2, Issue 4, December 2014, 197-204, https://www.sciencedirect.com/science/article/pii/S2213879X14000583.

[214] *Key Scientific Evidence and Public Health Policy Recommendations*, 2007, at 19, David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, Cindy Sage, MA, Sage Associates, https://bioinitiative.org/wp-content/uploads/pdfs/sec24_2007_Key_Scientific_Studies.pdf.

[215] See generally, https://ehtrust.org/research-on-childrens-vulnerability-to-cell-phone-radio-frequency-radiation/; see also, https://ehtrust.org/cell-towers-and-cell-antennae/compilation-of-research-studies-on-cell-tower-radiation-and-health/.

[216] Dr. Magda Havas: WiFi in Schools is Safe. True or False?, https://www.youtube.com/watch?v=6v75sKAUFdc.

[217] *Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations (MPBS)with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus*, Sultan Ayoub Meo et al, International Journal of Environmental Research and Public Health, 2015; https://www.researchgate.net/publication/283726472_Association_of_Exposure_to_Radio-Frequency_Electromagnetic_Field_Radiation_RF-EMFR_Generated_by_Mobile_Phone_Base_Stations_with_Glycated_Hemoglobin_HbA1c_and_Risk_of_Type_2_Diabetes_Mellitus.

[218] Meo, S. A., Almahmoud, M., Alsultan, Q., Alotaibi, N., Alnajashi, I., & Hajjar, W. M. (2018). *Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health*, American Journal of Men's Health; https://pubmed.ncbi.nlm.nih.gov/30526242/.

[219] Child With Heart Problems From Wireless: 5G Health Risks California SB 649 Hearing, https://www.youtube.com/watch?v=OgNLR9fQOX4&list=PLT6DbkXhTGoDakSqp1i_7milpwGx4xMFq.

[220] Letter by Dr. Beatrice Golomb, Professor of Medicine, UC San Diego School of Medicine, Aug. 22, 2017, https://mdsafetech.org/wp-content/uploads/2017/09/golomb-sb649-5g-letter-8-22-20171.pdf.

Children born of mothers who used cell phones during pregnancy developed more behavioral problems by school age than those whose mothers did not use cell phones during pregnancy, with the following results: "25% more emotional problems, 35% more hyperactivity 49% more conduct problems and 34% more peer problems."[221] A study involving 24,499 children found a 23% increase of emotional and behavioral difficulties.[222]

- **"Why Tech Leaders Don't Let Their Kids Use Tech"**

Technology executives already appear to heed this caution. In an article, "*Why Tech Leaders Don't Let Their Kids Use Tech*,"[223] it's reported that technology executives restrict or forbid their children's use of the very technology that they are providing to the public, including "the makers of smartphones and tablets, of social media channels and game boxes." Reported examples have included technology "titans" such as former Apple's Steve Jobs and Bill and Melinda Gates have admitted to placing restrictions on their children's use of technology. Chris Anderson, former Wired magazine editor and CEO of 3D Robotics, said that his kids "accuse me and my wife of being fascists and overly concerned about tech, and they say that none of their friends have the same rules. That's because we have seen the dangers of technology firsthand. I've seen it in myself, I don't want to see that happen to my kids."[224]

If these 5G towers are placed anywhere near children or their schools, the hazards of wireless radiation on children and their neurological development should be examined thoroughly. Tech Safe Schools has a wealth of information on the scientific studies showing harm, and how to protect school children from wireless radiation,[225] and delineates schools' fiduciary responsibilities.[226]

- **Adverse Impacts on Birds, Bees and Trees**

RF radiation has adverse environmental impacts to flora and fauna – birds, bees and trees.[227] There is no federal agency setting safety limits for flora and fauna, nor is there any funded mandate to do so.[228]

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[221] *Key Scientific Evidence and Public Health Policy Recommendations*, Supplement 2012, at 8, David O. Carpenter, MD, Director, Institute for Health and the Environment University at Albany, Cindy Sage, MA, Sage Associates, https://bioinitiative.org/wp-content/uploads/pdfs/sec24_2012_Key_Scientific_Studies.pdf.

[222] Miller AB, Sears ME, Morgan LL, Davis DL, Hardell L, Oremus M, Soskolne CL. Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. Front Public Health. 2019 Aug 13;7:223. doi: 10.3389/fpubh.2019.00223. PMID: 31457001; PMCID: PMC6701402, also available at https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223/full#B42.

[223] "Why Tech Leaders Don't Let Their Kids Use Tech," https://kidzu.co/health-wellbeing/why-tech-leaders-dont-let-their-kids-use-tech/.

[224] Id.

[225] https://www.techsafeschools.org/ (based in NY).

[226] https://www.techsafeschools.org/_files/ugd/2cea04_9edd62aa69d7475d87fc4ef20d56348a.pdf.

[227] Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment, Levitt, Lai and Manville, March 28, 2022, https://pubmed.ncbi.nlm.nih.gov/34047144/.

[228] EHT Letter to US National Park Service on 5G, Cell Towers and Impacts to Pollinators, Trees and Wildlife, Sep 15, 2020, https://ehtrust.org/eht-letter-to-us-national-park-service-on-5g-cell-towers-and-impacts-to-pollinators-trees-and-wildlife/.

RF radiation can affect wildlife's orientation, migration, food finding, reproduction, nest building, territorial defense, vitality, longevity and survival, [229] and has been associated with dramatic declines in wildlife. Trees next to cell towers have been consistently observed to become damaged and die.

Artificial, man-made RF radiation has been recognized as a form of environmental pollution which can harm wildlife, including bats and birds, such as sparrows. Cell towers located in their habitats would be continuously irradiating 24/7, 365 days a year, without refuge from the cell towers, and wildlife could suffer long-term effects, such as: "reduction of their natural defenses, deterioration of their health, problems in reproduction and reduction of their useful territory through habitat deterioration."[230]

Toxic effects "have been observed in mammals such as bats, cervids, cetaceans, and pinnipeds among others, and on birds, insects, amphibians, reptiles, microbes and many species of flora." [231] Different habitats for wildlife, including aquatic environments, "rely on the Earth's natural geomagnetic fields for critical life-sustaining information," with which artificial, man-made RF radiation interferes. [232]

A study performed by placing two mobile phones under a beehive showed that when the phones were turned on, within 20-40 minutes, the bees began emitting "piping" calls and squeaks announcing their start of swarming which means they are about to abandon the hive. [233] Another study corroborated this study and found that the bees "stopped producing honey, egg production by the queen bee halved, and the size of the hive dramatically reduced."[234]

Another study examining how insects, including the Western honeybee, react to RF radiation exposure at frequencies from 2GHz to 120GHz, in simulations found increases in absorbed power of

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[229] Id; see also, Johansson O, *The Stockholm Declaration about "Life EMC"*, Bee Culture Magazine 2022; May issue: 56-61 and Levitt BB, Lai HC, Manville AM. Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. Rev Environ Health. 2021 Sep 27. Doi: 10.1515/reveh-2021-0083. Epub ahead of print. PMID: 34563106. https://pubmed.ncbi.nlm.nih.gov/34563106/

[230] Electromagnetic pollution from phone masts. Effects on wildlife, Alfonso Balmori, August 2009, https://www.sciencedirect.com/science/article/abs/pii/S0928468009000030?via%3Dihub. See also, The incidence of electromagnetic pollution on wild mammals: A new "poison" with a slow effect on nature? Alfonso Balmori, November 2009.
Balmori, A. The incidence of electromagnetic pollution on wild mammals: A new "poison" with a slow effect on nature?. Environmentalist 30, 90–97 (2010). https://doi.org/10.1007/s10669-009-9248-y.

[231] Levitt BB, Lai HC, Manville AM. Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: how species interact with natural and man-made EMF. Rev Environ Health. 2021 Jul 8. doi: 10.1515/reveh-2021-0050. https://pubmed.ncbi.nlm.nih.gov/34243228/.

[232] Levitt BB, Lai HC, Manville AM. Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: how species interact with natural and man-made EMF. Rev Environ Health. 2021 Jul 8. doi: 10.1515/reveh-2021-0050. https://pubmed.ncbi.nlm.nih.gov/34243228/.

[233] *Why a mobile phone ring may make bees buzz off: Insects infuriated by handset signals*, Daily Mail, May 13 2011, https://www.dailymail.co.uk/sciencetech/article-1385907/Why-mobile-phone-ring-make-bees-buzz-Insects-infuriated-handset-signals.html; see also, "Cell Phones Caused Mysterious Worldwide Bee Deaths, Study Finds." Fox News, May 13, 2011, https://www.foxnews.com/tech/cell-phones-caused-mysterious-worldwide-bee-deaths-study-finds.

[234] *5G & Other Wireless Radiation Is Having A Detrimental Impact On Bees: Here's The Science*, Arjun Walia December 31, 2021, https://thepulse.one/2021/12/31/5g-other-wireless-radiation-is-destroying-bees/.

3-370%.[235] Researchers concluded an urgent need to reduce exposure and that "[a]s 5G will increase radiation exposures and use new higher frequencies shown to be highly absorbed into insects, scientists are calling for a moratorium on 5G."[236]

In a 2021 landmark report on the effects of RF radiation on wildlife, insects, plants and trees, it was found that RF radiation intensities, even at very low levels, from cell towers have adverse biological effects. Artificial RF radiation can disrupt the Earth's natural magnetic fields that birds, fish and other wildlife use to navigate and orient themselves.[237] The report is 150 pages with more than 1200 references, uncovering studies otherwise neglected on the subject.[238]

Moreover, with every new network, such as 4G or 5G, the signal structure becomes more complex than the previous network, yet no research has been done on "the biological effects of simultaneous exposure to multiple signals."[239]

Birds are particularly susceptible to RF radiation. Studies done in 1975 in the ranges of 1-10 KHz[240] and 10-16 GHz[241] showed that bird feathers (the hollow part) were receptors for RF radiation. A study of robins exposed to RF at a low range from 2KHz to 5MHz found that the birds were unable to use their electromagnetic compass for orientation.[242]

Birds are acutely sensitive to RF radiation due to their thin skulls, how their feathers can act as dielectric receptors of microwave radiation and the fact that many bird species use magnetic navigation.[243] For example, the birds' inability to discern impending storms via the earth's natural electromagnetic fields is finding a growing number of birds flying into the storms, rather than flying around them.[244] RF radiation is an emerging threat to wildlife orientation.[245]

The U.S. Department of the Interior (DOI) warned the NTIA against categorical exemptions of RF radiation emitted from cell towers on bird species.[246] DOI pointed to "mass mortality events" of impacts of birds with cell towers during peak migration seasons, estimated at 4 to 6.8 million bird

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[235] Id.
[236] Id.
[237] https://www.santafenewmexican.com/news/local_news/report-says-wireless-radiation-said-by-telecom-companies-to-be-harmless-could-be-hurting-wildlife/article_1ae80fc0-7d5d-11ec-8c13-4f3411ea8ea1.html.
[238] Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment, Levitt, Lai and Manville, March 28, 2022, https://pubmed.ncbi.nlm.nih.gov/34047144/.
[239] https://ehtrust.org/wp-content/uploads/Mt-Nardi-Wildlife-Report-to-UNESCO-FINAL.pdf at 35.
[240] The properties of bird feathers as converse piezoelectric transducers and as receptors of microwave radiation. I. Bird feathers as converse piezoelectric transducers, Blanco and Sierra, 1975, https://pubmed.ncbi.nlm.nih.gov/1235241/.
[241] The properties of bird feathers as converse piezoelectric transducers and as receptors of microwave radiation. II. Bird feathers as dielectric receptors of microwave radiation, Blanco and Sierra, 1975, https://pubmed.ncbi.nlm.nih.gov/1242004/.
[242] Id.
[243] Birds and Balmori: For the Birds, June 14, 2022, https://safetechinternational.org/for-the-birds/?fbclid=IwAR2_d2mc_JYi45umgMvG0-0SdQG3rf4Jf3sTao61T-kVyGzjnXs3WE1Uo5M.
[244] Id.
[245] "Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation," wildlife biologist, Dr. Balmori, at https://www.ncbi.nlm.nih.gov/pubmed/25747364.
[246] U.S. Dep't of Interior letter to NTIA, 2-7-14, https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf.

deaths per year, and "documented nest and site abandonment, plumage deterioration, locomotion problems, reduced survivorship and death…"[247]

The disappearance of bird and insect species from an old growth rainforest, in New South Wales, Australia, from 2000 to 2015, corresponded with an increasing number of cell tower installations starting with "3G" to "4G" and then "5G."[248] After the installations, it was reported that 70-90% of the wildlife had disappeared, including 66 bird species and 22 species of migratory, threatened and endangered birds, with 86 bird species exhibiting unnatural behaviors. [249] In sharp contrast, when the towers were shut off for 2 days, there was a "resultant explosion of biology on the mountain."[250]

It has been shown that trees are damaged by RF radiation from mobile phone base stations, with damage starting on one side and then "extending to the whole tree over time."[251] Tree damage was found with chronic exposure to RF radiation.[252]

Conclusion

In summary, OTI has not provided any evidence of a gap in telecommunications service. There are privacy and security vulnerabilities, particularly the potential tracking of our children's locations, the devaluation of our property values, the adverse environmental and health impacts from wireless radiation, and even if all of these issues could be mitigated, the Link5G Cell Towers would still be eyesores and an aesthetic blight, out of character with our neighborhoods. Easily accessible to us is a superior alternative of fiber optics for speed, capacity and security.

Respectfully Submitted,

Odette J. Wilkens
President & General Counsel
Wired Broadband, Inc.
a 501(c)(3) non-profit
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www.wiredbroadband.org
owilkens@wiredbroadband.org
646.939.6855

[247] Id at 5-6.
[248] Report for the United Nations Educational Scientific and Cultural Organization (UNESCO) And International Union for the Conservation of Nature (IUCN) Report detailing the exodus of species from the Mt. Nardi area of the Nightcap National Park World Heritage Area during a 15-year period (2000-2015), Ethno-botanist Mark Broomhall, https://ehtrust.org/wp-content/uploads/Mt-Nardi-Wildlife-Report-to-UNESCO-FINAL.pdf.
[249] Id. at 4.
[250] Id at 35.
[251] Radiofrequency radiation injures trees around mobile phone base stations, Aug. 24, 2016, https://pubmed.ncbi.nlm.nih.gov/27552133/.
[252] *Tree Damage from Chronic High Frequency Exposure*, https://ehtrust.org/wp-content/uploads/tree-health-radiation-Schorpp-2011-02-18.pdf.

ADDENDUM A

Photo from OTI's (formerly DoITT) presentation to NYC's Public Design Commission, 10-18-22, p. 40



ADDENDUM B
Photo from OTI's (formerly DoITT) presentation to NYC's Public Design Commission, 10-18-22, p.15



ADDENDUM C

OTI's Letter to Community Board 8 Manhattan

Office of Technology & Innovation

Hon. Manhattan Borough President Mark Levine
1 Centre Street, 19th Floor
New York, NY 10007

Manhattan Community Board District Manager Will Brightbill
505 Park Avenue, Suite 620
New York, NY 10022

Hon. Council Member Keith Powers
211 East 43rd Street, Suite 1205
New York, NY 10017

Hon. Council Member Julie Menin
444 East 75th Street, Unit 1B
New York, NY 10021

Madison Avenue Business Improvement District
29 East 61st Street, 3rd Floor
New York, New York 10065

November 16, 2022

Dear Community and Elected Officials:

We are pleased to share that the Office of Technology and Innovation (OTI, formerly DoITT) and our franchisee, CityBridge, are restarting the deployment of LinkNYC kiosks throughout New York City. As you know, Links are invaluable tools that provide free high-speed Wi-Fi, free nationwide calling, free charging ports for mobile devices, and 911 and 311 access to millions of people each year. We are proposing new sites throughout the five boroughs. This new proposed location is a critical component of the City's efforts to equitably expand Wi-Fi access across the City.

Below is a new site proposed for Manhattan Community Board 8. Because we want to bring Links to your area within a short timeframe, we ask that you provide any comments on this site as soon as possible and by January 16, 2023. If we do not receive feedback within 60 days, CityBridge will proceed with installation. Although the attached sites have

thus far met all of our siting criteria, it is possible that some of them will not be built, even if approved, due to technical factors.

Please see the locations of the sites below and on Open Data:

LinkNYC New Site Permit Applications (Data): https://data.cityofnewyork.us/SocialServices/LinkNYC-NewSite-Permit-Applications/xp25-gxux
LinkNYC New Site Permit Applications (Map): https://data.cityofnewyork.us/SocialServices/LinkNYC-New-Site-Permit-Applications-Map/tdt4-7qzu

#	Site ID	Street Address	Community District	Council District	Zone/Category	BID	Historic District/Landmark
1	MN-08-119916	1190 MADISON AVENUE	8	4	COMMERCIAL		
2	MN-08-119917	1050 5 AVENUE	8	4	RESIDENTIAL		Expanded Carnegie Hill Historic District
3	MN-08-119918	1000 5th AVENUE	8	4	PARKS		Expanded Carnegie Hill Historic District
4	MN-08-119925	46 EAST 91 STREET	8	4	COMMERCIAL		Expanded Carnegie Hill Historic District
5	MN-08-119930	1040 PARK AVENUE	8	4	RESIDENTIAL		Park Avenue Historic District
6	MN-08-119932	27 EAST 95th ST	8	4	COMMERCIAL		Individual Landmark Armory
7	MN-08-121861	24 EAST 63 STREET	8	4	COMMERCIAL	Madison Ave BID	Upper East Side Historic District
8	MN-08-121978	688 MADISON AVENUE	8	4	COMMERCIAL	Madison Ave BID	Upper East Side Historic District
9	MN-08-121988	30 EAST 64 STREET	8	4	COMMERCIAL	Madison Ave BID	Upper East Side Historic District
10	MN-08-GF0909	1105 PARK AVENUE	8	4	RESIDENTIAL		Park Avenue Historic District
11	MN-08-GF0910	1115 5 AVENUE	8	4	RESIDENTIAL		
12	MN-08-GF0911	1175 PARK AVENUE	8	4	RESIDENTIAL		Expanded Carnegie Hill Historic District
13	MN-08-GF0912	570 PARK AVENUE	8	4	RESIDENTIAL		Upper East Side Historic District

14	MN-08-GF0913	807 5 AVENUE	8	4	RESIDENTIAL		Upper East Side Historic District - Individual landmark Knickerbocker Club Building
15	MN-08-GF0919	1095 5 AVENUE	8	4	RESIDENTIAL		Expanded Carnegie Hill Historic District/ Individual Landmark Carnegie Mansion
16	MN-08-GF0925	1283 YORK AVENUE	8	5	RESIDENTIAL		
17	MN-08-GF0926	510 EAST 71ST STREET	8	5	RESIDENTIAL		
18	MN-08-GF0927	510 EAST 70TH STREET	8	5	COMMERCIAL		

If you have any questions or comments, please feel free to reach out to me. We look forward to working with you to make this new free service available to all New Yorkers.

Sincerely,

Leslie Brown
External Affairs Associate
New York City Office of Technology and Innovation

ADDENDUM D
MORATORIUM RESOLUTIONS BY COMMUNITY BOARD 8 MANHATTAN

Russell Squire
Chair

Will Brightbill
District Manager

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(212) 758-4616 (Fax)
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info@cb8m.com – E-Mail

The City of New York
Community Board 8 Manhattan

December 21, 2022

Honorable Sarah Carroll, Chair
NYC Landmarks Preservation Commission
Municipal Building
One Center Street, 9th Floor
New York, New York 10007

RE: 5G Link NYC Kiosks in Historic Districts

Dear Chair Carroll,

At the Full Board meeting of Community Board 8 Manhattan held on December 15, 2022, the board unanimously approved the following resolution by a vote of 42 in favor, 2 opposed, 0 abstentions, and 0 not voting for cause.

WHEREAS New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network;

WHEREAS the Transportation Committee of Community Board 8 had an extensive hearing with public participation on the benefits and drawbacks of the proposed towers;

WHEREAS the Landmarks Committee of Community Board 8 had a subsequent hearing with public participation on the benefits and drawbacks of the proposed 5G towers;

WHEREAS the towers are to be placed on sidewalks in historic districts;

WHEREAS the towers are 32 feet high and, therefore, out of scale with the buildings in historic districts;

WHEREAS the modernist design of the towers is unrelated to the architectural characters of buildings in historic districts;

WHEREAS the towers can be placed ten feet from an individual landmark building or a building in a historic district, thereby detracting from the presence of the historic structure;

WHEREAS the screens on kiosks or towers conflict with the Special Madison Avenue Preservation District's design guidelines;

WHEREAS 5G transmission cables can be placed fully underground, connect directly to buildings, and have no visual impact on the streetscape;

WHEREAS each 5GTower proposed for installation within a historic district must first receive a Certificate of Appropriateness from the Landmarks Preservation Commission

WHEREAS 5G towers are not appropriate and contextual in historic districts and should not be approved by the Landmarks Preservation Commission in historic districts;

WHEREAS the Landmarks Committee of Community Board 8 has reviewed the resolution prepared by the Transportation Committee of Community board 8;

WHEREAS the Landmarks Committee of Community Board 8 supports the resolution prepared by the Transportation Committee;

THEREFORE, BE IT RESOLVED that the installation of Link 5G towers in historic districts in Community Board 8 is disapproved;

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G towers and devices in Community District 8 Manhattan.

Sincerely,

Russell Squire

Russell Squire
Chair

David Helpern and Jane Parshall

David Helpern and Jane Parshall
Co-Chairs, Landmarks Committee

cc: Honorable Eric Adams, Mayor of the City of New York
Honorable Carolyn Maloney, 12th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Liz Krueger, NYS Senator, 28th Senatorial District
Honorable José M. Serrano, NYS Senator, 29th Senatorial District
Honorable Dan Quart, NYS Assembly Member, 73rd Assembly District
Honorable Rebecca Seawright, NYS Assembly Member 76th Assembly District
Honorable Julie Menin, NYC Council Member, 5th Council District
Honorable Keith Powers, NYC Council Member, 4th Council District

Russell Squire
620
Chair

Will Brightbill

District Manager

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The City of New York
Community Board 8 Manhattan

December 20, 2022

Edward F. Pincar
Manhattan Borough Commissioner
Department of Transportation
59 Maiden Lane, 37th Floor
New York, NY 10038

Matthew C. Fraser
Chief Technology Officer
NYC Office of Technology & Innovation
2 MetroTech Center, P1
Brooklyn, NY 11201

RE: Disapproval of new Link5G Kiosks within CB8

Dear CTO Fraser and Commissioner Pincar,

At the Full Board meeting of Community Board 8 Manhattan held on December 14, 2022, the board approved the following resolution by a vote of 40 in favor, 2 opposed, 0 abstentions and 0 not voting for cause:

WHEREAS; New York City, through its Office of Technology and Innovation (OTI), has contracted with CityBridge to install and operate a citywide wireless communications network; and,

WHEREAS; CityBridge installed its LinkNYC network as the initial deployment of the citywide wireless communications network intended to replace outdated public pay phones; and

WHEREAS; LinkNYC provided free wireless internet connectivity using towers placed on sidewalks throughout NYC, many of which include electronic display screens; and

WHEREAS; Community Board 8 and constituents of its district have reported adverse impacts resulting from existing LinkNYC infrastructure, including visual impacts, inappropriate usage, impacts on sidewalk clearances, and rat infestation; and

WHEREAS; CityBridge is now in the process of upgrading its LinkNYC network to Link5G to accommodate technological upgrades that have recently become commonplace in cellular communications; and

WHEREAS; Link5G infrastructure is a 32' tall tower that is installed on sidewalks in the public right-of-way; and

WHEREAS; Link5G towers in commercial districts include electronic screens similar to those found on LinkNYC kiosks that display advertising and public information; and

WHEREAS; the design of the Link5G towers has been approved by the Public Design Commission; and

WHEREAS; Link5G must adhere to siting requirements determined by NYC Department of City Planning, and must obtain Landmarks Preservation Commission approval if sited in historic districts; and

WHEREAS; CityBridge and OTI have proposed 18 sites across Community District 8;

WHEREAS; CityBridge and OTI have stated that the siting of proposed Link5G towers in Community District 8 are based on gaps in coverage and locations where excess demand for the network exists as determined by commercial cellular carriers; and

WHEREAS; 15 of the 18 sites proposed are in or near either the Upper East Side Historic District or the Carnegie Hill Historic District, where renowned architecture and iconic streetscapes would be interfered with if Link5G structures were installed; and

WHEREAS; locations proposed along Madison Avenue would be in conflict with strict guidelines for illuminated storefronts and signage, and would be in conflict with the Special Madison Avenue Preservation District's design standards that specifically prohibit illuminated advertising; and

WHEREAS; residents of Community District 8 have strongly objected to the design and the visual impacts that Link5G towers would have on streetscapes, both with and without screens; and

WHEREAS; there are widespread concerns that 5G towers will be constructed at distances considered too close to adjacent buildings, as has already occurred in front of 520 East 90th Street, and

WHEREAS; 10' of distance from a tower to a residence that is permitted is extremely insufficient and should be revisited as a policy; and

WHEREAS; Neither CityBridge nor the cellular network providers that Link5G service is intended to supplement have provided any evidence that dropped calls and limited capacity are present at the proposed Link5G locations;

WHEREAS; the proposed sites for Link5G don't include any locations in areas known to be potential digital deserts within Community District 8; and

WHEREAS; OTI and CityBridge have not provided detailed plans regarding the full build-out of Link5G, both within Community District 8 and in areas north of 96th Street and in the outer Boroughs; and

WHEREAS; there is a desire for any telecommunications infrastructure to be buried underground both for reliability purposes and to minimize visual impacts; and

WHEREAS; there have been questions raised by some residents as to whether sufficient research has been performed to fully assuage concerns that the radiation emitted by 5G infrastructure won't have any long-term impacts on public health or the environment, including young children, seniors, people with medical implant devices, pets, plants, and parks;

WHEREAS; the community-at-large has expressed their views that Link5G is unnecessary and unwanted in Community District 8 at present and until many of the issues identified have been resolved;

WHEREAS; New York City is in control of this process through its contract with the provider;

THEREFORE BE IT RESOLVED, that Community Board 8 Manhattan disapproves the proposal as presented to install Link 5G towers in Community District 8; and

BE IT FURTHER RESOLVED, that a moratorium be placed on construction and planning of Link5G poles and devices in Community District 8 Manhattan.

Please advise us of any action taken on this matter.

Sincerely,

Russell Squire

Russell Squire
Chair

Craig Lader and Charles Warren

Craig Lader and Charles Warren
Co-Chairs, Transportation Committee

cc: Honorable Eric Adams, Mayor of the City of New York
Honorable Carolyn Maloney, 12th Congressional District Representative
Honorable Mark Levine, Manhattan Borough President
Honorable Liz Krueger, NYS Senator, 28th Senatorial District
Honorable José M. Serrano, NYS Senator, 29th Senatorial District
Honorable Edward Gibbs, NYS Assembly Member, 68th Assembly District
Honorable Dan Quart, NYS Assembly Member, 73rd Assembly District
Honorable Rebecca Seawright, NYS Assembly Member 76th Assembly District
Honorable Keith Powers, NYC Council Member, 4th Council District
Honorable Julie Menin, NYC Council Member, 5th Council District

ADDENDUM E

“Take action to remove 5G Antenna from 520 E 90th St. “



“Photo taken from living room, APT 3D facing North from E90th ST. The cylinder is less than 10ft from the building…”

(Citing no “information about the use, range or strength of the signal to make our own health related conclusions,” “quality of life” issue, “invasive to our living space,” and reduction of property value.)

See @Gracie5GRemoval for full text.

ADDENDUM F

Letter from Dr. Kent Chamberlin
to
Community Board 9 Manhattan, January 6, 2023

[on next page]

University of New Hampshire

College of Engineering and Physical Sciences
Department of Electrical and Computer Engineering

Kingsbury Hall
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January 6, 2023

Manhattan Community Board No. 9
Hon. Barry Weinberg, Chair
Eutha Prince, District Manager
3291/3295 Broadway
New York, New York 10027

Dear Community Board Members:

I am writing you as a former member of the New Hampshire State Commission that was tasked with exploring the Environmental and Health Effects of Evolving Wireless and 5G Technology. This Commission was formed through bipartisan legislation and was supported by the governor. The Commission was comprised of unbiased experts in fields relating to health and radiation and were highly qualified to evaluate the issue in a fair and in-depth manner. The Commission submitted its final report in November 2020, with a key finding being that exposure to wireless communication radiation is harmful to the health of humans and the environment. Those findings apply to all forms of wireless radiation, which include all generations of cellphone radiation.

My purpose in writing is to alert you to the dangers of siting a cell tower near to where people, particularly young people, live, work or recreate. I provide relevant details about the New Hampshire Commission's findings on this issue in a presentation I gave to the Lenox, MA Board of Health. Please know that the International Association of Fire Fighters (IAFF) in 2004 adopted a position statement still in effect today forbidding wireless communication facilities on or near fire stations as firefighters were being injured by the radiation. Many of the firefighters exposed to the wireless radiation could not remember where they were going during emergencies, nor how to administer CPR. As Dr. Gunnar Heuser indicates at the EMF Medical Conference, functional MRIs showed damage to the gray matter of their brains from the radiofrequency radiation exposure.

Scientists, physicians, environmental and public health physicians, epidemiologists, pediatricians along with engineers such as myself have been calling for state and local governments to be proactive in protecting your citizens against radiation exposure. I realize that providing such protection may seem challenging. However, initiatives such as the New Hampshire Commission and the successful lawsuit brought about by the Environmental Health Trust and others are exposing the dubious claims by the FCC that wireless radiation is harmless. Given the mounting evidence regarding the clear harm of radiation, it is only a matter of time before meaningful protective regulations are put in place.

While telecom companies currently have the upper hand in that they seem to be able to force communities to accept whatever tower sites they mandate, there are actions that those

communities can take to delay or stop installations where people will be excessively exposed. For example, citizens in York, Maine have delayed the installation of antennas positioned close to a neighborhood. The Board of Health in Pittsfield, Massachusetts issued a cease-and-desist order against Version regarding a cell tower that was causing illness in a surrounding neighborhood. There are many other examples where citizens and administrators have worked together to protect people against cell tower radiation. Those examples can be used to strengthen your ordinances to help protect against inappropriate cell tower siting.

I am currently working with my state legislators to pass legislation that would provide protections against excessive radiation exposure. The original legislation called for a 1,640-foot setback for all new cell towers; this setback is one of the recommendations made by the New Hampshire Commission, and the rationale for picking that distance is explained here. The legislation is currently being revised so that it can be acted on in the next legislative session.

Wireless radiation dangers are real, and they can be significant in their impact on human health and the environment. I encourage you to do whatever is within your power to protect your constituents against it.

Sincerely,



Kent Chamberlin, PhD
Professor & Chair Emeritus
Fulbright Distinguished Chair

Odette J. Wilkens
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Written Testimony of
Odette Wilkens, President & General Counsel
Wired Broadband, Inc.
owilkens@wiredbroadband.org

Hearing of New York City Council Committee on Technology
June 7, 2023

This is in connection with the questions posed to OTI at Manhattan Community Board 7.

On May 30, 2023, the Landmarks Committee of Manhattan Community Board 7 (MCB7), held a public hearing with Nick Colvin, CEO of CityBridge presenting. CityBridge requested that the hearing not be recorded, and where the public was asked to submit questions ahead of time so that OTI would sift through and determine which questions CityBridge would answer.[1] The public was not allowed to ask questions during the hearing. Indeed, none of the questions set forth below were posed to or answered by CityBridge. Below is the text of what was posed to MCB7 for CityBridge.

QUESTIONS FOR OTI AT MCB7 MEETING ON MAY 30, 2023

Preface: In OTI's September 12, 2022 presentation to the PDC (slide 34), OTI promised to work with the PDC to "discuss optimal community outreach." PDC issued its approval for a pilot of 200 towers in residential and historic districts in Certificate 28229 conditioned on the LinkNYC "team" to "provide details on the community reception of the poles, including the design and provisioning of service." The PDC Certificate did not limit community input to siting or to any subsequent review otherwise required

[1] CityBridge CEO Nick Colvin's presentation to the Landmarks Committee of Manhattan Community Board 7 on 5-30-23, where the author and a constituent were present. There is no recording of the 5-30-23 meeting because, as the district manager stated to the constituent and as the constituent reported, CityBridge did not want the meeting recorded, and "we committed to CityBridge to not record and archive for the public."

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by federal law. By so limiting the questions that MCB7 may ask is contrary to the PDC directive in Certificate 28229.[2]

NEPA AND NHPA REVIEW

1. Is OTI viewing CityBridge's violations of NEPA and NHPA as a breach or material breach under the franchise agreement?
    a. See, e.g., Sections 15.6.1 (iii), (iv), (vi) and (vii)(a), 15.6.4 and 15.21.1 at https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf
    b. Has a notice of breach or default been issued to CityBridge?
2. Who's conducting the FCC environmental reviews that CityBridge was instructed by the FCC to conduct?
3. What is the extent of the NEPA checklist review—just NHPA and RF or the entire checklist? Which exclusions apply?
4. Is City Bridge submitting documentation of the NEPA review and compliance to OTI? To the FCC? On already built towers as well as unconstructed towers?
5. Will the documentation be made publicly available and if so, how and at what point in the process?
6. Will RF studies be made available to the public, and if so, when?
    a. How can we review the
        i. FCC NEPA and NHPA compliance reports on towers to be built
        ii. RF reports
        iii. Post-construction NEPA reviews
7. During the review or since the April 20, 2023 letter:
    a. Has all construction halted? Have any antennas been installed?
        i. On May 5, 2023, antennas were observed being installed at 2nd Ave & 1st St
    b. Are there any antennas operational in MCB7 district?
    c. Have antennas that were operational been turned off?
        i. Were antennas operational at the time of receipt of the April 20, 2023 letter?
        ii. Were antennas made operational after receipt of the April 20, 2023 letter?
8. Which, if any, Link5G towers, has SHPO and Tribes declined to conduct post-construction 106 review on?

[2] https://www.nyc.gov/assets/designcommission/downloads/pdf/09122022-pres-OTI-pf-Link5G.pdf; PDC Meeting 9-12-22 Minutes (see Certificate 28229), https://www.nyc.gov/assets/designcommission/downloads/pdf/minutes-9-12-22-rev-2.pdf.

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a. Will we be able to see a list of what has been declined?
b. How can we see the complete 106 review on those towers to ensure collocations on those towers have completed 106 review?

CASE LAW IN NY

9. *Extenet v. Flower Hill* decision (2022)

a. Federal case law in NY (underscoring 2nd Circuit ruling): for federal pre-emption to apply, telecoms must show a gap in phone service and they are using the least intrusive means to fill that gap.

b. There are no records of gaps, as confirmed by OTI and CityBridge at a community board meeting.

c. Why then is OTI telling community boards that 5G is federally required?

NHPA REVIEW AND CONTRACTUAL OBLIGATIONS

1. Has OTI requested CityBridge to halt all construction and installation activity in Federally registered Historic Districts or near Federal Landmarks in order to comply with FCC's April 20, 2023, letter requiring Section 106 reviews for all existing and proposed Link5G structures?
   - If not, why not?
   - Has OTI requested CityBridge to provide an update on anticipated impact(s) to ongoing construction schedules resulting from FCC requirements for Section 106 reviews?
   - If CityBridge has provided an update, when will you share details with regard to the forecasted impact?
   - If CityBridge has not provided an update, when do expect to receive that update?

2. As of today, at least 16 Community Boards have voted for a moratorium or disapproval on new construction in their districts.
   - Has CityBridge provided any estimates on the impact of these moratoriums on construction and installation schedules?

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3. Given that OTI has asserted wireless revenue is essential to viability of the new financial model for LinkNYC (Link5G), has CityBridge signed contract(s) with any wireless provider(s) to install equipment in multiple Link5G structures in MCB7 or in New York City as a whole? [3]
   - If so, which wireless providers have signed contracts with Citybridge for Link5G?
   - Where can the public find information about which providers are operating at specific Link5G structure sites?
   - If no multi-site wireless carrier contracts have been signed, has Citybridge estimated when contracts will be signed?

4. During the September 19, 2022 "LinkNYC Phase 1 Deployment Proposal" PowerPoint presentation to the Planning Design Commission (PDC) Brett Sikoff from OTI stated it was necessary to immediately offer up to 200 new wireless structure sites in residential and historic neighborhoods in order to secure wireless contracts.[4] Mr. Sikoff went on to elaborate that "57 sites in Residence Zoning and Historic Districts have been selected by a major carrier to deploy cellular equipment today. Discussions are underway with carriers regarding an additional 143 sites over the next 6 months." (emphasis added.)

   As a result of that presentation, the PDC gave unanimous approval to 200 Link5G pole installations under Certificate 28229, with several conditions. That was nine months ago!

   - Has CityBridge provided your department (or PDC) with any further specifics on firm commitments received regarding the 200 so-called "Phase 1" sites that were purportedly being selected or considered by "major" wireless carrier(s)?
   - Which if any of these committed sites been submitted to the Landmarks Preservation Commission?

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[3] The October 18, 2021, Link5G Design Proposal PowerPoint presented jointly by the Department of Information, Technology and Telecommunications, CityBridge and Zenfi Networks states: (on slide 5) "*In 2021, the City amended the franchise (agreement and introduced a mixed financial model: advertising* ***and 5G cellular services revenue****. The mixed model came with realistic financial requirements so that the program would survive."* Further, on same slide: "*The original LinkNYC program, built primarily in Manhattan, relied solely on advertising revenue. That financial model failed. The program did not grow throughout the outer boroughs, and by 2019, LinkNYC faced bankruptcy.*" https://www.nyc.gov/assets/designcommission/downloads/pdf/10-18-2021-pres-DoITT-p-Link-5G.pdf

[4] Purportedly this was result of: " *The "chicken or egg" conundrum is that carriers are hesitant to commit to individual sites in NYC unless and until they have confidence that there will be a sufficient number of Link5Gs deployed throughout an area (including in Residence Zones and Historic Districts) to reach the density required to meet their coverage and capacity needs. Making available up to 200 sites will increase carrier confidence in making capital commitments*". https://www.nyc.gov/assets/designcommission/downloads/pdf/09122022-pres-OTI-pf-Link5G.pdf

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- If no site commitments have been received from wireless carriers, has OTI requested CityBridge to provide any further updates on what is delaying "Phase " commitments?

5. In Amendment No. 3 as ratified by the FCRC on June 9, 2021, CityBridge promised to "construct, install and activate" 100 new Link5G communications "structures" by the end of "Build Year Six" (2021) and an additional 260 structures by the end of "Build Year Seven" (2022). [5]
    - As of today, nearly two years after the ratification of Amendment No. 3, does OTI consider CityBridge to be current or on schedule with construction projections?
    - Does OTI consider CityBridge to be compliant with promises contained in Part I. of Amendment No. 3 for actual installation of so called "CD Structures" in designated Community Districts? ("…in Manhattan above 96th Street, or in the Bronx, Brooklyn, Queens or Staten Island.)
    - If yes, exactly how many "CD Structures" in "Equity Districts" have been constructed and installed by CityBridge under Amendment No. 3?
    - Where specifically are those "CD Structures"?
    - If CityBridge is not current on those construction schedule commitments, what action has OTI taken to assure that construction schedules for CD Structures will be met by CityBridge?

6. The "Phase 1" Deployment Proposal also contained maps that displayed 57 "major carrier selected sites" and provided more details and photos for a subset of 12 "representative sites" in four boroughs (none were shown in Staten Island.) But these were only symbols on maps and most sites lacked any specific details. On slide 14, the Deployment Proposal further elaborated:

    "There is not sufficient information today to forecast precisely where the carriers will ultimately commit to deploy their 5G equipment, and site vetting takes several months... As (future site selections become) available, notice will be provided to the Commission."

    - If site selections have been made, where can the public find information about all of the specific "Phase 1" site selection(s), if any?
    - CityBridge has already constructed over 100 wireless structures. Many of these are now "Live." Why were those 100+ sites constructed and installed first – apparently even before "Phase 1"?

[5] See specifically Page 4 Item 7. New Section 1.2.3 of Attachment SRV
https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement-amendment-3.pdf

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7. Again, referring to October 2021 Design Proposal, which includes assertion (on slide 17) that "19.5 feet the minimum transmitter height permitted while complying with FCC safety regulations."
    - Can you point us to the specific citation in FCC "safety regulations" that require a 19.5 feet minimum transmitter height?
    - Can you also explain why if 19.5' is minimum (vertical) height above ground to meet FCC safety requirements, then how will the same wireless transmitters be allowed just several feet horizontal separation distance from nearest walls or windows and potentially even closer to fire escapes or balconies?

8. Does OTI consider CityBridge as franchisee current with scheduled Minimum Annual Guarantee payments for Contract Years 6 and 7 (as specified in Item 2 - Section 6.3.1) and for the annual installments for the "Remainder of Forborne Payments" for Contract Year 7 (as per item 3 - New Section 6.3.2) that were promised under Amendment No. 3?
    - What payments and amounts have been remitted by CityBridge?
    - When are the next payments due and in what amounts?

9. Has CityBridge provided the City with documentation (as required Part IX. - new Section 7.4 under Amendment No. 3) evidencing it is current with Minimum Cumulative Equity Contributions Commitments as promised within 30 days of effective date and by end of Build Year 6 – for a total of $75 million?
    - Has CityBridge confirmed that it will remain current and provide documentation demonstrating $100 million Minimum Cumulative Commitment by end of Build Year 7?

10. As condition of PDC Certificate 28229 approved in September 2022, CityBridge was to "submit local and global examples of multi-tenant 5G pole structures sited on sidewalks in comparable dense urban neighborhoods with the goal of suggesting alternatives for a pole design in Residence Zoning and Historic Districts" to the PDC.
    - In the intervening nine months, what "local and global" examples has CityBridge submitted to PDC?
    - In the September 12, 2022 presentation to PDC by Mr. Sikoff stated that LinkNYC would work with "PDC to ensure that New York City receives the best design possible for residential deployment." What progress has been made in a new alternate design for Residential and Historic districts?

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11. In the conclusion (slide 34) of the September 12, 2022 presentation to the PDC, OTI promised to work with the Commission to "discuss optimal community outreach." And, an additional condition of Certificate 28229 was to for the LinkNYC "team" to "provide details on the community reception of the poles, including the design and provisioning of service."
    - In the intervening 9 months, what specific steps is OTI and CityBridge taken to "achieve optimal community outreach?"
    - What details about "community reception" have been submitted to the PDC?
    - If no details regarding community reception have been provided to the PDC, why not? And, when will these details be provided?

RF LEVELS

1. What is the expected RF radiation level from the antennas that will be in homes in the main beam of the antennas?
    a. If OTI does not have this information, then how is OTI justifying putting these antennas/towers up?
2. Where is the safety data. on long term exposure to children showing no risk?
3. What federal agency with health and safety expertise) is in charge of ensuring cell tower and 5G radiation is safe? Where are the research reports by these agencies?

Respectfully Submitted,

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The New York City Council
Legislation Details

City Hall
New York, NY 10007

File #:	T2023-3577	**Name:**	Oversight - LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.
Type:	Oversight	**Status:**	Committee
		In control:	Committee on Technology
On agenda:	6/7/2023		

RE: Testimony (written) in front of the New York City Council

The IRRREGULATORS Demand an Immediate Investigation of Verizon's Participation in One of the Largest Accounting Scandals in American History.

We Don't Need the LinkNYC Wireless Kludge; We Need to Solve the Digital Divide--- and Not another Wireless Bait and Switch.

Presented by:

Bruce Kushnick
Managing Director
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IRREGULATORS:
Who We Are
Our Work in New York

June 7th, 2023

What we are Submitting:

- Part 1: We supply the Verizon NY 2022 Annual Report, published May 26, 2023

In this document:

- Part 2 We discuss how LinkNYC has been a disaster on so many levels that it is hard to count them all.
- Part 3 Supplies a basic Timeline of the major attempts by former Mayor Bloomberg and de Blasio to have wireless and Wifi helped to solve the Digital Divide, and they all mostly tanked or did not do the job.
- Part 4: The Fiber Optic Future We Never Got.
- Part 5: Supplies our letter to former Mayor de Blasio discussing that Verizon NY had not fulfilled its obligations to properly upgrade NYC to FiOS.
- Part 6: Supplies our Letter to former Mayor de Blasio: New York City Must Call for a Halt to the Billion + Dollars of Cross-Subsidies and Overcharging by Verizon NY, the Public Telco Utility
- Part 7: Four Snapshots -- America's prices are out of control compared to overseas;. a short summary of the Verizon NY 2022 Anneal Report.

    - Verizon's Wireless Overcharging per GB, vs Overseas Prices.
    - America's 'Triple Play' Prices== Overcharged up to $175.00 Per Month or More — Over $2,000.00 Per Year
    - Verizon NY 2022 Annual Report; Massive, Corrupt, Financial Accounting Scheme.
    - Where did the Verizon NY construction money, charged to local phone customers, go?

Let Us Start:

"Solving the Digital Divide" has been the well meaning battle-cry of municipalities and politicians since the 1990s, and at every turn, more recently, from Mayor Bloomberg or de Blasio, or Adams, wireless is always hyped up as the substitute for a fiber optic future-- regardless of whether there were commitments to upgrade the city or state by replacing the existing copper wires with a fiber optic one--which can supply a great deal more capacity. But, wireless or Wifi is also a kludge, not only because wireless requires a fiber optic wire to work, but because wireless has lots of issues, from the fact that 5G can't handle large distances from the antennas, or worse, it also requires a 'line of sight' -- i.e., the signal can have problems; even from shrubs or when there is another building in-between.

In Part 2 we discuss how LinkNYC has been a disaster on so many levels that it is hard to count them all. First, the original plan was to replace the existing payphones with these monolith kiosks, but there was only a partial deployment -- about 25-30%. This left 60-80% of the payphones not replaced and millions of callers were left without basic public phone service. Next, when done, there will only be Swiss-cheese coverage, because the range of Wifi is so limited using 5G. The maps provided clearly show that 70-80% of the supposed coverage areas with the upgraded WiFi will still not he able to get the service.

But the real subplot is worse. The story told is only the Wifi-public face, and it leaves out that these cantennas were designed to have wireless carriers rent space for retail 5G and other services and moreover, this plan is being renewed with the claim that the City will lose advertising revenues and franchise fees--It is not solve the Digital Divide. And, on top of all of this, there has been a failure to pay over $70 million in fees to the City, and some penalties have been applied.

And how does the Verizon FiOS deployment requirements for NY City relate to the wireless cantennas? Verizon was supposed to have 100% coverage of NY City's residential locations -- and thus, there are no 'underserved' customers-- as everyone in the 5 boroughs should have been able to at least get a high speed service. And while they may not be able to afford this connection, then the real question should be -- why are prices so outrageously priced? This is especially a critical question because prices are supposed to be 'fair and reasonable', because the construction was being subsidized by rate increases on wired services, and most importantly, if there were fiber optic wires in these underserved areas, where are they? Why weren't they put into use? And why were New Yorkers charged for services that they never received?

But, it is much larger and important series of questions that must be asked, because the outcomes could help to upgrade all of New York State, and impact NY City-- Over the last decade, with our experts, we uncovered that the financial books have been manipulated and have made the entire public utility appear unprofitable-- when in fact, the investigations and actions could helped to generate billions in funds to upgrade the

entire state -- not through government subsidies but through halting cross-subsidies and other financial machinations that have been left to continue and overcharge New Yorkers, as well as America.

Part 3 Supplies a basic Timeline of the major attempts by former Mayor Bloomberg and de Blasio to have wireless and Wifi helped to solve the Digital Divide, and they all mostly tanked or did not do the job.

Truth is, wireless has been a bait and switch for the last 3 decades as we have documented over and over. In fact, as we point out, Verizon's current FiOS Broadband Internet Home Service is currently a ploy where the fixed wireless (FWA) service is being 'mushed' to blur the line of a fiber optic wired service and this inferior wireless service.

Part 4: The Fiber Optic Future We Never Got.

In Part 4 we lay out that Verizon failed over and over to deliver on fiber optic deployments that were to take place since the 1990's, including FiOS, the FTTP, Fiber to the Home service, in 2005, but it is important for the City to realize that there is both a NYC FiOS franchise, as well as issues and commitments made to the rest of NY State, -- impacting the prices of all services, from wireline to wireless, as well as the expenses and construction budgets, or the charging of customers for the construction.

New York Telephone, then NYNEX, Bell Atlantic and now Verizon New York had started in 1992 to claim that it was going to replace the existing copper wires with fiber optics and was able to get deregulation at every turn.

In 2005, Verizon claimed it would be deploying FiOS fiber optic broadband to the home and NY State granted massive rate increases on wired customers to fund this "massive deployment of fiber optics" -- i.e.; low income families, seniors, rural customers, and everyone else who had service, have all had a continuous series of rate increases, known as 'harvesting'.

By 2011, Verizon announced it was no longer going to continue to roll out FiOS, and it appears that it would illegally transfer the utility construction budgets to wireless.

Truth be told, (and documented) Verizon had no plans to upgrade the rural areas post the year 2011 -- or the low income areas, -- as this was told to the investor community, but not the public. This has meant that wired customers have been illegally charged for the build out of the wireless networks, for over a decade. and Verizon diverted the utility construction budgets to fund their wireless build out. -- because it made them more profits.

How did Verizon get away with this? Verizon's FiOS FTTP, fiber the premises, has put in based on using "Title II", Common Carrier network and therefore is part of the state telecommunications public utility. This directly contradicts Verizon's statements that 'Title II' harmed investments. As we show -- it was the investment mechanism to charge local phone customers thousands of dollars extra per line.

Thus, on one level, Verizon scammed the State, on another Verizon also was harming New York City.

Part 5: Supplies our letter to former Mayor de Blasio discussing the fact that Verizon NY had not fulfilled its obligations to properly upgrade NYC to FiOS.

The Massive Financial Accounting Scandal Must be Dealt with.

Part 6: Supplies our Letter to former Mayor de Blasio: New York City Must Call for a Halt to the Billion + Dollars of Cross-Subsidies and Overcharging by Verizon NY, the Public Telco Utility

All of these actions were done through the manipulation of the accounting rules where the entire state public utility is being dismantled -- and using these cooked formulas, has turned the state's critical infrastructure into a cash machine for the use of Verizon's other subsidiaries, including wireless.

We have attached the Verizon NY 2022 Annual Report, (spreadsheet) published on May 26th, 2023 by the NY Public Service Commission -- and it shows massive financial manipulations and cross-subsidies that has been going on for decades.

And with decades of analysis and documented -- We demand an immediate investigation by the NY City Council, the NY Attorney General's Office, and the NY State Public Service Commission of over a billion dollars in questionable and potentially illegal cross-subsidies in just Verizon NY, and just for the year 2022.

When halted, this could supply enough funds to build out a fiber optic network throughout the State-- as these monies were diverted to illegally fund the company's wireless mobile and now fixed wireless networks. And it would dramatically lower rates, as the subsidiaries that got a free ride will have to pay market prices.

And all of this is visible in this Verizon NY 2022 Annual Report, and it is also relevant to this City Council inquiry for multiple reasons.

There are many consequences dealing with the Digital Divide,

First, this has allowed Verizon to seriously inflate all prices in New York but it also impacts America, because the underlying parts of the networks, known as backhaul, (the

data lines that go to the cell sites or the banks, have excessive profits, and thus all wireline and wireless prices in the US are 5-20 times more expensive than overseas.

Worse, because Verizon never fully upgrades the networks to fiber and thus let the networks deteriorate, there was no competition to lower prices-- and because of this, the cable companies can add made up fees to inflate prices. On top of all this, there is a defacto agreement with the cable companies that gave them the wired-broadband and cable networks -- and not have direct competition, and Verizon kept wireless. In fact, Spectrum wireless service is reselling Verizon Wireless. -- Collusion and not competition, as Spectrum is bundling this with their other services, giving it monopoly advantages for wireline- high-speed broadband, and Verizon for wireless.

On top of all of this , there have been campaigns to rewrite history and 'common wisdom' -- which over time became the history.

And with **institutional amnesia**, we now find that no one understands what happened in their state with broadband, and Verizon (or the other state public utilities in the other states) is never even mentioned in the state broadband agencies' reports.

Verizon has been able to hide in plain sight and, like diabolical character in a Harry Potter movie, Voldemort, Verizon is 'the person you do not name'.

Part 7: Four Snapshots -- America's prices being out of control compared to overseas countries; we also include a a short summary of the Verizon NY 2022 Anneal Report.

- Verizon's Wireless Overcharging per GB, 7,400%-to-65,000% vs Overseas Prices.
- America's 'Triple Play' Prices Overcharged up to $175.00 Per Month or More — Over $2,000.00 Per Year
- Just Released for Public Review: The Verizon NY 2022 Annual Report Shows a Massive, Corrupt, Financial Accounting Scheme.
- Where Did the Verizon NY construction money, charged to local phone customers, go?

The IRREGULATORS is an independent, consortium of senior telecom experts, analysts, forensic auditors, and lawyers who are former senior staffers from the FCC, state advocate and Attorneys General Office experts and lawyers, as well as former telco consultants. Members of the group have been working together, in different configurations, since 1999.

New Networks Institute, Teletruth and the IRREGULATORS, 1999-2022
Reports, Complaints, Proposals, Filings and Testimony in NYC and NY State.

PART 2: Another NYC Wireless WiFi Bait and Switch, and then some.

Wikipedia summarized some basic facts and LinkNYC (and we paraphrase).

- The total cost for installation is estimated at more than $200 million.
- The Redlining and Digital Inequity in low-income neighborhoods was to be corrected by LinkNYC kiosks that were supposed to be installed across the city; however, the LinkNYC kiosks were largely concentrated in wealthy neighborhoods in Manhattan,
- This number of kiosks was supposed to reach 7500, and yet there were only 1,869 kiosks by May 2020.
- New York state comptroller Thomas DiNapoli released a report in 2021, finding that 86 of the City's 185 ZIP Codes had kiosks; Manhattan was the only borough that had LinkNYC kiosks in the vast majority of its ZIP Codes.
- The advertising has been estimated to bring in over $1 billion in revenue over twelve years, with the City of New York receiving over $500 million, or about half of that amount.
- However, in four of the first five years the Links have been active, actual revenue fell short of goals. This is partially due to the fact that some local small businesses and non-profits were given advertisement space for free.

We have put together a series of questionable items we documented.

Chart 1: Thousands of Payphones were not replaced, harming millions of people who relied on them for basics, like 911. The LinkNYC plan was supposed to be a substitute for working payphones that were being decommissioned**.**

Chart 2 and Chart 3: There is Swiss Cheese Coverage for free WiFi even after the Kiosks are put in. The plan gives a map of a section in Brooklyn with the initial current deployment, and then what would happen when completed. But, since the antenna range is only 450 feet, these charts show the majority of residential customers will never get service.

These Cantennas are a Con. -- Selling Advertising and Selling Cell Site Space on Streets for 4G and 5G

While these services are being claimed to be based on ‘solving the Digital Divide’, NYC has not been told that there are 2 other subplots -- selling advertising and allowing multiple wireless carriers offering retail 4G and 5G services -- and increasing the power multiple times.

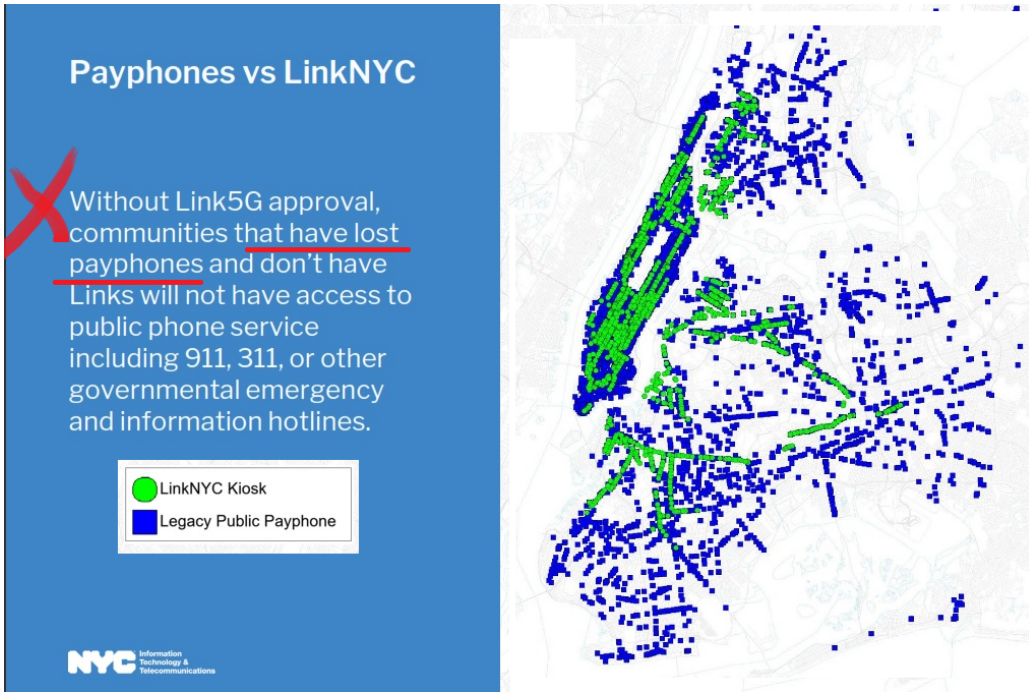
Chart 4: **Sell Advertising on Kiosks** This is really about selling advertising and NOT serving the low income families who are the underserved and the pitch is so that the City's franchise and ad revenues are not harmed.
Chart 5: Help Verizon et al sell retail cell service. The plan is to load up these wireless cantennas with wireless carriers' services'; the WiFi for low income families is just a ploy to push over a plan that will help the wireless companies, such as Verizon, avoid having to deal with their own pole attachments and siting issues.

Chart 6: A New Hubris: Low income families can't get "Mobile Broadband"? This is a kludge because it REQUIRES A FIBER OPTIC WIRE, EVERY 450 FEET; And even though the wires are going down a street, they will not be turning them on to offer fiber optic wireline connectivity service anytime soon.

PART 2:

Chart 1: The Payphone Clusterfork

This is a map of the payphones that were removed to make way for the LinkNYC, which never showed up.



In 2014, CityBridge signed a franchise agreement that said it would install 7,500 operational kiosks within a decade The Links replace the city's network of 9,000 to 13,000 payphones, a contract for which expired in October 2014.

In 2011, the last available data showed that there were 27,000,000 calls in NYC's payphones, and while some pay phones were not being used, others had heavy usage, but were not kept active.

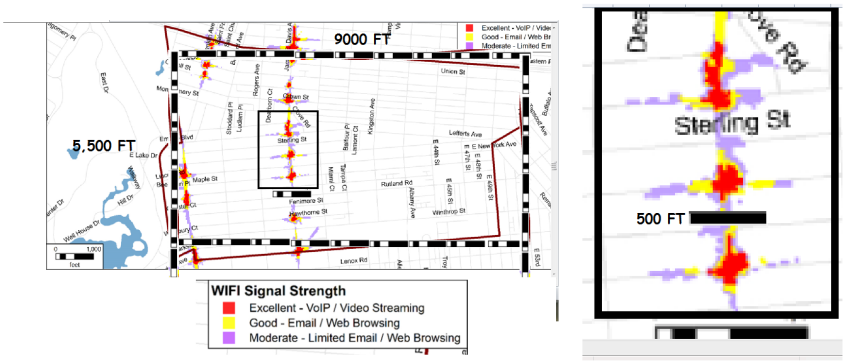
As of July 2017, there are 920 Links citywide; eventually, there will be 7,500 Links installed in the New York metropolitan area; the company has installed just 1,816 by July 2019,

Chart 2 and Chart 3: There is Swiss Cheese Coverage for free WiFi even after the Kiosks are put in.

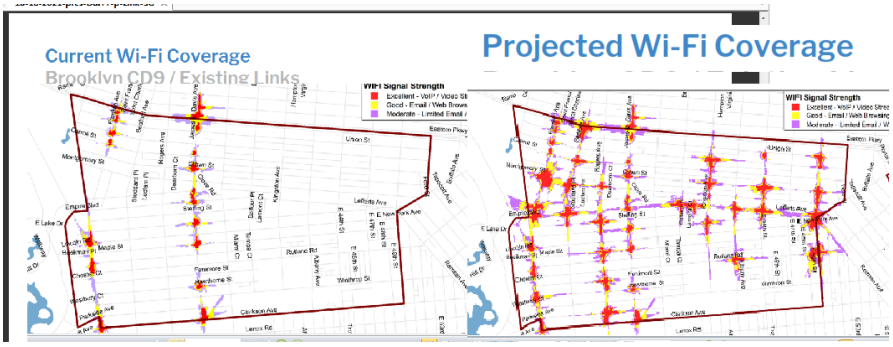
There is no Broadband WiFi Internet for ALL.

Even after this next round of build outs, because the wireless technology being used only covers a radius of about 450 feet, there will be gaping holes in the roll out.

This first picture is a snap-shot used by NYC to show the current trial deployment of these WiFi sites, and notice the detail on the right gives a blow up view.



And this shows the first trial area, on the left, and on the right we have the projected roll out. Notice that it is still a Swiss cheese roll out because the range of these cell sites doesn't even cover a few blocks -- 450 feet is about the length of 1 block.



And yet, LinkNYC claims it will leave 'underserved' communities with critical access to broadband connectivity. This from a company that only rolled out a fraction of their

required kiosks -- and the ones that did show up on the maps were in wealthy NYC neighborhoods.

- No further expansion of LinkNYC program beyond Manhattan and limited outer borough neighborhoods —leaving most unserved New Yorkers without critical access to broadband connectivity.
- Link5G will expand the free LinkNYC Wi-Fi network and bring mobile broadband and fiber infrastructure directly to underserved communities.

Chart 4: Selling Advertising and Selling Cell Site Space on Streets for 4G and 5G.

All of this 'hype' and puffery doesn't really address 2 underlying things.

This is really about selling advertising and NOT serving the low income families who are the underserved.

"**Without Link5G there will be...**

- A loss of street furniture advertising used by local small businesses and communities.
- No publicly accessible option for 911/311.
- A loss of revenue stream from a marquee franchise program.
- A loss of 25% advertising space for City to promote its initiatives and public service announcements.
- The Risk of Link kiosks going dark across the five boroughs.

And the other play here is NOT free Wifi, but having these massive antennas so that the company can sell to other competing cellphone companies to offer their 4G and 5G services -- And, worse, these cantennas will have multiple companies all active at once.

Chart 5: Help Verizon et al sell retail cell service.

This is the innards of these Cantenna devices. Notice that they have been designed, not for Wifi, but for space to put other wireless services to be sold as retail services.

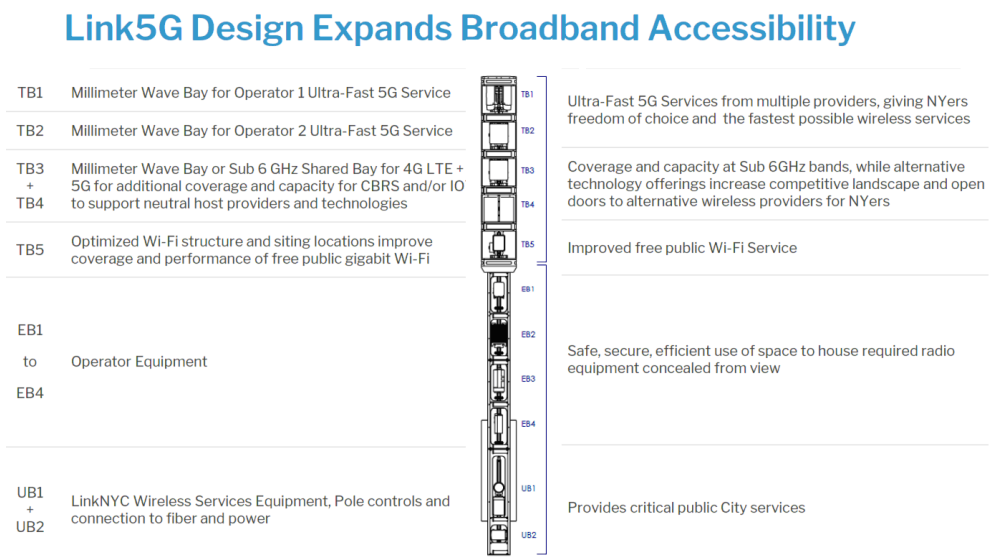
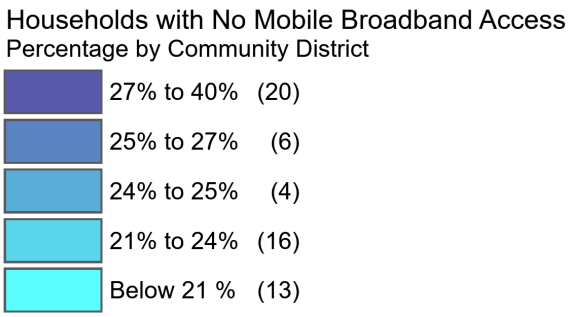


Chart 6: A New Hubris: Low Income Families Can't Get "Mobile Broadband"?

So desperate is the City that have created a new category of the Digital Divide, "Mobile broadband internet"

> "Link5G will expand the free LinkNYC Wi-Fi network and bring mobile broadband and fiber infrastructure directly to underserved communities."

Digital Divide: Mobile Broadband Desert



Not being able to get "Mobile Broadband Internet" is just like living in the desert and someone offers you more sand. The question has never been about this inferior broadband product -- it was always and should always be about not being able to get high-speed wired, fiber optic service, not some kludge.

This is a kludge because it REQUIRES A FIBER OPTIC WIRE, EVERY 450 FEET; And even though the wires are going down a street, they will not be turning them on to offer fiber optic wireline connectivity service anytime soon.

Which brings us to the next part - How Verizon hid the fact that it created the Digital Divide, continuously raised rates, and fooled everyone as no one knows that Verizon was supposed to upgrade ALL of New York City, thus hiding the fact that there are un-upgraded areas in NYC…

PART 3: The NYC Wifi & Fiber Optic Broadband Disaster Timeline

Partial Timeline of the Wifi Boondoggle and the Damaged Broadband Plans.

This is a short list of highlights to supply a timeline of WiFi deployments to solve the Digital Divide.

June 9, 2011, Huff Post

'Free Wi-Fi Service In NYC Parks Announced By Mayor Bloomberg, AT&T CEO Randall Stephenson

> "Mayor Michael Bloomberg and AT&T Chairman and CEO Randall Stephenson today announced a five-year initiative to provide free Wi-Fi service at 26 locations in 20 New York City parks across the five boroughs, AT&T will install and maintain the service this summer at no cost to taxpayers.
>
> "Assembly Member Rodriguez said, "AT&T's launching of free of charge internet service to Jefferson Park is a remarkable step in bridging the digital divide in low-income communities.…Council Member Cabrera agreed, adding, "Internet access is a critical developmental tool for children, families, and community groups—all of whom use our city parks on a regular basis. I'm excited to see AT&T investing in an effort to bring the Internet to many who need it, and I look forward to a day of expanded Wi-Fi coverage for park goers in our City."
>
> "The initiative comes as part of Road Map for the Digital City, the City's strategy to make New York the nation's leading digital city.

December 10, 2013

Mayor Bloomberg Announces Country's Largest Continuous Free Public WiFi Network WiFi Network Covering 95 City Blocks in Harlem Providing nearly 80,000 Residents with Connectivity On-the-Go

> "Mayor Michael R. Bloomberg today announced the launch of a new outdoor public WiFi network in Harlem accessible to all users at no cost. The Harlem WiFi network will extend 95 city blocks, from 110th to 138th Streets between Frederick Douglass Boulevard and Madison Avenue

> making it the largest continuous free outdoor public wireless network in the nation."

Wikipedia

> "Phase 1, from 110th to 120th Streets, finished in 2013; Phase 2, from 121st to 126th Street, was expected to be complete in February 2014; and Phase 3, the remaining area, was supposed to be finished by May 2014. The network was estimated to serve 80,000 Harlemites, including 13,000 in public housing projects who may have otherwise not had broadband internet access at home. At the time, it was dubbed the United States' most expansive "continuous free public Wi-Fi network."

November 17, 2014, Wikipedia

"The office of New York City Mayor Bill de Blasio announced the plan on November 17, 2014, and the installation of the first kiosks, or "Links," started in late 2015. The Links replace the city's network of 9,000 to 13,000 payphones, a contract for which expired in October 2014.

"As of July 2017, there are 920 Links citywide; eventually, there will be 7,500 Links installed in the New York metropolitan area,"

September 15, 2016

LinkNYC Turns Off Internet on Wi-Fi Kiosks After 'Inappropriate' Use

August 14, 2016

Are LinkNYC Wi-Fi Kiosks Bridging The Digital Divide As Promised?

> "The five kiosks in my area [67th and Broadway] are in front of higher-end buildings," one woman wrote to WSR. "There are none in front of [NYCHA's Amsterdam Houses] just a few blocks away. Seems like something is off about this."
>
> "The big goal is addressing digital inequality," said project visionary Daniel Doctoroff, CEO of Sidewalk Labs, in an interview, estimating that three million New Yorkers do not have access to broadband. "Without fast access to the Internet, you cannot have equal opportunity."

January 2020, NextCity.org

The de Blasio Master Universal Broadband Plan

> "In January 2020, under former Mayor Bill de Blasio, the city released an ambitious $2.1 billion plan for universal broadband across the city — the first effort of any large U.S. city to strategize delivery of equitable internet access to all its residents. The proposal was to build "neutral host" infrastructure that could be shared by multiple internet operators rather than a single company, increasing competition to the entrenched private companies that had failed to address New York's digital divide. In forging this infrastructure, the city would provide opportunities for community-based providers to use city-owned property for expanded, affordable service."

March, 3 2020

City Hall May Pull Plug on LinkNYC Owner Over Missing Kiosks — and $75M Owed

> "Promises Not Kept
>
> "In 2014, CityBridge signed a franchise agreement that said it would install 7,500 operational kiosks within a decade….But the company has installed just 1,816 of the 2,353 kiosks that were supposed to be up and running by July 2019, according to the city's Preliminary Mayor's Management Report.
>
> "DoITT Commissioner Jessica Tisch testifies at City Council on March 3, 2020. "New Yorkers who would benefit most from this service are not getting it … because CityBridge is delinquent," she said.
> "
>
> "In 2016, LinkNYC's then-general manager, Jen Hensley, told the Committee on Technology that restrictions imposed by Verizon, which controls access to the underground conduit of fiber optic cables the kiosks connect to, impeded kiosk installations in parts of the city."

February 8th, 2021, Bloomberg

Struggling New Yorkers Tasted Free Wi-Fi — Until the Bills Came

Some families were unaware service was just a short-term promo NYC officials pleaded unsuccessfully with providers for more

> "New York City broadband providers won praise last year for giving students free internet service after the pandemic hit and schools went remote. Then came the bills.

The "free internet" deals were mostly limited-time promotions that brought new subscribers to companies like Optimum parent Altice USA Inc. and Spectrum parent Charter Communications Inc."

October 28, 2021

New York City to Close Digital Divide for 1.6 Million Residents, Advance Racial Equity

"Mayor de Blasio announces landmark advancements in digital equity across New York City, building critical broadband infrastructure for up to 1.6 million New Yorkers, while partnering on immediate-term affordable internet connectivity for more than 250,000 residents

"Mayor Bill de Blasio today announced the largest step of any city in American history toward providing affordable broadband for all. Through its Internet Master Plan, New York City will be the first city in the nation to reverse the digital redlining that has left communities of color disconnected, ensure that M/WBEs share in the economic growth of the broadband industry, and incentivize at scale high-quality affordable internet service options for New Yorkers.

"Broadband isn't a luxury, it's a necessity," said Mayor Bill de Blasio. "We are closing the digital divide and bringing our city into the 21st century by reaching communities most in need."

Nov 8, 2022, Next City

What Happened To New York City's Internet Master Plan?

"As the first effort by a large U.S. city to strategize equitable internet access is tabled, the community-based providers that New York City had tapped to build infrastructure have been left high and dry.

"Mayor Adams announced Big Apple Connect, a partnership with Altice and Charter to bring affordable service to the 300,000 New Yorkers living in public housing."

"While Next City's reporting underscores that the new administration did not consult with the original Internet Master Plan team, it also points to a larger issue. The community-based providers that the city had tapped to help build "neutral host" infrastructure have been left high and dry — in favor of

a partnership with two major companies the master plan would have challenged."

Part 4: Some Basic Facts About Verizon New York's FiOS FTTP failure to properly upgrade NY State, or New York City, the accounting manipulations and the wireless bait and switch.

1) The fiber build outs were part of the state telecommunications public utility and supposed to be used for Title II common carrier services.

When discussions occur pertaining to the FiOS fiber to the premises, "FTTP", service, no one ever claims that the wires are part of the existing state utility for the provision of Title II common carrier services. Here's the actual language from a Verizon NY FiOS franchise from 2005.

Verizon New York FiOS Franchise, 2005

On June 15, 2005, the New York Public Service Commission ("NY PSC") "declared that Verizon NY's FTTP upgrade is authorized under its existing state telephone rights because the upgrade furthers the deployment of telecommunications and broadband services, and is consistent with state and federal law and in the public interest." The NY PSC determined that, unlike a company seeking to build an unfranchised cable television system, Verizon NY already has the necessary authority to use the rights-of-way to provide telecommunications service over its existing network. *See* Declaratory Ruling on Verizon Communication, Inc.'s Built-Out of its Fiber to the Premises Network, NY Public Service Commission, Case 05-M-0520/05-M-0247, June 15, 2005 at 4.

As more fully described in Exhibit 1, Verizon NY maintains that it is constructing its FTTP network pursuant to its authority as a common carrier under Title II of the Communications Act of 1934, as amended, and Section 27 of the New York Transportation Corporations Law. For this reason and others, certain terms and conditions may differ between the incumbent cable provider's franchise and Verizon NY's franchise.

But, this is just one state. Click for a collection of quotes detailing that Title II was used as the investment mechanism to build out the FTTP fiber optic networks that was supposed to be used for FiOS — in MA, NY, NJ, PA, MD, DC, and other states. This excerpt below is part of the Verizon DC FiOS franchise.

The proposed cable service will be provided over VZ DC's FTTP network, an extension and enhancement of the existing telecommunications network. A general description of the construction of the FTTP network is provided in Attachment 4.

VZ DC will install its FTTP network as a common carrier pursuant to Title II of the Communications Act of 1934, as amended, in accordance with its authority under DC and Federal law. Accordingly, VZ DC is not seeking authority through this Application to construct the FTTP network, but rather is seeking a franchise to use the FTTP network, once installed, to provide cable services in the District.

2) Verizon et al. claimed Title II harmed investment and that broadband is "Title I", which directly contradicts what they told the states.

We need to be very clear here. Verizon told its investors and the FCC and anyone else who listened that broadband was an "information" service, "Title I", and that Title II harmed investment; They did not tell the truth.

This second excerpt is from Verizon's Open Internet Comments, July 15, 2014

> "Imposing a Title II common carriage regime on broadband providers would be a radical change in course that would only chill, not spur innovation. Title II is a regulatory dinosaur, crafted eighty years ago — and based on 19th-Century laws regulating railroads — to address the one-wire world of rotary telephones."

We filed multiple complaints and comments about this Janus-faced story telling. From these documents, filings and press statements we see that Verizon's claims that Title II harms investment is patently not true. (Click to read comments filed in the Net Neutrality proceedings.)

Why did Verizon do this? By classifying the fiber optic wires as "Title II", they could have the budget for FiOS be subsidized by the local phone customers and rate increases. If it was classified as Title I, then it would be an "information" service and it is not legal to put the expenses into the 'telecommunications' state utility.

3) Telcos continually increased the rates charged to local phone customers on the false promise of a massive deployment of fiber optic infrastructure.

Verizon's entire series of rate increases were based on 'losses' and the "massive deployment of fiber optics". Unfortunately, as we uncovered, the losses were artificial, and the massive deployment was charged to local phone customers. But here's the rub;

by 2011, the construction budgets were diverted to wireless. This is from the NY State Public Service Commission pertaining to rate increases on basic local phone service.

> This price increase will generate needed additional short-term revenues for Verizon, as the company faces the dual financial pressures created by competitive access line losses and the costs of building out an advanced voice/video/data network in the State. As the Commission has noted, Verizon's financial condition is "relevant" when the Commission considers pricing changes because "the state has an interest in a viable company. This is especially important given the magnitude of the company's capital investment program, including its massive deployment of fiber." "There seems to be little question that the company is in need of financial relief; Verizon [New York] reported an overall intrastate return of a negative 4.89% in 2006 and its reported intrastate return on common equity was a negative 73.6%."[3] For 2007, Verizon reported an overall intrastate return of negative 6.24% and an intrastate return on common equity of negative 46.0%.
>
> Moreover, this price change will encourage the migration of customers towards higher-value service bundles, consistent with the trend toward bundled service offerings in the market as a whole.

4) Telcos unlawfully diverted the construction budgets for Local Service from fiber to the home to wireless buildouts post 2011.

In 2012, Fran Shammo, former Verizon CFO told investors that the wireless company's construction expenses have been charged to the wireline business.

> "The fact of the matter is Wireline capital — and I won't get the number but it's pretty substantial — is being spent on the Wireline side of the house to support the Wireless growth. So the IP backbone, the data transmission, fiber to the cell, that is all on the Wireline books but it's all being built for the Wireless Company."

In 2012, the NY Attorney General confirmed that wireless and FiOS cable were funded via the state 'intrastate' telephone utility construction budgets. In 2011, Verizon NY stated that the company spent over $1 billion on the utility capital investment. The NY Attorney General claimed that 75% of this construction budget did not go to upgrade and maintain the telephone utility but for the company's other lines of business, including wireless and for FiOS, which is a 'cable TV service', as stated in the franchises granted in NY.

> "Verizon NY's claim of making over a 'billion dollars' in 2011 capital investments to its landline network is misleading. In fact, roughly three-quarters of the money was invested in providing transport facilities to serve wireless cell sites and its FiOS offering. Wireless carriers, including Verizon's affiliate Verizon Wireless, directly compete with landline telephone service and the company's FiOS is primarily a video and Internet broadband offering."

5) Telcos manipulated the accounting rules in every state over the last two decades in order to charge the majority of all construction to local service.

This is the "money" chart. The opening chart is based on this excerpt of the Verizon NY 2020 Annual Report dealing with network and construction expenses, including the underlying financials. We will get back to it in a moment. (Note: The Verizon NY 2021 Annual Report is due out on May 26th, 2022.)

	Verizon NY Wired Telecommunications Public Utility Networks, 2020				
Line	Item	Total	Nonregulated	Local Service	Special Access
No.	(a)	(b)	FiOS, VOIP	Copper wires	Backhaul
1	Telephone Network in Service	$32,218,641,592	$1,073,995,451	$19,880,745,992	$11,263,900,149
2	Telephone Network under Construction	$ 871,896,854	$ 93,947,758	$ 640,356,850	$137,592,246
	SOURCE: Annual Report of VERIZON NEW YORK INC. For the period ending DECEMBER 31, 2020				
	Percent of Network Construction		3%	62%	35%
	Percent of Network Under Construction		11%	73%	16%
					IRREGULATORS

The Verizon New York 2020 Annual Report is the state-based financial report that is required by NY State. It is the only publicly available state annual report that we know of that supplies all of the information in one place, though other states have some annual reporting requirements, their financial reports are not made public or do not present all of the information.

NOTE: This is NOT the Verizon Communications, Inc., Annual Report, which is for the holding company, and the link we provide supplies the Verizon NY Annual Report as well as a 'walkthrough" we created to understand some of the significant areas.
This state-based financial report is for the primary state public telecommunications utility, which most reading this article do not know that they still exist.

The Majority of ALL Network Expenses have been put into Local Service.

Line 1 of this chart supplies the 'telephone network in service', — (which is referred to in the industry as "plant") and it shows Verizon NY's networks at $32 billion dollars, and Local Service has paid almost $20 billion, 62% of the total, while Business Data Services, was only 35%, and Nonregulated was only 3% of the total.

How can this be possible if there are no upgrades and maintenance of the copper wired networks?

These numbers show that 2/3rds of the networks' expenses have been built over the last 4 decades were charged to the copper-based local service line of business, while the 'nonregulated' services have paid a fraction of these expense.

Line 2 on the chart shows the "network under construction" i.e., the money being spent in 2020 for networks that are in progress of being built — had 73% of the total…$600 million, charged to Local Service while FiOS and VOIP only paid 11%, only $94 million.

There was no buildout of the copper-based networks nor are they even being properly maintained, and in 2020, Verizon NY only spent $42 million dollars. Over the last decade, the amount spent ranged from $18–57 million dollars per year, and the 10-year average was around $35 million.

And to say that this has been a long-time issue would be stating the obvious. The Verizon NY annual report from 2020 is not 'unique'; this entire scheme has been going on for decades.

This is from the Verizon NY 2003 Annual Report and what is clearly seen is that the Local Service category (here called NY State), has $19 billion out of the $29 billion in networks (here called "plant").

Annual Report of VERIZON NEW YORK INC.
For the period ending DECEMBER 31, 2003

Line No.	Item (a)	Total (b)	Nonregulated (c)	New York State (f)	Other (g)
1	Telephone Plant in Service	$28,771,601,000	$454,611,000	$19,126,162,000	$9,142,644,000
2	Noninterest Bearing Telephone Plant under Construction	205,775,000	2,327,000	0	203,448,000

Nonregulated	Local Service	Backhaul
2%	66%	31%

It would take too long to explain why these 2 charts, separated by 18 years, should be almost identical, but the simplest answer is — the books are cooked in multiple ways so the formulas for expenses have been frozen since 2000, putting the same amount of expenses into each of these business areas, regardless of the revenues.

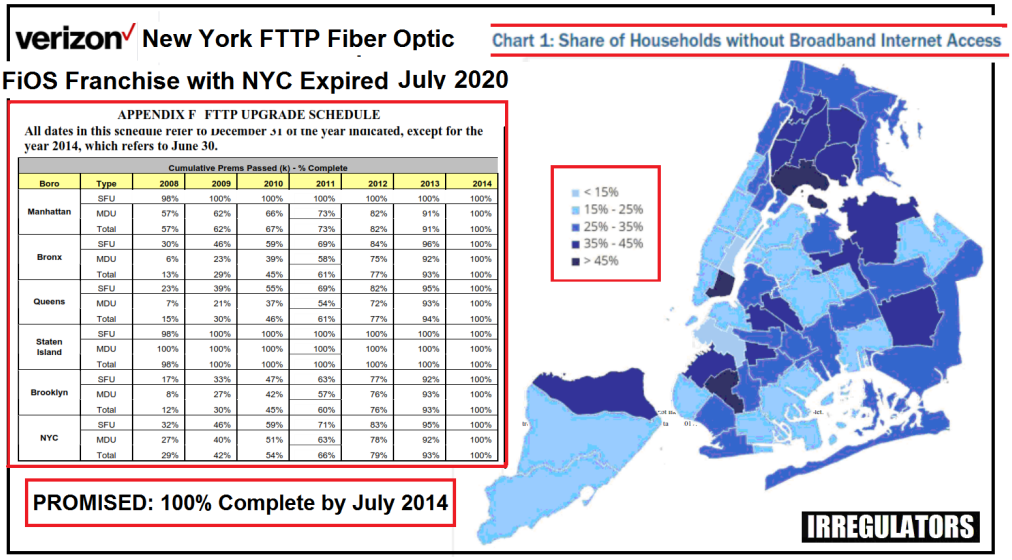
6) Telcos failed to make good on their promises and legal obligations to build fiber optic networks to homes and businesses in each state, starting in the 1990s.

A National Problem Due to the Use of Corrupted Accounting.

Every state has a state telecommunications public utility and every state's accounting, controlled by AT&T, Verizon and CenturyLink, is virtually identical to Verizon New York. Period.

PART 5:

Dear Mayor DeBlasio, Do not renew Verizon NYC FiOS franchise until 100% has been upgraded to fiber optics and customers are made whole—Solving NYC's Digital Divide.



(This chart excerpts the Verizon NYC franchise showing 100% completion by July 2014. The chart on the right shows households without Broadband Internet Access; 26% can not get FiOS.)

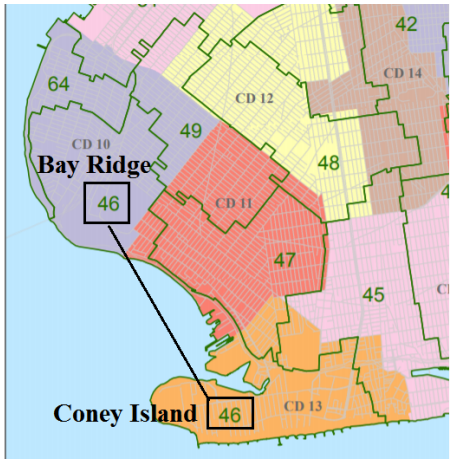
- We are asking the City of New York to not renew the Verizon FiOS cable franchise, which expired in July 2020, until Verizon has finished 100% of residences with an FTTP Fiber to the Premises connection.
- We are asking for maximum penalties and fines that can be applied and require Verizon to make whole those who were never able to get the service in their neighborhood.
- We are asking the City to join in our call for investigate whether Verizon failed to balance the deployments so that low income areas were served equally for the deployment of these networks—a social injustice.
- Also, there is supposedly a settlement with Verizon that has been whispered about to have wireless as a substitute. We request all settlement discussions must stop now.

In a second letter, we ask the City to call for investigation of a massive financial cross-subsidy scheme underway where $1.1-$1.6 billion has been overcharged in just 2019 based on the Verizon New York 2019 Annual Report, published June 2020. As discussed,

the construction budgets that should have been used to build out New York City and the rest of the NY state with fiber optics were diverted to build out Verizon's Wireless networks.

The Pandemic and the need for Online-Learning has exposed the gaps in America's communications infrastructure and locally the failure of Verizon to deliver on their franchise contract. The Digital have and have not issue is not new, but it has been given lip service for the last decade. Unfortunately, the current pandemic has exposed a long-standing failure of the large telecommunications companies to meet their obligations to deploy fiber-based broadband to large parts of America, particularly in rural areas and inner cities, creating the Digital Divide.

But, imagine my surprise when I saw a map of the assembly districts in Brooklyn and that Bay Ridge and Coney Island were connected, not by just a bicycle path.



On a Zoom call hosted by Assemblyman Mathilde Frontus and the Southern Brooklyn Community Roundtable, about the opening of the schools, I also learned that Coney Island is not that connected; according to Census, 23% of the households don't have high speed broadband. And while schools will most likely open up, they will be going virtual and we should all be really annoyed. (And we note that the Census information is known to inflate the number of those with a broadband connection.)

The opening chart compares the Verizon FiOS NYC timeline with a picture of the Households without Broadband Internet Access.

The recent New York City Master Plan details specific holes in the City's broadband:

> "Current broadband subscription costs can be a burden on the budgets of low-income families. For example, 46% of New York City households living in poverty do not have broadband in the home."

> "18 percent of residents — more than 1.5 million New Yorkers — have neither a mobile/wireless connection nor a wireline home broadband connection."

And according to the plan, Verizon FiOS is only available to 74% of the public – and these are residences only; the original deal left out small business requirements.

Verizon had an obligation to upgrade all of NY City and guaranteed it.
The New York City Verizon FiOS cable franchise made is abundantly clear that Verizon would not sleep until New York City was a fiber optic paradise:

> **"FORM OF GUARANTY**
> "In consideration of the award of the Cable Franchise Agreement by and between the City of New York and Verizon New York Inc., dated 2008, we, Verizon Communications Inc., hereby unconditionally and irrevocably agree to provide all the financial resources necessary for the satisfactory performance of the obligations of the Franchisee under the Cable Franchise Agreement and also to be legally liable for performance of the obligations of the Franchisee in case of default or revocation of the Cable Franchise Agreement.

The Social Justice Violations are Clear based on the Cable Franchise Contract

Mayor DeBlasio, when you served as the NYC Public Advocate, you detailed that there was a 'social justice' clause in the Franchise where Verizon was responsible to making sure that the deployment was being done in low income areas as well as high income areas. Equally and second 5.14 leveled the deployment to cover all households>

> "Pursuant to the authority granted to my office by Section 24 of the Charter of the City of NY, I hereby request the following information:
>
> "Beginning in February 2009, Verizon New York Inc. was required to maintain records of the number of units and service areas passed by the FiOS network in each borough, with accurate maps [§11.3]. Please provide copies of any and all such records and maps.
>
> "§5.1.4 of the franchise agreement requires that the median income of units that have been wired to not exceed the average household income of all households in New York City. Please provide any and all records or documentation related to income levels in the areas in which the FiOS network has been installed to verify that this clause has been followed."

Moreover there were 'checkpoints' in the agreement to make sure that the work was being done to meet the completion deadlines of the Verizon buildout of the network.

> "There have been three required "checkpoints" to date, according to §5.1.2 of the franchise agreement, June 30, 2010, June 30, 2011, and June 30, 2012. Please provide copies of any documentation and/or progress reports submitted by Verizon New York Inc. at these checkpoints."

Penalties and Fines The City has a number of options to deal with a failure to finish the infrastructure commitments.

15.6.3. if the Franchisee intentionally makes a material false entry, or repeated false entries that are material in the aggregate, in the books of account of the Franchisee applicable to this Agreement, or a material false statement (or repeated false statements that are material in the aggregate) in reports or other filings submitted to the City (materiality for purposes of this clause being defined as material with respect to accurately documenting the Franchisee's compliance with its obligations under this Agreement);

15.6.5. if the Franchisee engages in a course of conduct intentionally designed to practice fraud or deceit upon the City;

15.6.6. if the Franchisee, intentionally engages or has engaged in any material misrepresentation in any representation or warranty contained herein;

Simply put, we believe Verizon should be liable for all monies listed below because they never fulfilled their obligations at the check points. This would be compounded by other monies to make those who could not get the service whole.

If Franchisee does not attain the "NYC Total" percentage of households passed required as of the date as set forth in Appendix F due to the triggering of one or more of the Checkpoint Extensions provided for in Section 5.1.2 or otherwise, then the required amount of the Performance Bond shall be reduced only when the "NYC Total" percentage of households passed thereafter is attained.

2008: Thiry-Five Million Dollars ($35,000,000)
2009: Thirty Million Dollars ($30,000,000)
2010: Twenty-Five Million Dollars ($25,000,000)
2011: Fifteen Million Dollars ($15,000,000)
2012: Ten Million Dollars ($10,000,000)

2013: Five Million Dollars ($5,000,000)
2014: One Million Dollars ($1,000,000)

Conclusion

The opening chart comparing the commitments made by Verizon to upgrade New York City's residential locations left gaping holes where 25% can't even get the service. But, it appears that the majority were in low income areas, where the percentage is even higher. This has meant no serious high speed broadband internet or cable competition, and prices that have proven to be prohibitive for many families.

There is another part of the problem however problem to fix the Digital divide and making services affordable, finally… America must come to grips the fact the prices for

communications are 3-14 times more expensive than countries, worldwide, and this is on broadband, internet, wireless, phone and even cable services.

Part II: In a separate letter: Verizon New York is the primary telecommunications public utility in New York state and it covers New York City. We have called for an investigation of a massive financial cross-subsidy scheme underway where $1.1-$1.6 billion has been overcharged in just 2019 based on the Verizon New York 2019 Annual Report, which was published in June 8th, 2020. As discussed, there is a clear bright line detailing that utility construction budgets that should have been used to build out New York City and the rest of the NY state with fiber optics were diverted to build out Verizon's Wireless networks. At the same time, Verizon Communications was able to move billions in Corporate Operations expenses into Local Service, creating tax benefits for Verizon, but higher prices for New Yorkers.

Solving the Digital Divide at this critical time must start now. . The City should back our call for a state-wide investigation and halting of the cross-subsidies of Verizon NY and the other Verizon lines of business, including wireless. This would provide enough funding (without government subsidies) to upgrade the state with fiber optics – halting the subsidies can also lower rates by removing the excess charges on local phone customers and on the networks critical infrastructure.

Part 6
LETTER 2: New York City Must Call for a Halt to the Billion + Dollars of Cross-Subsidies and Overcharging by Verizon NY, the Public Telco Utility

The New York City Internet Master plan claims:

> "Every New Yorker deserves easy, affordable access to the internet. With the Internet Master Plan, we are giving notice to corporations that the days of creating a digital divide in our city are over. Providing equitable broadband service to all New Yorkers regardless of where they live or how much they make is vital to ensuring everyone has the basic tools they need to succeed."

If this is really the position of the City, then we request that the City join our call for an investigation to halt a massive financial cross-subsidy scheme that has been going on for years. We estimate that Verizon has overcharged its NY customers by $1.1-$1.6 billion in just 2019. And this is only a partial amount of the total. This analysis is based on a 10 year examination of Verizon New York's financial reports.

Most Important: On June 8th, 2020, the Verizon New York 2019 Annual Report was published. The Internet Master Plan doesn't mention or examine that Verizon NY is New York State's primary telecommunications public utility and it includes New York City.

LETTER 1, We requested the following of the City of New York:

- Do not renew the Verizon FiOS cable franchise, which expired in July 2020, until Verizon provides access to FTTP, Fiber to the Premises, to 100% of NYC residences, as required by the expired franchise agreement.
- Apply maximum penalties and fines against Verizon, as specified in the agreement, for its failure to offer FTTP broadband to all households in the City.
- Hold Verizon accountable for not balancing its FTTP deployments as required, depriving low-income areas of parity with other parts of the City—a social injustice.
- Discontinue any renewal and dispute settlement negotiations with Verizon and establish a transparent process that invites public participation.
- No bait-and-switch should be allowed. Embrace the principle that wireless is not a suitable substitute for FTTP, which Verizon is pushing in NY and other jurisdictions.

The City's Internet Master Plan showed that Verizon has massive FTTP deployment holes, mainly in low-income areas. Moreover, in Upstate New York, Verizon has left whole cities without proper upgrades.

To summarize: Verizon intentionally violated its agreements because it envisions an all-wireless future with a dramatically reduced work force, lower overhead and increased profits. It has manipulated its reports and narratives to portray landline or wired service as unprofitable. And Verizon grossly inflates the promise of 5G and operates a shell game to pretend that 5G can be economically feasible.

In truth, Verizon diverted billions of dollars in construction budgets to fund its wireless network. However, local phone customers, including low-income families and rural areas, have paid rate increases multiple times—thousands of dollars per family-- for a fiber optic future. Communications prices in the US are 3-14 times more than overseas and have been inflated artificially by these financial machinations. The lack of accountability is astounding. In NY, responsible authorities have conducted no audits or investigations of Verizon's gaming the system.

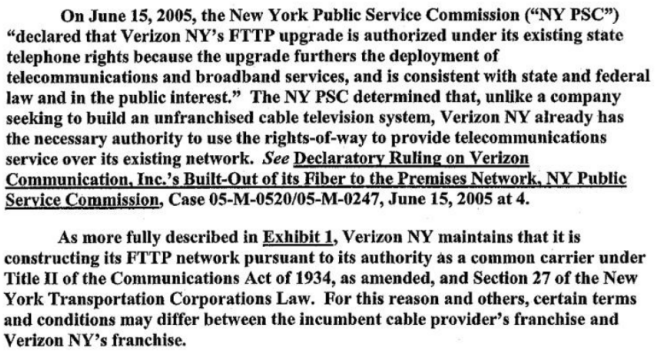
Thus, halting the billions that were diverted to Verizon's wireless and the other lines of business, will not only right a collection of wrongs, but will supply billions that should have been used to upgrade the entire state with fiber optics, as well as lower rates on all communications services.

We Will Address:

1) Verizon NY is a state-based telecommunication utility that covers NYS and NYC. And Verizon NY is the entity that has the contract with NYC for FiOS.
2) The "FTTP", "Fiber to the Premises" wires used for FiOS, are part of this state utility and are "Title II", providing common carrier services.
3) Verizon NY was allowed to increase rates on local service and other wired services multiple times in order to fund FTTP.
4) Verizon New York diverted billions of dollars of the utility construction budgets to build out their wireless business. It left whole cities in Upstate NY with legacy services and ignored parts of NYC, mainly the low-income areas.
5) Verizon Management told investors that Verizon's wireless networks were being built via the wireline construction budgets.
6) Verizon has no intention of finishing New York FTTP deployments, and will seek to substitute wireless service, devoting its construction budget to the fiber optic wires it needs for its wireless network to connect antennae and stations.
7) The Verizon NY 2019 Annual Report shows that billions in Verizon-wide, Corporate Operations expenses are over-allocated to local service; that the majority of construction budgets are being put into 'local service' but are being used by wireless; and that Verizon Wireless is underpaying Verizon NY when it uses these networks for "backhaul" (the data networks connecting cell sites and switching centers.)
8) IRREGULATORS v FCC: Blame it on FCC accounting rules, that are deformed and put the majority of all expenses into the wired utility to make it unprofitable.

Putting the Facts on the Table.

1) **Verizon NY is a state-based telecommunication utility, covering NYS and NYC.**
   From NY Telephone to NYNEX to Bell Atlantic and now Verizon NY, the primary state-based public telecommunications utility has a very long history of claiming it would upgrade the state's copper-based infrastructure with fiber optics and charging consumers to fund the projects over the last three decades.

2) **The FTTP, fiber to the premises, wires, used for FiOS, are part of the state utility, providing Title II, common carrier services.**
3) 

On June 15, 2005, the New York Public Service Commission ("NY PSC") "declared that Verizon NY's FTTP upgrade is authorized under its existing state telephone rights because the upgrade furthers the deployment of telecommunications and broadband services, and is consistent with state and federal law and in the public interest." The NY PSC determined that, unlike a company seeking to build an unfranchised cable television system, Verizon NY already has the necessary authority to use the rights-of-way to provide telecommunications service over its existing network. *See* Declaratory Ruling on Verizon Communication, Inc.'s Built-Out of its Fiber to the Premises Network, NY Public Service Commission, Case 05-M-0520/05-M-0247, June 15, 2005 at 4.

As more fully described in Exhibit 1, Verizon NY maintains that it is constructing its FTTP network pursuant to its authority as a common carrier under Title II of the Communications Act of 1934, as amended, and Section 27 of the New York Transportation Corporations Law. For this reason and others, certain terms and conditions may differ between the incumbent cable provider's franchise and Verizon NY's franchise.

The reason Verizon classified FTTP as Title II was to allow it to charge the state local phone customers and the wired networks for the construction of these networks. (NOTE: Verizon misrepresented this to the Federal Communications Commission, claiming that the FTTP was for "Title I", information services, and that the "Title II" classification actually impeded investment. Title II services, ironically, have been the investment mechanism for FTTP.)

4) **Verizon New York was allowed multiple rate increases on local service and other wired services in order to fund fiber optic networks.**

June 2009: Statement by NY Public Service Commission.

> "We are always concerned about the impacts on ratepayers of any rate increase, especially in times of economic stress…Nevertheless, there are certain increases in Verizon's costs that have to be recognized. This is especially important given the magnitude of the company's capital investment program, including its **massive deployment of fiber optics in New York**. We encourage Verizon to make appropriate investments in New York, and these minor rate increases will allow those investments to continue."

5) **Verizon New York diverted billions of dollars of the utility construction budgets to build out their wireless business.**

In 2012, the NY State Attorney General claimed that 75% of the capital expenditures in New York State went to fund the building of the fiber optic wires to cell sites and to FiOS, not to the maintain the state's copper networks

> "Verizon New York's claim of making over a 'billion dollars' in 2011 capital investments to its landline network is misleading. In fact, roughly three- quarters of the money was invested in providing transport facilities to serve wireless cell sites and its FiOS. Wireless carriers, including Verizon's affiliate Verizon offering wireless, directly compete with landline telephone service and the company's FiOS is primarily a video and Internet broadband offering....Therefore, only a fraction of the company's capital program is dedicated to supporting and upgrading its landline telephone service."

But, unknown to the Attorney General, by 2012, Verizon was no longer building out FiOS, and had focused almost exclusively on the illegal use of the utility construction budgets for wireless.

6) **Verizon Management told investors that Verizon's wireless networks were being built via the wireline construction budgets.**

In 2012, Fran Shammo, former Verizon CFO told investors that the wireless company's construction expenses have been charged to the wireline business.

> "The fact of the matter is Wireline capital — and I won't get the number but it's pretty substantial — is being spent on the Wireline side of the house to support the Wireless growth. So the IP backbone, the data transmission, fiber to the cell, that is all on the Wireline books but it's all being built for the Wireless Company."

This is now called "One Fiber" and it is done to hide the transfer from wireline to wireless.

7) **It appears Verizon has no intention of finishing New York fiber optic deployments.**

Verizon Communications, Inc, the holding company's 2019 Annual Report (as opposed to the Verizon NY, state-based annual report) did not even mention any obligations pertaining to wired fiber optic wired services, or that there are state utilities.

"We are focusing our capital spending on adding capacity and density to our 4G LTE network, while also building our next generation 5G network. We are densifying our network by utilizing small cell technology, in-building solutions and distributed antenna systems. Network densification enables us to add capacity to address increasing mobile video consumption and the growing demand for IoT products and services on our 4G LTE and 5G networks."

8) **Investigate the Billion + in Overcharging and Cross Subsidies** We estimate that Verizon NY Local Service was overcharged an estimated $1.1-$1.6 billion, in just 2019, in just New York , including NYC. (This is the low number.)

- Verizon New York has shown losses of over $2 billion for most years over the last decade, almost all created by "Local Service",
- Local Service was charged over $1/2 billion in "Corporate Operations" expense, 61% of the total Verizon assigned to NYS.
- In 2017, Local Service was charged $1.8 billion, 61% of the total for this line item.
- Local Service was charged $205 million, 54% of the total, for "Marketing". When was the last time you saw an advertisement or video commercial for basic copper-based phone service?
- "Local Service" is the basic, wireline, voice-only, copper-wired based business. It was charged $1.2 billion in "Construction & Maintenance" and has historically actually spent only $75–$125 million.
- Verizon New York's Backhaul had $1.9 billion in revenues but paid ½ of what Local Service paid for construction or corporate operations expenses and had a 55% profit margin.

Here's the problem. Local service should not have been paying billions in corporate operations expenses, nor $1.2 billion in construction or $205 million in marketing, which means all of this is subsidizing other lines of Verizon's business instead of having upgraded and maintained the NYS' infrastructure or finishing Verizon's FiOS New York City franchise.

9) **IRREGULATORS v FCC: Blame it on FCC accounting rules, that are deformed and put the majority of all expenses into the wired utility to make it unprofitable.**

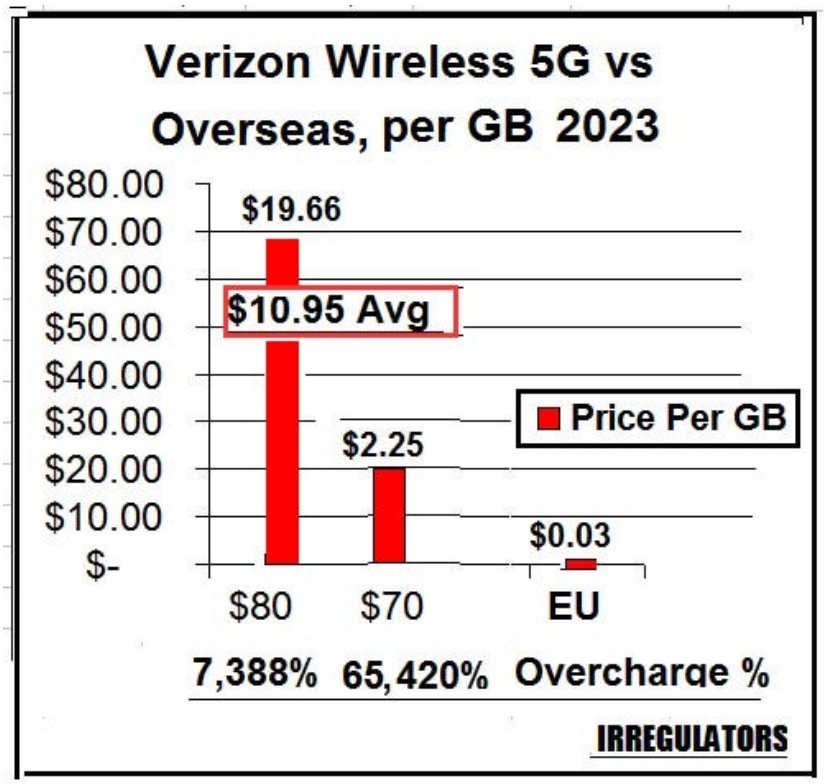
It is impossible to explain all of the intricacies of how the FCC accounting formulas became deformed. The IRREGULATORS took the FCC to court to expose how the rules created this massive financial cross-subsidy scheme. We got the decision we wanted: NY State is now independent of the FCC and can halt all of these cross-subsidies.

If New York is to have an affordable high speed broadband, internet, fiber optic future, the City and State must stop Verizon's unchecked ability to continue this shell game.

Click for links to our bios, filings, etc.

Part 7: Four Snapshots -- From America's prices being out of control compared to overseas countries, we also include a a short summary of the Verizon NY 2022 Anneal Report.

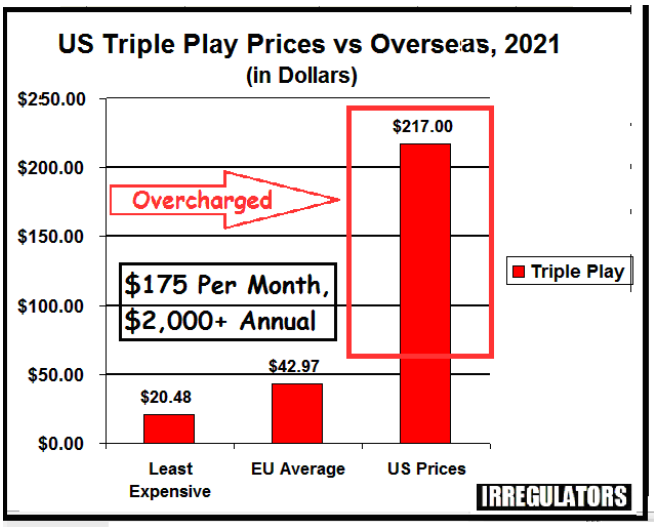
Verizon's Wireless Overcharging per GB, 7,400%-to-65,000% vs Overseas Prices.



The above chart shows that overseas, the median 5G mobile broadband service cost per GB is .03 Euros — (one Euro is now $1.08 dollars) — less than 3 cents. Meanwhile, the Verizon 5G mobile broadband services we focused on in Part 1 costs $70 and comes with 5GB, and when taxes are added, it comes to $19.66 per gig. The $80 dollar service price per GB is $2.25, with the average of the two at $10.95 per GB, taxes and made-up hidden fees added.

Compare less than 3 cents per GB and $10.95 per GB, for the average of the Verizon 5G Wireless service — — and this means that the cost differential for these services is really, really huge. It is a whopping 7,400%-65,000% difference (rounded). (Verizon's average of $10.95 is 36,400% above the median price per GB overseas.)

America's 'Triple Play' Prices Overcharged up to $175.00 Per Month or More — Over $2,000.00 Per Year.



Click for this Cable Triple Play Master Summary PDF

How can America's prices for the cable triple play — (phone, cable TV and ISP-broadband) be almost 10 times more when comparing Consumer Reports' 2019 findings with the data from other countries, highlighted in the European Union Commission recent 2021 report? And, as the report details, even basic stand alone high speed broadband prices overseas are a fraction of what we're paying in the US.

We've even been beaten out by Bulgaria, Romania and even Slovakia:

> "Overall, Lithuania, Latvia, and Romania have the most attractive prices for broadband internet in the EU….Bulgaria, Poland, Hungary and Slovakia follow; France, Czechia and Italy have low prices especially for Triple Play offers."

The first step of fixing the Digital Divide is to make prices affordable and there is nothing in any of the government's plans that is going to fix this.

How is it possible that America's Triple Play is $150-$200 a month over what is being charged overseas — that's over $2,000.00 a year being charged to families — including low-income families and seniors? This is on top of the fact that there could be only one or no providers of high-speed services in the rural regions or parts of cities.

Just Released for Public Review: The Verizon NY 2022 Annual Report Shows a Massive, Corrupt, Financial Accounting Scheme.

Annual Report of VERIZON NEW YORK INC. For the period ending DECEMBER 31, 2022

Line No.	Item (a)	Total (b)	FIOS Video Nonregulated (c)	Local Service New York State (f)	BACKHAUL Other (g)
9	Total Operating Revenues	3,571,708,161	1,177,041,947	825,629,346	1,569,036,868
	Operating Expenses				
11	Total Plant	$ 2,521,823,844	$ 983,045,913	$ 1,040,132,092	$ 498,645,838
12	Marketing	273,689,619	83,670,154	147,868,792	42,150,673
13	Customer Operations Services	125,581,489	8,646,169	83,046,135	33,889,185
14	Access	105,119,145	0	50,442,893	54,676,252
15	Corporate Operations	1,212,629,201	123,247,994	736,141,775	353,239,432
16	Subtotal	4,238,843,298	1,198,610,231	2,057,631,688	982,601,379
17	Depreciation & Amortization	1,210,960,566	52,803,602	755,012,644	403,144,320
18	Total Operating Expenses	5,449,803,865	1,251,413,833	2,812,644,332	1,385,745,700
19	Net Operating Revenues	(1,878,095,703)	(74,371,886)	(1,987,014,986)	183,291,169

Answer This

- This excerpt was taken directly from the Verizon NY 2022 Annual Report, (spreadsheet) released May 26th, 2023. How is it possible that "Local Service", the basic copper-based voice phone service, which is no longer being sold, and had revenues of $826 million, is being charged the majority of corporate expenses (Column F, Line 15)? (Keep in mind that these expenses are mostly for Verizon Communications, Inc, the holding company, that owns the state telecom utilities in their service areas as well as many other affiliated corporations, which includes cellphone services.)

- We will go through this in detail, but Local Service was charged: *(Estimates for overcharging are based on other information in the financial reports and filings.)
- Construction — Over a billion dollars which is not being used by Local Service. This should be $20–40 million; $1 billion in overcharging.
- Marketing — Charged almost $148 million, the majority, for a service that is not being marketed — Overcharged $148 million.
- Corporate Operations expenses — Paid $738 million, 60+% of the total (which includes the executive pay, lobbying, lawyers and even the corporate jets). Overcharged $725 million (or more).
- CONCLUSION: Over $2 billion, in just 2022, in just Verizon NY. The other expense categories are equally egregious.

Where Did the Construction Money Go?

Local Service is paying 73% of the construction that is underway; known as "Work in Progress", the other lines of business pay chump change.

Annual Report of VERIZON NEW YORK INC. For the period ending DECEMBER 31, 2022

Line No.	Telephone Plant in Service / Plant under Construction (a)	Total (b)	Nonregulated (c)	New York State (f)	Other (g)
			FiOS video	local service	Backhaul
	Telephone Plant in Service	$35,106,397,766	$1,255,669,358	$21,684,947,090	$12,165,781,318
19	Plant under Construction	857,811,157	92,430,010	629,644,120	135,737,027
	Cash Working Capital *	172,429,535	0	172,429,535	0

Telephone Plant in Service	4%	62%	35%
Plant under Construction	11%	73%	16%
Cash Working Capital *	0%	100%	0%

This chart shows that Local Service (Column F, Line 19) paid $629.6 million dollars in "plant under construction", which is 73%, while the other lines of business, like the Nonregulated FiOS video, paid only 11%, only $92 million

.

Local Service Utility Functions as the Bank:

- Moreover, the state utility appears to be acting as the bank by paying for the 'working capital' of $172 million.
- If there is no construction of the state utility's intrastate networks, then how is it that the Local Service category is picking up the majority of the expenses?
- And where is the (Line 19) $630 million dollars going?

Bruce Kushnick, IRREGULATORS
June 7th, 2023 Technology committee -- LinkNYC and 5G oversight.
attached is the testimony as well as the Verizon NY 2022 Annual Report, which is delivered to the public as a spreadsheet.

9. INCOME AVAILABLE FOR RETURN AND CALCULATION OF RATE BASE

1. All columns must be filled in for those companies whose toll settlements are based on actual cost. Companies that receive toll settlements on the basis of average cost need to complete columns (b) through (e).

2. The totals as reported on this schedule should conform with amounts reported on corresponding schedules.

3. Include in column (g), Part 36 interstate amounts and any reconciliation of New York State amounts.

4. Include on Line 27 any adjustments needed for items includable in Earnings Available for Rate of Return calculation purposes which are not includable in the lines above (e.g. tax imputation for imputed interest, etc.) Please identify and explain.

Line No.	Item (a)	Total (b)	Nonregulated (c)	Other Adjustments (d)	Subject to Separations (e)	New York State (f)	Other (g)
	Operating Revenues						
1	Local Network Services	$490,495,883	$0		$490,495,883	$487,930,863	$2,565,020
2	Network Access Services	1,471,288,449	0		1,471,288,449	32,553,982	1,438,734,467
3	Long Distance Network Serv.	33,559,692	0		33,559,692	31,933,183	1,626,510
4	Miscellaneous	415,156,310	0		415,156,310	283,684,887	131,471,423
5	Settlements	-	0		0	0	0
6	Nonregulated Revenues	1,177,960,585	1,177,960,585		0	0	0
7	Subtotal	3,588,460,919	1,177,960,585	0	2,410,500,334	836,102,915	1,574,397,419
8	Uncollectibles	16,752,757	918,637		15,834,120	10,473,569	5,360,551
9	Total Operating Revenues	3,571,708,161	1,177,041,947	0	2,394,666,214	825,629,346	1,569,036,868
	Operating Expenses						
10	Plant Specific	2,282,822,073	950,088,538		1,332,733,535	903,047,702	429,685,832
11	Plant Non-specific	239,001,771	32,957,375		206,044,396	137,084,390	68,960,006
12	Marketing	273,689,619	83,670,154		190,019,465	147,868,792	42,150,673
13	Customer Operations Services	125,581,489	8,646,169		116,935,319	83,046,135	33,889,185
14	Access	105,119,145	0		105,119,145	50,442,893	54,676,252
15	Corporate Operations	1,212,629,201	123,247,994		1,089,381,207	736,141,775	353,239,432
16	Subtotal	4,238,843,298	1,198,610,231	0	3,040,233,067	2,057,631,688	982,601,379
17	Depreciation & Amortization	1,210,960,566	52,803,602		1,158,156,964	755,012,644	403,144,320
18	Total Operating Expenses	5,449,803,865	1,251,413,833	0	4,198,390,032	2,812,644,332	1,385,745,700
19	Net Operating Revenues	(1,878,095,703)	(74,371,886)	0	(1,803,723,818)	(1,987,014,986)	183,291,169
	Operating Taxes						
20	Operating FIT	(702,150,927)	(290,255,852)		(411,895,075)	(340,619,032)	(71,276,043)
21	Deferred Operating FIT-Net	259,045,528	17,021,623		242,023,905	125,665,058	116,358,847
22	Operating Investment Tax Credit - Amort (Option 2)	0	0		0	0	0
23	Total Federal Income Taxes	(443,105,399)	(273,234,230)	0	(169,871,169)	(214,953,974)	45,082,805
24	Other Operating Taxes	410,548,248	18,312,766		392,235,482	247,849,217	144,386,265
25	Total Operating Taxes	(32,557,151)	(254,921,464)	0	222,364,313	32,895,243	189,469,070
26	Other Operating Income and Expenses	(14,936,359)	(490,301)	0	(14,446,058)	(9,487,799)	(4,958,259)
27	Net Operating Income*	(1,860,474,911)	180,059,278	0	(2,040,534,188)	(2,029,398,028)	(11,136,160)
28	Rate Case Adj, if applicable					75,357,679	
29	Net Operating Income after Rate Case Adj	($1,860,474,911)	$180,059,278	$0	($2,040,534,188)	($1,954,040,349)	($11,136,160)

223-95

* Net Operating Income on Line 27 should equal Net Operating Income on Sch 12, Line 16, Column C.

9. INCOME AVAILABLE FOR RETURN AND CALCULATION OF RATE BASE

Line No.	Item (a)	Total (b)	Nonregulated (c)	Other Adjustments (d)	Subject to Separations (e)	New York State (f)	Other (g)
1	Telephone Plant in Service	$35,106,397,766	$1,255,669,358	$0	$33,850,728,407	$21,684,947,090	$12,165,781,318
2	Noninterest Bearing Telephone Plant under Construction	857,811,157	92,430,010	0	765,381,147	629,644,120	135,737,027
3	Telephone Plant Held for Future Use	0	0	0	0	0	0
4	Materials and Supplies	5,391,385	664,720	0	4,726,665	3,646,165	1,080,501
5	Prepayments	16,249,770	0		16,249,770	(3,971,884)	20,221,654
6	Cash Working Capital *	172,429,535	0		172,429,535	172,429,535	0
7	RTB Stock	0	0		0	0	0
8	Other Rate Base Adjustments, If Applicable	0	0		415,784	415,784	0
9	Unamortized Deferrals	0	0		0	0	0
10	Depreciation Reserve	23,105,647,541	296,630,303		22,809,017,238	14,548,588,501	0 8,260,428,737
11	Amortization Reserve	1,106,739,922	129,882,438	0	976,857,484	767,945,511	208,911,973
12	Accumulated Deferred Income Taxes	1,203,469,965	214,405,395		989,064,570	227,747,195	761,317,375
13	Accumulated Deferred Investment Tax Credit (Option 1 Only)	0	0		0	0	0
14	Rate Base (Lines 1-9 minus lines 10-13)	$10,742,422,185	$707,845,952	$0	$10,034,992,017	$6,942,829,602	$3,092,162,415

* Allowance based upon collection of revenues and operating expenses:

For Example:

	Amount	Percentage	Lag Days	Weighted Days
1. Advance Billings (Local Service, etc.)	$40	40.0%	15	6
Arrears Billings (Toll, etc.)	$60	60.0%	45	27
	$100	100.0%		33

2. Weighted Days - 33 divided by 365 days equals 9.04%

3. Operating Expenses minus Depreciation multiplied by 9.04% equals Cash Working Capital

I'm urging New York to ban all Link5G cell towers.

For several years I've fought (and eventually won) a battle in Ithaca NY that is happening in towns across the country, all with critical implications for the health of Americans.

Before Covid, I was traveling in Europe and saw widespread opposition around the 5G rollout, which is essentially blanketing towns with new cell antennas often right next to homes. This didn't hit home until I discovered the attempt to do the same in Ithaca. Ignorant of the issues involved, I spent dozens of hours researching the topic. I was shocked by the **massive amount of science - literally thousands of peer-reviewed studies (including a 10-year, $30 million one by the NIH) - showing harm to humans (especially children) from pulse-modulated microwave (cell) radiation.** I was even more alarmed by the fact that it seems to have gone under the radar in national media and does not seem to be being addressed at the national level. The millions of dollars of misinformation and lobbying sponsored by the telecom industry certainly hasn't helped, nor has the FCC who is supposed to represent citizens but instead is 'captured' by the telecom industry, according to experts like the Harvard University Center for Ethics.

The massive amount of science showing harm is why **the World Health Organization classifies this radiation in the same category of carcinogen as DDT and lead.**

This science is why countries and regions around the world have taken significant steps to minimize the impacts of wireless radiation.

This science is why firefighters across America oppose cell antennas on their facilities.

This science is why insurance companies will not cover cell antennas - they deem them too "high risk".

And this science is why **THE TELECOM COMPANIES THEMSELVES HAVE WARNED THEIR SHAREHOLDERS OF THE RISK OF LAWSUITS DUE TO THE EFFECTS OF CELL RADIATION!** In fact, an Ecolog Institute Report commissioned by T-Mobile and DeTeMobil Deutsche Telekom MobilNet recommended an **exposure limit 1000x lower than the FCC's current power density limit** after reviewing the research on biological effects.

New Hampshire is the first state to study the science of this issue in depth. After a year of review, their official Commission recently voted overwhelmingly to raise the red flag on cell antennas, and they recommended that any cell antennas should be at least 1640 feet from homes or schools. From their report:

> **This Commission acknowledges the large body of peer-reviewed research that shows that the type of radiation generated by wireless devices can have a deleterious effect on humans, especially children, as well as animals, insects, and vegetation.....The World Health Organization and the whole insurance industry are hedging their bets against this radiation because of potential harm…A large number of independent scientists have concluded that the thresholds for Japan and the U.S. are unsafe…Why are the FCC exposure limits set for the United States 100 times higher than countries like Russia, China, Italy, and Switzerland?...Why have thousands of peer-reviewed studies showing significant DNA damage, brain and heart tumors, infertility, and many other ailments, been ignored by the FCC?...A likely explanation is that [they] are 'captured'...whose Commission members come from the industry they are overseeing.**

Moved by this massive amount of science, I helped organize hundreds of Ithacans to assist the Ithaca City Council in writing new codes that would legally minimize any new cell antennas. While Council members were skeptical at first, **the science convinced all but one of them to pass new, excellent codes in late 2021**.

I have since learned of many communities around the country going through a similar process, with Ithaca now being used as a model on how to legally push back against unnecessary antennas and limit any additional physical harm to citizens.

Despite these changes in Ithaca and other towns, **telecom companies are still rushing to install literally hundreds of thousands of new cell antennas around the country, sowing the seeds for a massive health crisis unfolding under the radar.**

Perhaps the most frustrating thing about this issue is the fact that in 1996, the telecom industry lobby inserted a clause into the Telecommunications Act saying that local governments are not allowed to officially consider environmental/health effects regarding siting cell towers. (According to experts, this is because they already knew the research showing this danger and wanted to inoculate themselves against risk. After all, *why would they need to do this if they were confident of their safety*?) **I believe this is one of the most immoral and outrageous laws ever passed in our country, especially since the very stated purpose of most local codes (including Ithaca) is to protect the health and safety of its citizens**. The expert attorney who Ithaca hired to write its codes, Andrew Campanelli, has said:

> **The Telecommunications Act [of 1996] not only violates the 10th Amendment by stripping local governments of their power to protect their local citizens, but violates a fundamental right of self-defense under the Constitution, because it prevents individuals from protecting themselves against intrusion into their homes of illegally excessive levels of RF radiation.**

Given the significant negative impacts of this issue, several lawsuits have been set in motion. In a victory for our cause in 2021, the DC Circuit Court of Appeals (with **Ketanji Brown-Jackson** as a member) ruled against the FCC, essentially saying their cell radiation guidelines have not addressed the science of harm on this issue (the **FCC's outdated guidelines are the most lax in the world, 100 times higher than in countries like Italy, Switzerland, Russia and China!**). A good 2-minute clip on this.

Finally, at a personal level I know this is a grave danger to the health of Americans because I suffer from 'Electro-Magnetic Sensitivity' (EMS), a condition covered under the American Disabilities Act. Whenever I get near a cell tower or high-powered wifi router (same radiation), I start to get a headache and feel dizzy. Within minutes of me moving away, I fully recover. Millions of Americans (and countless others throughout the world) have the same condition, many suffering much worse than me. **We are the living proof of the veracity of the science, and I believe we are the 'canaries in the coal mine' for the significant health challenge this poses to humanity.**

Six decades ago, we knew the science regarding tobacco's harm. Little was done, and millions died prematurely. Four decades ago, we knew the science of global warming. Nothing was done, and we are now facing the consequences. Let's not make the same mistake with wireless radiation.

Please stop this madness and ban all new towers in the city.

Thank you.

Andrew J. Molnar
Ithaca, NY
Illumine Consultants

Antonella Di Saverio

disaverio.anton@gmail.com

Date of Hearing: 6/7/2023

Dear Honorable Council Members:

I am writing as a member of the public and also as the Chair of The Environmental and Sanitation Committee of Community Board 1 in Queens.

On Wednesday, January 21, 2023, Brett Sokoff and Stacey Gardner of OIT (Office of Innovation and Technology) and Robert Sokota, CEO, Citybridge presented at a joint committee meeting between the Environmental/Sanitation Committee and the Transportation Committee to discuss and review LinkNYC New Site Permit applications.

The following guests, three of which are experts in the field of electrical/microwave radiation, attended.

- Theodora Scarato, Environmental Health Trust
- Kent Chamberlin, former NH Commissioner on health impacts of 5G, Chair Emeritus, Electrical and Computer Engineering Department, University of New Hampshire
- Odette Wilkens, Esq., Wired Broadband, Inc., a nonprofit
- George Sinopides, a Port Authority Liutenant who was injured by a 5G pole placed outside of his home

At this meeting OIT was asked for RF compliance reports and the assurance that these devices are in compliance with FCC limits; along with requests for other information. To date, the requested information has not yet been received.

At this meeting, Office of Innovation of Technology indicated that the installer (in this case City Bridge) must be compliant with the regulations for RF emissions. However, we have not been provided with any documentation proving that the devices are in compliance.

What's most concerning is that Robert Sokota indicated that the RF waves emitting from the device would be radiating from 500 feet to several thousand feet (well within the proximity of peoples personal residences which would be a small number feet away.) In the example discussed at the meeting, the cumulative radiation from multiple carrier transmitters on the LinkNYC 30 foot structure would be entering

directly into the apartments of people residing at Queens Bridge housing where small children and elderly reside.

It appears that a safer option, if the city truly wants to provide additional connectivity would be through fiber-optics/broadband.

Because we did not receive information that would assure us that these devices would not cause bodily harm, the committee voted to present a motion to the entire board recommending a disapproval of 5G poles and NYCLink devices until we could evaluate safety studies. The motion was carried and the Board voted to disapprove the installation.

As stewards of our community, we need to be certain beyond a shadow of a doubt that none of our community members would suffer bodily harm as a result of these devices. To allow the installation without the due diligence of safety review is irresponsible and capricious.

I urge the City Council to halt the installation of these devices until such a time where independent studies can be reviewed and it is determined that these devices are safe for longterm human exposure.

Sincerely,

Antonella Di Saverio

Antonella Di Saverio

Community Board 1 Environmental and Sanitation Chair & Astoria Resident

I'm Arnold Gore from Brooklyn, where I have lived for 8 years in community board 8, having previously resided in Washington Heights for 30 years. I am a senior citizen who was on the Manhattan Solid Waste Advisory Board. I would like to read part of the testimony of Dr.Kent Chamberlin, PhD former Chair of the University of New Hampshire Department of Electrical Engineering and Computer Engineering. Dr Chamberlin was a member of the New Hampshire State Commission evaluating the Hea;th & Environmental Effects of Evolving Wireless and 5G Technology.

"My purpose is to alert you to the DANGERS of siting a cell tower near to where, people, particularly young people, live, work or recreate.... Scientists, physicians, environmental and public health physicians , epidemiologists. Pediatricians along with engineers such as myself have been calling for state and local governments to be proactive in protecting your citizens against radiation exposure... For example, citizens in York, Maine have delayed the installation of antennas positioned close to a neighborhood. The Board of Health in Pittsfield, Massachusetts issued a Cease and Desist order against Verizon regarding a cell tower that was causing illness in a surrounding neighborhood. ,,, Those examples can be used to strengthen your ordinances to help protect against inappropriate cell tower siting. I am currently working ,,, to pass legislation that would provide protections ,,, calling for a 1,640 foot setback for all new cell towers, this setback is one of the recommendations made ny the New Hampshire Commission...Wireless radiation dangers are real and they can be significant in their impact on human health and the environment, I encourage you to do whatever is within your power to protect your constituents against it. "

Within New York State, Woodstock,NY has passed such a model zoning and siting ordinance.

From: r <arnoldgore@aol.com>
Sent: Friday, June 9, 2023 7:58 PM
To: Testimony
Subject: [EXTERNAL] NYC Link 5G Kiosks Hearing 6/7/

I'm Arnold Gore from Brooklyn NY submiting additional comments.
The presentation by Office of Technology Innovation and Citybridge tried to finesse the serious health consequences. While their statements are technically true as to the letter of the law, they are not protective of humsn exposure.
The Federal Communications Commission(FCC) wireless exposire standards were set in 1996. There has been a greatmany medical and scientific studies supporting increased levels of Brain Cancer, Neurological problems and infertility linked to wireless exposure. See ehtrust.org/science
The Distict of Columbia Circuit Court of Appeals, one level below the US Supreme Court, olargevnumber of studies rdered the FCC to reevaluate the studies raisedspecifically addressing the heal;thy issues raised. That decision was rendered August 13,2021. To date FCC has not taken any action.1 The Harvard Center for Ethics found the FCC to be a captured agency. The Chaimen have come from the wireless industry.
It is up to the local City Council to take the actions still reserved to it by the Telecommunications Act of 1996.
The locality maintains the right to grant zoning and siting permits for construction of infrastructure. If a cellular telephone call can be completed a permit can be denied. If there is a gap in service the telecom may be allowed to furnish the power needed to complete a telephone call, not what is being proposed now by the telecoms. This authority was affirmed by the Court in the Eastern District of New York2 It will be easier to Sustain these Denials if a local zoning and siting law is enacted.
Woodstock, NY has enacted a model law..but one must be tailored to our needs.

1- Environmental Health Trust v FCC DC Circuit Court of Appeals 2021
2- Externet v Flower Hill *(EDNY) 2022*

From: hwlyfstr@aol.com
Sent: Tuesday, May 30, 2023 8:44 AM
To: Testimony
Subject: [EXTERNAL] Deployment of RF microwave radiation (5G) in the City
Attachments: Pace University (Mayor Adams City Hall location) 1 Pace Plaza New York NY 10038 May 15.2023 2pm.zip

Ladies and Gentlemen*:*

Oversight – LinkNYC: Deployment of 5G Infrastructure and Wi-Fi Connectivity across the City.

Thank you for leading this critical discussion and for allowing testimony.

Currently NYC residents are being exposed to some of the highest levels of wireless radiation in the nation, but no one knows since everyone is repeating the "5G" marketing term instead of talking about the actual " 5G product" or "5G service," which is **Radiofrequency/Microwave (RF/MW) Radiation, a hazardous physical agent**. Not only are people being irradiated by unmonitored microwave towers and antennas with "4G", "5G" RF/MW Radiation and Wi-Fi, but many are suffering with health problems from smart meter radiation.[7] Please see attached RF/MW Radiation readings, which according to the empirical science of building biology, are in extremely hazardous territory.

Both Wi-Fi and the microwave oven operate at about 2.4 to 2.5 GHz.[3] The reason why 2.4 to 2.5 GHz is very problematic is because this frequency is a wavelength of about 5", which is close to the dimensions of the human head and brain, as well as other organs. And this means that radiation absorption is maximized in these organs. Further, because of maximized absorption, no exposure level is safe.

Since New York policy is not to monitor or measure wireless radiation levels but instead allow industry to pollute, New Yorkers are experiencing the negative effects through health damage including but not limited to violence, homicide, depression, suicide, neurological impairment, infertility, strokes, heart attacks, anxiety, and other harms. Tens of thousands of peer-reviewed studies positively establish adverse bioeffects from RF/MW Radiation exposure - that's more studies than smoking, lead, or asbestos. [1][2][4][13]

Microwave radiation from wireless infrastructure is blanketing NYC with the same 2.4 - 2.5 GHz frequency as a microwave oven and other frequencies, and there is absolutely zero monitoring or measuring of the power levels or New Yorkers' duration of exposure to RF/MW Radiation.

One aspect of wireless infrastructure that is ignored is the continual harvesting of data, in violation of New Yorkers' right to be free from unwarranted surveillance. Who is collecting the data and for what purpose? It's no secret that the US government continues to struggle [9] with cyber-attacks on infrastructure because all wireless networks have a back door to China. The installment of "5G" systems in NYC ***is*** the installment of the CCP biometric surveillance system. Did you think 5G was only about making cell phone calls? No, it's about surveillance. At any time, the vulnerable wireless systems could be disabled, intentionally.

In addition to being a state security problem, the FCC guideline adopted in the 1990's and followed by NYC was determined to be non-protective of health or the environment:

"The U.S. Court of Appeals for the D.C. Circuit ruled the Federal Communications Commission (FCC) failed to provide a reasoned explanation for its determination that its wireless radiation guidelines -set in 1996- adequately protect against all harmful effects of exposure. The legal case brought by Environmental Health Trust (EHT) challenged the agency's 2019 decision not to change its 1996 health and safety guidelines regarding wireless-based technologies (including 5G)." [5]

In conclusion, deployment of 5G Infrastructure and Wi-Fi across the NYC will exponentially increase the levels or microwave radiation exposure to New Yorkers, causing even more harm to health and damage to the environment. The systems will increase the ability of hostile adversaries to easily cause harm, intentionally.

The solution is to hard wire connections that New Yorkers have already paid for [10][11], with fiber to the premises, and to take the microwaves out of the air.

Sincerely,

Beverly Foster

Wayne, PA 19087

Reference

1.) *Scientific evidence invalidates health assumptions underlying FCC and ICNIRP exposure limits determinations for radiofrequency radiation: implications for 5G (icbe-emf.org)

2.) Actual or potential effects of ELF and RF/MW radiation on enhancing violence and homicide, and accelerating aging of human, animal or plant cells. (lincoln.ac.nz)

3.) Why Everything Wireless Is 2.4 GHz | WIRED

4.) 38,767 publications and 7,002 summaries of individual scientific studies on the effects of electromagnetic fields: EMF-Portal | Home

5.) What Evidence of People Injured by Wireless Radiation was Ignored by the FCC - Historic Lawsuit EHT et al. v FCC - Environmental Health Trust (ehtrust.org)

6.) Mystery Illness on East 4th Street - WESTVIEW NEWS

7.) Smart Meter Action Alert-NY State - YouTube

8.) New Yorkers 4 Wired Tech

9.) U.S. State Department warns China could hack infrastructure, including pipelines, rail systems (msn.com)

10.) Search Results for "New York " – The IRREGULATORS | An Independent, Expert Telecom Team

11.) New Yorkers have already paid $ 6,735,908,260 for FTTP that they never got.
Overcharged America – The IRREGULATORS | An Independent, Expert Telecom Team

12.) RF/MW Radiation Readings Chinatown NYC November 10, 2022:
The Microwave Radiation Invasion • ZERO5G

13.) Effects of microwave radiation on brain energy metabolism and related mechanisms | Military Medical Research | Full Text (biomedcentral.com)

14.) Ten Steps to Reduce Wireless and Cell Phone Radiation in Your Home: Healthy Living (ehtrust.org)

16:09:07

0.6 mG

19 mW/m2

EMF

1

V/m Normal

PEAK: 52 V/m

WiFi/Phone

GQ EMF-390

16:12:34

30
mW/m2

0
V/m

EF

0.6
mG

PEAK: 0.7 mG

Cell Tower

GQ EMF-390

Ave:-85dbm Chn:405/812kHz
2.452GHz -83dBm
2.430 + -77
2.400GHz (-92dBm) 2.504GHz

16:06:45

0 V/m

0.5 mG

EF EMF

RF

16.37

mW/m2 Web

Pk:127.0 mW/m2

Cell Tower

GQ EMF-390

HF 35C
HF-Analyser
800 MHz-2700 MHz
Audio
199.9 µW/m²
1999 µW/m²
Signal
RMS
Peak
Power
044
Power Flux Density
GIGAHERTZ SOLUTIONS
Made in Germany
CE
LTE/4G
GSM
(LTE/4G)+GSM
UMTS/3G
LTE/4G
Radar
GPS
DAB
GPS
DECT
WLAN
Video
Micro-wave
700
1000
1500
2000
2500
typ. HF-Services (MHz)

My name is Chelsea Formica. I live at 520 E 90th Street where a 5G wireless facility was placed atop a city owned light pole by ExteNet less than 10 feet from my infant son's bedroom. This pole is different from the Link NYC poles, but the issue with OTI's lack of communication remains the same and should serve as a tale of caution for all constituents today as to what will happen once a pole is erected and to the lack of communication that will happen thereafter.

Our community board was not given the contractual 15 day notice to discuss or refute this pole's erection that is less than 10 ft from my infant son's bedroom and people's living spaces. Since then Community Board 8 has called for a moratorium on all 5g pole installation in our district.

In addition, this pole blocks our view of a Nationally Registered Historic site - The Municipal Asphalt Plant. We are currently looking into whether or not Section 106 was completed.

We had Council Member Menin, Borough President Mark Levine, Senator Liz Kreuger, and Assembly Member Rebecca Seawright all cosign a letter to ExteNet and OTI asking that the pole be removed because of a failure to notify constituents and because of the proximity to our building. OTI refused to relocate a single pole.

ExteNet and OTI responded to this letter stating that "when the site is operational, ExteNet would offer to conduct a field RF Emissions test that they believe would affirmatively demonstrate that the site meets all Federal RF Emissions safety standards". Since both OTI and ExteNet have not followed through with any transparent, promised and/or required communication either before or after this pole was installed I am here today pleading for information from OTI on when the pole will be turned on, when these tests will be completed, when/how we will be able to see test results and if there is any way we can move this single pole. This is for the safety of my baby and my family.

Thank you

Yes, we do love NYC

Earlier this year, a new campaign, **We ❤️ NYC**, was launched to "showcase the city's strengths and mobilize New Yorkers to make sure this remains the greatest city in the world." That's straight out of the campaign's website, www.welovenyc.nyc.

And as a Bronx-born New Yorker whose families have lived in various New York boroughs for approximately 140 years, I very much love NYC.

But I'm deeply worried about it — and its citizens — in light of the plan to install thousands of enormous, 'Jumbo' 5G antennas on giant monopoles on New York City streets.

If we really love NYC and love New Yorkers, you will reject this plan. They're unsightly. They're less effective than wired broadband and FTTP (Fiber To The Premises). But far more critically, they're a biological health risk. Thousands of peer-reviewed scientific studies have shown that the installation and implementation and 24/7 operation of non-ionizing, non-visible EMF radiation — regardless of its use — is a health threat. That's science talking. Not fear-mongering.

I don't deny the need for technological progress. Far from it: I work in the communications business and use it every day. I just know there are considerably safer options.

The **We ❤️ NYC** website goes on to say that "once again, New Yorkers are coming together to mobilize civic action and community engagement as the catalyst for a renaissance of the city and its neighborhoods." A renaissance is a rebirth, a period when ideas flourish. When challenges are met with exciting, fresh thinking and a culture evolves and advances.

5G monopoles all across City zip codes is a regression. Or worse, an assault on our future.

I urge you to act in the best interest of your constituents — the reason you chose to sit in this Council in the first place — and use common sense. For the common good. Say yes to NYC and no to monopoles. That would be an act of ❤️.

Thank you.
Chet Moss
June 10, 2023

I visit NYC often and cannot be exposed to the science-based detrimental health effects of Link5G. Please make the 2.3 trillion dollar telecom industry responsible for protecting citizens from its products!

-Deborah Fontana

RE: LinkNYC 5G Towers

Dear Council Members,

I am a resident of Westbeth in the West Village, I vote, and I **strongly oppose** the installation of 5G towers in my neighborhood. I am a senior living on a fixed income and cannot afford internet service in my home. I need service on my home computer that I can afford. I cannot stand on a street corner to connect to the internet. These towers do not solve the problem for people like myself who cannot afford internet service. These towers only benefit tourists and street traffic (and the private company getting revenues from ads and internet providers).

I am asking that the council STOP the installation of these towers. The West Village has no broadband problem and there is no need for them in our neighborhood. These towers will be an **unsightly blight** on an historic neighborhood where streets are already overcrowded and difficult for pedestrians to navigate. More importantly, they are a **health hazard**. Studies show that the electromagnetic radiation emitted by these towers is a health hazard to those living near them.

I have experienced these health hazards firsthand, having grown up on a street near a field of electric towers. My neighborhood was a cancer cluster and my mother developed early onset Alzheimer's at age 50! There are studies that link electromagnetic waves to Alzheimer's and cancer and many other health issues. "Numerous recent scientific publications have shown that EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life."* And over 500 studies confirm this! The EPA told us the air was safe to breath after 911, and this turned out not to be true. Yet we are expected to believe the claims of LinkNYC on the safety of these towers.

Finally, **there is no need for 5G towers in my neighborhood.** Our area is already fully wired for broadband and existing cell coverage is excellent. OTI has failed to respond in any meaningful way to the resolution that Community Board 2 passed describing in detail the reasons it is asking for a moratorium on construction of LinkNYC 5G towers in our area, nor have they responded in any meaningful way to the letters sent by all of our local elected officials that describe in detail the reasons they are asking for a moratorium on the construction of these towers in our area.

Please STOP THIS INSANE IDEA of putting UNSIGHTLY AND HEATH-THREATENING 5G towers in our landmarked and historic West Village!

Sincerely,

Debra Jenks
Westbeth Artists Residence
55 Bethune Street
New York, NY 10014

* https://blogs.scientificamerican.com/observations/we-have-no-reason-to-believe-5g-is-safe/

Elizabeth Fox

Thank you to this council for allowing me to speak. I am honored to be here representing the building where I live, 1115 5th Avenue.

Our building is united in strong opposition against the installation of the 32 foot tall 5G towers, including the one planned for the front of our building. 1115's position is also laid out in the written testimony submission from our Board president George Stonbely.

First, the imposing 5G Towers do not belong in residential communities where existing infrastructure can accommodate current and future telecom equipment. Making use of existing infrastructure for updates to telecom equipment is both a precedent in our city and how countless other cities are rolling out 5G services. In fact, in the intersection in front of our building where they are proposing a tower, there is already 5G equipment in place on the intersection lampposts!

Second, these 32 foot imposing towers do not belong in designated historic districts, particularly the Carnegie Hill Historic District, where residents, like myself, take lots of pride in our community's ongoing commitment to historic preservation and the upkeep of our community's beauty. The character of our historic neighborhood attracts residents and visitors alike, and we simply do not want imposing towers marring our neighborhood's beauty and our commitment to preservation.

Third, largely due to the beauty of our historic neighborhood and the many schools, museums and doctors' offices within it, Carnegie Hill welcomes countless visitors to our neighborhood. As a result, the sidewalks are quite busy with

tourists, school children, and the many elderly residents who live within the neighborhood. The last thing we need are additional, imposing street furniture, especially when there are alternative locations for the 5G equipment and the neighborhood already has robust 5G service.

Fourth, it is deeply troubling that CityBridge has already ignored the proper rules and regulations for their proposed plan by installing towers prior to a section 106 review by state authorities under FCC policy. This blatant disregard for the law and procedure shows that this for-profit entity is not operating in good faith for the collective community, despite what CityBridge may say. Thus, we desperately need this esteemed Council, to compel an end to this plan and demand better from OTI.

I now want to speak on a personal level. My husband and I live on the second floor of 1115 5th Avenue with our three young children, and the proposed tower will be just 13 feet from my three year old's bedroom window. We purchased the apartment just before the announced location of the 32 foot telecom tower, and truly, we would not have purchased the apartment had we known of the tower's siting. What makes this all the more galling, is that we are planning a renovation of our apartment, and as part of that, we of course must adhere to the City's landmark designation requirements. As many apartment owners know, these requirements cause our renovation to be much more costly and time-consuming. We understand though and are okay with the additional time and cost because we so deeply value our historic community and its commitment to preservation; it

is why we chose our apartment. It is terribly unfair that this City would allow a for-profit tech company to install 5G towers that degrade and crowd our streets, but will require us, individual apartment owners, to adhere to strenuous and costly landmark designation rules.

I hope that common sense will prevail and the historic districts will be spared these deeply obtrusive and unwanted 5G towers.

June 9, 2023

To the Honorable Jennifer Gutiérrez and the Committee on Technology,

Thank you for the opportunity to send my written testimony to the New York City Council Committee on Technology on June 9, 2023 to support my on-line testimony on Wednesday, June 7, 2023.

My name is Erika L. Ewing. I am:

- CEO and Founder of Got To Stop LLC
- 24-year Harlem resident in the Mt. Morris Park Historical Landmark District across from Marcus Garvey Park.
- Board of Trustees of Mt. Morris Park Community and Improvement Association
- Board of Trustees, Sisulu-Walker Charter School in Harlem
- Former Chief of Staff Black Lives Matter of Greater of New York.
- Member of New York Alumnae Chapter, Delta Sigma Theta Sorority, Inc.

THREE SITES ARE PROPOSED FOR LinkNYC 5G TOWERS IN CENTRAL HARLEM AND TWO SITES IN EAST HARLEM.

- **3 MT. MORRIS PARK W. NY, NY 10027 (Manhattan Community Board 11)**
  - This site is less than 30 ft from my front window.
- **18 MT. MORRIS PARK W. NY, NY 10027 (Manhattan Community Board 11)**
- **W. 121 and Malcolm X Blvd. NY, NY, 10027 (Manhattan Community Board 10)**
- **20 East 111th St. (Manhattan Community Board 11)**
- **401 East 110th St (Manhattan Community Board 11)**

Manhattan Community Boards 10 and 11 wrote a resolution to disapprove all 5 sites.

I have attended several community boards and heard the CityBridge LLC and OTI presentations. CityBridge LLC and OTI have strategically and racially targeted the underserved communities, telling them 5G is what underserved New Yorkers and low-income people need. They gave no alternative solutions for “closing the digital divide” and verbosely pushed their agenda. CityBridge LLC President Robert Sakota falsely constructed a divisive narrative that if we oppose 5G Towers, we are turning our backs on the poor and underserved in our communities. This tactic is disingenuous, and it is gaslighting because it places an unfair burden on the community board; if your community board chairs or members cannot articulate their views and or lacks data and scientific and technological knowledge to support why they reject the LinkNYC 5G Towers, question, or express their dissent, then the community has failed to provide a sufficient, significant, and sound rationale to prove why you would oppose LinkNYC 5G Towers.

The community shouldn't have to prove dissent.
If the Community Boards vote "NO,"
It's because WE, THE COMMUNITY, SAID SO!

On Monday, April 3, 2023, I met with the NYC Office of Technology and Innovation OTI, accompanied by Civil Rights Attorney Jorge Vasquez, Vasquez Sagarra LLC, and Madlyn Stokely, the President of Mt. Morris Park Community Improvement Association. **Chief Technology Officer Matthew C. Fraser declined our meeting at the request of Mayor Adams. Instead, he had us meet with** Brett Sikoff, the

Executive Director of the Franchise Administration, and CTO, Counsel Dineli Diaz, In the meeting, Brett Sikoff said NYC Landmarks and Preservation Commission is the only one who can approve or disapprove of the LinkNYC 5G Cell Towers infrastructure in our Harlem Historic landmark district.

The Central Harlem nor East Harlem community was not on the list of locations in the last amendment of the franchise agreement between CityBridge LLC and NYC OTI because Mount Morris Park Historic District did not fit their criteria, nor are we classified as an "Equity district." Brett Sikoff from OTI acknowledged that but said things like this happen.OTI, Brett Sikoff said the NYC Landmark Preservation Commission is my only hope.

TO BE TOLD BY OTI and CITYBRIDGE LLC FREE PUBLIC WIFI IN CENTRAL HARLEM HAS NOT EXISTED BEFORE THE LINKNYC KIOSKS IS A LIE!

FREE PUBLIC WIFI WAS INSTALLED THROUGHOUT HARLEM IN 2013 under Bloomberg's Administration. December 3, 2013: "Mayor Michael R. Bloomberg today announced the launch of a new outdoor public WiFi network in Harlem accessible to all users at no cost. The Harlem WiFi network will extend 95 city blocks, from 110th to 138th Streets between Frederick Douglass Boulevard and Madison Avenue making it the largest continuous free outdoor public wireless network in the nation.

Read more: https://www.nyc.gov/office-of-the-mayor/news/394-13/mayor-bloomberg-country-s-largest-continuous-free-public-wifi-network#:~:text=Mayor%20Bloomberg%20Announces%20Country's%20Largest%20Continuous%20Free%20Public%20WiFi%20Network&text=Mayor%20Michael%20R.,all%20users%20at%20no%20cost.

CENTRAL HARLEM DOES NOT NEED LinkNYC 5G WIRELESS SERVICE For Pedestrian Foot Traffic.

MARCUS Garvey Park offers Free WiFi Services to pedestrians and motorists through the NYC Department of Parks and Recreation. See Lin*k:* *https://www.nycgovparks.org/facilities/wifi*
Selling our Harlem streets to wireless telecommunications companies for their profit is not what Harlem asked for, wants, or needs, nor was our historic district listed in the current 3rd Amendment of the Franchise Agreement.

TO BE TOLD BY OTI and CITYBRIDGE LLC, "OUR HARLEM DISTRICT IS POOR AND DISADVANTAGED" IS FALSE AND INFLAMMATORY!

Central Harlem's Mt. Morris Park Historical Landmark District is a vibrant district despite our challenges. The residents, business owners, churches, daycares, schools homeowners, community-based organizations, and associations, including the NYC Parks and Recreation Department, Marcus Garvey Park Alliance, SAVE Harlem Now, and the Harlem Historic Parks Administration living within the proposed area of the three LinkNYC 5G Cell Towers **WERE NOT CONSULTED or given a needs assessment survey**, **nor are we categorized as an Equity District and listed in the 3rd Amendment of the Franchise Agreement between NYC and CityBridge LLC and yet three were proposed in our district.**

There is no "singular" definition to define the digital divide?" The LinkNYC 5G Cell Towers franchise agreement with CityBridge LLC solely concentrates on one aspect of the digital divide - AVAILABILITY

while blatantly ignoring the other measurable data AFFORDABILITY, QUALITY OF SERVICE, RELEVANCE, and SAFETY.

CITYBRIDGE LLC DEFINITION, WHILE IT MAY APPEAR PROFITABLE TO THE CITY, ONLY PROFITS THE WIRELESS COMPANIES. CityBridge LLC LLC LinkNYC 5G PLAN IS DIVISIVE AND EXPLOITATIVE, AND IT THREATENS OUR MORTALITY AND QUALITY OF LIFE IN CENTRAL HARLEM.

At the previous NYC City Council Committee on Technology Public Hearing held on May 3, 2020, with DOITT, CityBridge LLC, and ZenFi. Watch Hearing

SEVERAL QUESTIONS WERE ASKED. MANY RESPONSES WERE VAGUE, AND SEVERAL WERE LEFT UNANSWERED, such as the impacts on CYBER SAFETY, PRIVACY, IDENTITY SECURITY, SELLING PERSONAL INFORMATION AND DATA, While other questions about health safety were dismissed.

Our Harlem community continues to be an environmental dumping ground, a place for social, political, and economic exploitation and experimentation with an over-saturation of drug treatment centers.

The LinkNYC 5G Towers negatively impact, exacerbate, and compound our existing problems related to:

- **Safety: Environmental Health Risks**
  - **OTI and CityBridge LLC have not provided any data or research to prove safety. OTI and CityBridge LLC have a SAFE HARBOR, a legal immunization clause that protects the companies who lease the tower space. It does not protect the community from environmental, safety, and health risks.**
  - To accept OTI's CityBridge LLC services without knowing LinkNYC5G Cell Towers' adverse environmental and health risks is irresponsible. This is not a risk we should take, especially when it impacts and could potentially threaten all community residents. Harlemites live with the highest asthma rates and other environmental stressors that comprise those with pre-existing health conditions. According to the Environmental and Health Data Portal (EH Portal): Understand how environments shape NYC."
  - Asthma and the Environment in Central Harlem - Morningside Heights Central Harlem-Morningside Heights includes Zip Codes: 10026, 10027, 10030. 10037, 10115, "Asthma is a common lung disease and a leading cause of hospitalizations for children under 15. This report provides a summary of asthma indicators by neighborhood. It also describes housing and neighborhood characteristics that can make asthma worse." Read more: https://a816-dohbesp.nyc.gov/IndicatorPublic/beta/neighborhood-reports/central_harlem_morningside_heights/asthma_and_the_environment/
- **Fire Safety:**
  - **Radiation Fires are Deadly and Could Desecrate the Harlem Community.** Radiation is the transfer of heat by electromagnetic waves. This process does not require a material to be in contact with the object that is emitting the radiation. Radiation can travel through a vacuum, which makes it very efficient at transferring heat over long distances.
  - Read More. https://ehtrust.org/cell-tower-safety-risks-fires-and-collapse/
  - Example: https://anash.org/fire-extinguished-on-roof-of-crown-heights-apartment-building/

- **Security**
- **Over-policing and Surveillance in Black and Brown Communities**
    - Data Shows: FACIAL RECOGNITION “Independent assessment (https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8280.pdf) by the National Institute of Standards and Technology (NIST) has confirmed these studies, finding that face recognition technologies across 189 algorithms are least accurate on women of color. Read:https://sitn.hms.harvard.edu/flash/2020/racial-discrimination-in-face-recognition-technology/
- **Decrease in property value.**
- **Tenant protections and evictions:** Constructive Eviction and "Implied Warranty of Habitability 'in NY ”— a tenant’s right to live in a safe and comfortable home. NY State law establishes three requirements for landlords to comply with the warranty.
- **Environmental Hazards:** https://ehtrust.org/science-on-health-risks-of-cell-towers-5g-exposure-small-cell-densification-and-new-wireless-networks/
- **Medical Red-Lining: Over saturation of drug treatment facilities and self-harm reduction centers**
- **Increase of Homelessness, Mentally Ill, and Drug addicted communities sleeping in and around the Harlem Historic District and Marcus Garvey Park.**
- **Theft**
- **Access and affordability of technological devices compatible with the LinkNYC 5G NYC Towers**

These LinkNYC 5G Towers will not help strengthen or provide fast, reliable, and safe internet connections in your homes. LinkNYC 5G Towers are designed for the streets. They are unsafe and unsecured connections for wireless cellular phones by design; they will entice wireless companies to invest and make money. The city nor the residents in that community reap any financial benefits from leasing space to LInkNYC 5G Towers. These companies who are affiliates of CityBridge LLC will.

NYC has already lost millions investing in CityBridge LLC with the Links-NYC Kiosk program. Read here: https://www.theverge.com/2020/3/5/21166057/linknyc-wifi-free-kiosk-google-new-york-sidewalk-labs-payments-revenue.

Read more about CityBridge LLC:
https://finance.yahoo.com/news/zenfi-networks-soon-boldyn-networks-130500310.html
https://www.boldyn.com/?utm_source=referral&utm_medium=press_release&utm_campaign=May2023_Sokota_JerseyCitySummit_Event
.
Mt. Morris Park Historic District has been a place of solace and peace for myself and many residents and should continue to be a radiation-free and safe community for all of New York City to enjoy.

I ask the City Council Committee on Technology and the Mayor of NYC to strongly accept and consider my written testimony and begin to put the lives of millions of New Yorkers’ lives before greed, profit, or industry. GOT TO STOP Perpetuating the Digital Divide and Keep NYC Safe, Protected, Informed, and Educated (SPIE) through LinkNYC5G Transparency.

There are solutions to closing the digital divide that benefit all. The key is Fiber to the Premises, not Wifi, and certainly not 5G military weaponry, surveillance, and radiation towers. We don't need Wifi software or and LinkNYC 5G Towers to connect to the internet. We need HARDWARE! Fiber should be installed on

all the premises, similar to what Mayor Adam's current Big Apple Connect Program provides FREE for residents in NYCHA buildings

Our lives are not for profit, exploitation, or experimentation with technological advancement in 5G wireless telecommunications.

WHEREAS I REJECT the five proposed LinkNYC 5G Cell Towers in Central Harlem.

- **18 Mt. Morris Park West, NY, NY 10027**
- **3 Mt. Morris Park West, NY, NY 10027**
- **W.121st Street and Malcolm X Blvd, NY, NY 10027**
- **20 East 111th St. (Manhattan Community Board 11)**
- **401 East 110th St (Manhattan Community Board 11)**

WHEREAS I PROHIBIT future land use and plans of installing LinkNYC 5G Cell Towers in Central Harlem, East Harlem, and NYC.

WHEREAS I STRONGLY RECOMMEND the City of New York terminate their contract with CityBridge LLC and all of its affiliate sponsors, individual investors, etc. BAI Communications, ZenFi Networks and soon to be Boldyn Networks in June 2023 for the safety and security of all New Yorkers and fiduciary technology partners and stakeholders.

Our lives are in your hands.

Humbly submitted,
Erika L. Ewing



Got To Stop LLC
erika@gottostopllc.com

WRITTEN TESTIMONY TO NYC COMMITTEE ON TECHNOLOGY

JUNE 7, 2023

GEORGE SINOPIDIS

Contact info:

gsinopidis@aol.com

I am George Sinopidis. I have been in public service for at least 20 years, and I am a Police Lieutenant in New York and I supervise about 150 people. I own a three-story house in Astoria which I purchased in 2013 and renovated it. My sister and I used to live there.

As a Police Lieutenant I only rely on facts. And what I'm about to tell you are the facts.

In September 2020, I came back from Europe where my father just had quadruple bypass surgery. Just several feet from my front yard were a newly installed pole, replacing the old utility pole, with a multidirectional wireless antenna on top. The pole is 35' to 40' tall.

Other wireless antennas are attached to overhead wires that are parallel to the second and third stories of the house where my sister and I lived. I didn't know anything about the harms from wireless radiation, until I became injured. For the first time in my life, I went from being perfectly healthy, to suffering from heart arrhythmias, headaches, and not being able to sleep, out of nowhere.

The canister on top of the pole appears to be omnidirectional and two antennas facing in opposite directions but seeming to cover almost 360° at a slightly lower level than the canister itself. My front yard lines up with the 1000-unit apartment building across the street which was probably the target of the wireless carrier.

I went to my cardiologist who fitted me with a cardiac monitor halter which I wore for 2 weeks. The results showed multiple arrhythmias, which are premature ventricular contractions. That means that a critical heartbeat came too early, disrupting my heart's normal rhythm.

Because the arrythmias came on so suddenly and severely, I had to undergo an invasive procedure in the hospital where they placed a catheter through an artery into my heart. The doctor tried to replicate the arrhythmia to see if he could perform a cardiac ablation. That's a procedure that destroys an area of the heart tissue that is causing rapid and irregular heartbeats. But, to the doctor's surprise, he was not able to replicate the arrhythmia.

That's because I only experienced arrhythmia when I was in my house, not when I was outside of my house. In fact, when I returned from this hospital procedure, the arrhythmia returned when I got back to my house. So, the doctor did a second procedure to perform a cardiac ablation, but again, he found nothing wrong.

I then decided to try an experiment. I stayed with my girlfriend in her apartment in the city, and I discovered that my symptoms simply did not occur, and I was able to sleep.

But this hasn't just affected me; it has also affected my sister. When the pole and antennas were installed, my sister at 31 years old had just completed seven months of chemotherapy at Sloan-Kettering. She had been diagnosed with non-Hodgkin's Lymphoma. When I came back caring for my father in Europe, I found my sister sicker than when I had left, and she was having headaches and nausea. When she told her oncologist about the new wireless antennas, he said that wireless radiation could aggravate her condition and the cancer could come back. He said it was essential she avoid all radiation including wireless radiation after her treatment.

My sister and I have since moved out of the house.

Also, this has been a financial drain. I put my life's savings into buying the house and renovating it from top to bottom. I created four apartments and had a financial plan for my future and a revenue stream. Then the wireless antennas arrived. I am now $250,000 in debt, shouldering a mortgage for a house that neither my sister nor I can live in. I have had difficulty renting the apartments in the house. I now have an unmarketable house.

What is disturbing to me is that I received no notice, no warning. The city should have safe zones, a buffer zone from houses. What's fair is fair. We should have input on where these wireless antennas and towers go. Why not put the tower in the flat surface parking lot by the 1000-unit apartment complex the carrier was trying to service?

Everybody I called at the city to discuss this situation was either abrasive or they didn't have any information. The lack empathy from city officials, and the lack of resident

control – like all our freedoms are taken away with these towers – is like nothing I've ever seen before. It doesn't make any sense.

I've been a public servant all my life. I was a full paramedic at 19 – the youngest in New York City. A police officer at 20. I worked my way up doing every beat that you can do. I was at ground zero after 9/11 with my partner. We took turns going into the World Trade Center to pull people out. As I would pull a person out to safety, my partner would run back in. We'd switch. It was during one of those switches, as I was pulling a person to safety, my partner ran back in and then the tower collapsed. My partner was later found in the rubble.

I use wireless technology and I use a cell phone. But you can't put these towers in people's yards or close to their homes with no notice, no negotiation, no room for compromise. I guess the telecom carrier liked the angle from my front yard because they probably made more money. It was a more direct line of radiation at more apartments. But I'm paying the price.

The height of the pole in front of my house is similar to the Link5G cell towers at about 32' and the city wants to put these poles in this district. The city is not doing its job because it is not providing us with true participation. They've already entered into agreements with City Bridge to place these Link5G cell towers next to our homes. Again, if this is a done deal, then there is no real prior notice and no true participation. Isn't the city supposed to be protecting our health and safety?

If I'm not doing my job, I get indicted. If city officials aren't doing their job, nothing happens to them. Aren't city officials supposed to be protecting us from this unnecessary radiation? So, what happens to them if they don't? Nothing.

I recommend disapproval and a moratorium for all further wireless installations, including the Link5G cell towers, in this district until the city can come up with a better plan that makes sense to the residents with their full prior participation and full prior approval.

East 85th Street
New York, NY 10028

info@ryansdaughter.nyc

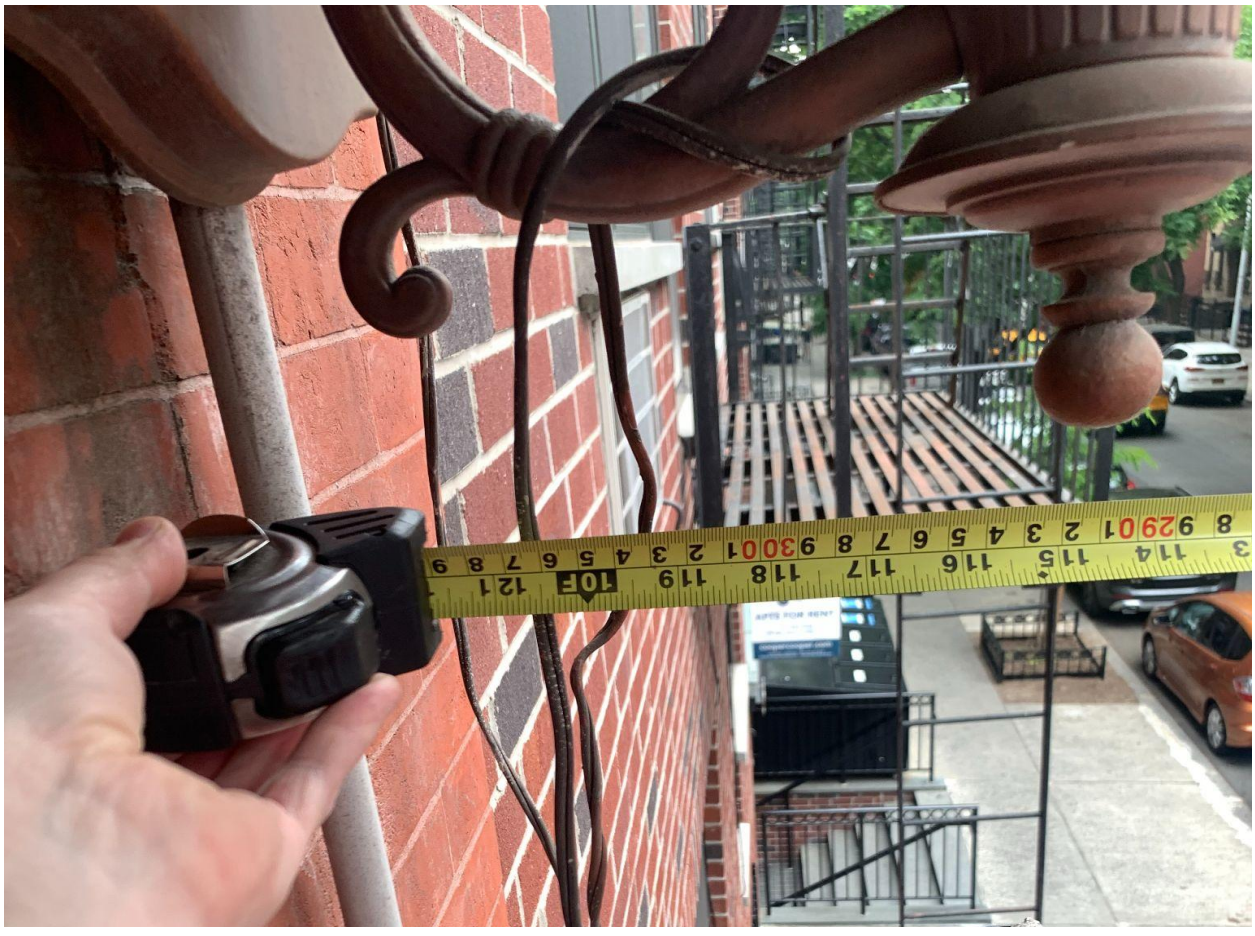
June 7, 2023

To the Committee on Technology,

Please be aware that as a resident, business, and building owner on the upper east side, I am concerned about the installation of 5G towers in the area, most specifically directly outside of 350 East 85th Street - which may or may not be a part of the LinkNYC 5G Tower system. I do not know who owns this tower. Last Spring we were startled by the appearance of a work crew who began work by moving the streetlamp existing in front of the building. They dug up the lamp and moved it approximately 12 inches toward 2nd Avenue. There was no notification or information shared regarding the work. Later in the summer of 2022, another crew arrived to install the 5G tower on this newly placed street lamp. Crews returned numerous times to work on the tower, both at the top and under ground. In speaking with these crews I was made aware that the workers have strict orders regarding how long they can work on the units and how long they can spend near them. I learned very little else regarding the 5G units, I still do not know who owns them or who is responsible for them. There are no markings on them. These units sit right outside the window of my building and the building next to me. I can only guess that they moved the pole to satisfy some requirement as to the distance allowed for a residential building. But I can't be certain since they were placed in a stealth-like manner. They not only change the look of the street, but I am most concerned that they may also be harmful to its residents. I am here today to ask that there be more investigation, education, transparency, and responsibility and accountability concerning the installation of these units. I would like to know who controls them, owns them, and who is accountable for them? I look forward to learning more at this hearing and hope that this new technology will be properly checked and that those who own it will be accountable for it. I have attached photos of the units both from the street view and from inside 350 East 85th Street. The units are 10 feet 2 inches from the building. Thank you for your time on this issue.

James Gerding
East 85th Street
Jim@ryansdaughter.nyc


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NYC City Council - Select: Committee on Technology

Technology Committee Oversight Hearing

Support for Deployment of 5G
Infrastructure and Wi-Fi Connectivity

To: Jennifer Gutiérrez and members of NYC CIty Council
From: Jared M. Harris - 4523 Broadway NY, NY 10040
Date: June 7, 2023

Hello, my name is Jared Harris and I am a resident of Washington Heights in NYC. The purpose of my testimony is to give my support to the deployment of 5G infrastructure and Wi-Fi connectivity in my community.

Improving access and speed of cellular and Wi-Fi connectivity plays a vital role in keeping NYers up to date with the latest technologies. This allows us to participate in all of the new and upcoming solutions the internet provides. Whether it's access to research or getting timely information on commuting, the internet provides all of us with boundless information.

I am a big proponent of community Wi-Fi. Everyone should have access to the internet because without it one can miss out on so much. Our everyday lives now require an internet connection. Even applying for jobs is primarily an online task. Not to mention the plethora of free education the internet provides.

In closing, please vote in favor of deploying 5G infrastructure and expanding Wi-Fi connectivity in our communities.

Testimony for City Council Energy Committee Hearing June 7, 2023

File #T2023-3577

From Jill McManus, ### E. 81st St, New York, NY 10028, jimac4@verizon.net

The Link5G cell towers suddenly appearing around the city seem like alien intruders attempting to collect money for the city and telecoms through advertising and hype, while posing an as-yet unknown risk to the health of New Yorkers.

The planned buildout of 4,000 Link 5G cell towers (and up to 7,500 by 2026) will bring millions of NYC residents, including elders, pregnant women, children, people with physical disabilities or immune system problems, pets, trees and other life forms into involuntary daily exposure to invisible electrical emissions of RF radiation 24/7, containing several different frequencies at different levels of effective power. No agency is monitoring emissions levels, nor the aggregate levels of co-located antennas. Telecom compliance with FCC limits is done on the "honor system."

Thousands of peer-reviewed scientific studies show that radio waves, especially the irregular "millimeter wave" signals used for 5G that pulse millions of times per second, can affect or disrupt biological processes (for example calcium function in the cells) even at levels well below the FCC "exposure guidelines" which were set 27 years ago and based only on temperature increase where a phone was held on a plastic male head. By allowing the densification of cell towers New York City is taking a Las Vegas-type gamble on the present and future health of our NYC population. Most insurance does not cover radiation injuries. The telcoms' annual reports to stockholders admit this liability.

5G uses at least three times the energy needed for 4G and leaves a much larger carbon footprint which will increase with the explosion of 5G gadgets and devices for the Internet of Things and Bodies, and data storage. The Link5G cell towers are geared towards building future capacity for profitable sales of these items, and information-gathering for sale of data to third parties, not for need. We don't need this.

The wireless buildout is been touted as a way to "close the digital divide." However, it will have opposite result. Many of the choices of sites are questionable. Many installations have been centered on so-called "equity areas" identified by the telecoms, claiming they did a needs survey in 2020 (but with no locatable documentation). Some people in those areas resent being considered needy and do not want the towers. Few in the areas that do need more coverage can afford 5G phones and services. The reality is that they will be stuck with an inferior, if not already outdated, technology, lodged in an unsightly, intrusive 32-foot sidewalk obstruction facing into private residences. Wireless needs constant upgrading, is easily

hackable, and will expose people in “equity areas” to wireless RF radiation. Fiber optic cable to the premises, or even better, to the device, is more reliable, more private, more secure, and emits no radiation when used alone (rather than used for wireless backhaul). Affordable fiber will allow children to do their homework safely at home. Fiber has been called “future-proof” and acknowledged as better for national security by former FCC Chairman Tom Wheeler, who used to advocate for wireless at any cost when he was at the FCC! The military invests heavily in experimental 5G technology for battlefront coordination, control of space, and crowd control (the latter called Active Denial). Do we want to open 5G access to every block?

When Verizon, our public utility, failed to implement its promise of fiber (FIOS) to the premises for all New Yorkers by 2014, they nailed the Digital Divide into place! Verizon claimed that fiber was unprofitable, took the billions of dollars collected over more than a decade by rate increases on local service, and by employing cross-subsidies diverted them to their private wireless division, where they can charge what they like. They also closed out competitive start–ups and made their carrier lines too expensive for small fiber companies to lease. Thus the creation of the Digital Divide. (See *Irregulators v. the FCC* http://irregulators.org/ and https://scientists4wiredtech.com/2020-irregulators-vs-fcc-law-suit/

NYC should demand more back from Verizon than the $500 million settlement it got in 2017, and assure us, with documentation, that the money is being used to build fiber to the premises for all New Yorkers. Wireless must be kept to the minimum for emergency outdoor calls as prescribed by law in the Telecommunications Act of 1996, and used only for inaccessible rural areas. This would instantly lower the amount of RF radiation exposure for New Yorkers, safeguard our health, and limit future liabilities to the City.

I urge the Technology Committee to order a moratorium on any further installation of the Link5G cell towers in NYC and to deactivate the already installed towers until more is known about the health effects and public safety. We need to reexamine the use of wireless and move forward with “wired broadband” – i.e. fiber to the premises installation.

I thank the Committee for hearing my testimony.

Jill McManus

Good Afternoon members of the New York City Council,

My name is Jules Block and I'm here to testify about the positive impact LinkNYC has had on my small business as well as my community involvement.

As the owner of a pet care company called Bark Slope, I've experienced first hand the benefit that the free Link Local ads can have for small businesses. My grooming salon is in a community that loves to support small business, and the Link Local ads highlight my services directly to that community. I've been able to promote new services and draw new clients to my business. It's difficult to run a small business in a city like New York. Even though I've been successful for over a decade, finances are always tight. Having the opportunity to advertise directly to my local community, at no cost, has helped to increase my bottom line.

I also use the ads to inform myself of local happenings. It was because of a LinkNYC ad informing about the deadline for applications to local community boards that I put in an application and was named as a new member of CB6.

The staff at LinkNYC have always been helpful and courteous, and I'm very grateful to be able to have access to their services.

Julie Ann Ashcraft's Testimony Before the NYC City Counsel Technology Committee

As a low income person, I DO NOT NEED LinkNYC Wifi.

I already receive free internet from the FCC via the Affordability Connectivity Program.

ACP gives me the opportunity to choose a Wifi or a *wired* Ethernet connection.

I choose Ethernet because:
Wifi interferes with clear thinking;
Wifi interferes with sleep, and
Wifi interferes with other important body processes—including how the body uses Calcium!

I do NOT own a cell phone. I do NOT use Wifi. And I wisely opted out of a dangerous SMART meter.

Before I installed metal screens over windows, mirrors and SHEET METAL over walls in my top floor apartment, I could feel microwave radiation from nearby wireless antennas and routers COOKING MY BODY! Incoming radio frequencies also interfered with electronic equipment such as my handheld decibel sound level meter.

Although I still need to put sheet metal on the floors to block neighbors' incoming electrosmog, the shielding I've already installed is improving my health and enabling my houseplants to grow into trees. My indoor forest not only removes carcenogeic air pollutants, it converts the CO2 I exhale into pure, clean oxygen!

LinkNYC Wifi towers pose a FIRE THREAT to outdoor trees and to all nearby tenants living in combustible wood frame buildings such as the RENT STABILIZED building I live in. LinkNYC tower fires have the potential to suddenly destroy low income and affordable housing at a time when we need it most.

Even when operating normally, LinkNYC Wifi towers exude harmful electrosmog that disabled electrosensitives such as myself *walk blocks out of our way to avoid.*

Professional EMF blocking clothing is expensive beyond my means, so I am left grappling with mylar blankets, tin cans and steel window screen in an effort to cobble together a portable Faraday suit to protect me against Wifi when I am outside my home.

You do not accomodate people with disabilities by bombarding us with electomagnetic frequencies that have already harmed us.

Committee on Technology
Oversight Committee
Re: LinkNYC Deployment of 5G Infrastructure and WiFi Connectivity across the City
6/7/2023

Written Testimony

by

Julie Mardin
Fifth Avneue
New York, NY 10003
juliemardin@earthlink.net

Dear Committee Members,

Thank you so much for your oversight of this very important matter.

I am a lifelong New Yorker, living in Greenwich Village for the past 30 years. I have an interest in the environment, and in good healthy food, just like the mayor. It was this interest that made me sensitive to any news of suppression of inconvenient science. If you read about the early days of cell phone technology, you will see all sorts of shenanigans similar to what was happening in the tobacco industry, and pretty much any other major industry where a lot of money is at stake.

Just to give a couple of examples:

In 1995 Drs. Henry Lai & Narendra Singh published work sponsored by the National Institutes of health documenting double strand DNA breaks in the brain cells of rats after just 45 minutes of microwave radiation at levels far below heating and safety guidelines.[1] Double strand DNA breaks will eliminate the cell's repair mechanism and can lead to poorly functioning cells, or cancer. It could also lead to cell death, which could lead to neurodegenerative, diseases, such as alzheimers, ALS, MS.

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[1] https://pubmed.ncbi.nlm.nih.gov/8627134/

This publication scared Motorola enough to set out to 'war game the science.' They funded contractors to disprove the claims, tried to influence the researchers, and offered funds to keep the research going indefinitely. Nevertheless when the results instead started to be replicated, funding for this type of research dried up.[23]

Similar tactics were used to bury the findings of Dr. Allan Frey, working for the Office of Naval Research and the American Army, the main researcher in this field in the 1970s, who found he could speed up or stop the hearts of frogs,[4] and lower the blood brain barrier with just minutes of exposure to microwave radiation. The blood brain barrier is the thin membrane that protects our brain from the toxins and heavy metals circulating in our system. This effect has implications for early onset dementia, and other cognitive disorders which have seen an increase in recent years. This work was also set up to be debunked by army contractors that used faulty methods.[5]

The work of these scientists uncovered just some of the possible mechanisms that can belie so many different illnesses that are on the rise today. Industry proponents often point to an FDA report that only looks at cancer. It takes the position that the science is inconclusive, and that there is in fact no quantifiable evidence of human harm. They go so far as to say that there has been a slight decrease in cancer in the overall population.

But the Government Accountability Report on 5G points out that the FDA and other organizations "only reviewed a subset of the relevant research," and the FDA report only focused on cancer-related animal and human studies of frequencies below 6 GHz. (At least two of the antennas in the Link5G structures are reserved for higher frequency mm waves, above 6 GHz.)

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[2] https://www.youtube.com/watch?v=NZl2MSHDKls

[3] https://www.youtube.com/watch?v=28FtRM4Xw9U

[4] https://www.researchgate.net/publication/232083331_Modification_of_Heart_Function_with_Low_Intensity_Electromagnetic_Energy, Allan Frey, Edwin Eichert

[5] https://www.researchgate.net/publication/303123645_Cell_Phone_Health_Risk

Not only did the FDA do a limited literature review looking only at cancer, but it omitted impacts to the brain and oxidative stress, effects that Lai and Singh had been documenting. It omitted evaluation of children's unique vulnerability, and the effects on reproduction. It discounted the results of the National Toxicology Program[6] which is why numerous scientists—including several now retired US government scientists—are calling for the FDA to retract the review as it offers unsubstantiated assurance of safety, even calling the FDA's position preposterous.[7] For a comprehensive critique please see Environmental Health Trust's rebuttal.[8]

It also does not deal with any of the science on nervous system disorders, which has become epidemic according to an article by Pritchard et al., and WHO statistics.[9]

Also, the characterization that cancer is going slightly down seems a little deceptive, in that certain types of cancer are on the rise, including the highly virulent forms of brain tumors, glioblastomas,[10] as well as colorectal cancers, which are starting at younger ages.[11]

Even the major insurers will not offer insurance for harms from electromagnetic field radiation, which they classify as an environmental pollutant, and see potential claims of personal injury as a major risk.[12]

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[6] https://thehill.com/opinion/healthcare/416515-theres-a-clear-cell-phone-cancer-link-but-fda-is-downplaying-it/

[7] https://ehtrust.org/press-statement-from-dr-albert-manville-on-the-fda-report-on-cell-phone-radiation-2/

[8] https://ehtrust.org/wp-content/uploads/FDA-Declaration-EHTRUST.ORG-December-14-2021.pdf

[9] Are rises in Electro-Magnetic Field in the human environment, interacting with multiple environmental pollutions, the tipping point for increases in neurological deaths in the Western World? Pritchard et al. 2019 https://www.sciencedirect.com/science/article/pii/S0306987719300040

[10] Malignant brain tumors most common cause of cancer deaths in adolescents and young adults, First comprehensive study of 15-39 year-old population *Date: February 24, 2016, Source:American Brain Tumor Association https://www.sciencedaily.com/releases/2016/02/160224132910.htm*

[11] https://acsjournals.onlinelibrary.wiley.com/doi/full/10.3322/caac.21772

[12] https://ehtrust.org/wp-content/uploads/Swiss-Re-SONAR-Publication-2019-excerpt-1.pdf

The reassurances of safety are coming from very conflicted industry sources and agencies which appear to be captured, as has been well documented in the case of the FCC.[13]

The thought that we are going to be densifying our electromagnetic environment on such a scale with these colossal towers just seems a very shaky foundation for our way of life.

In order to reassure us, we are told that 5G will put out less power, that it will reduce exposures. And yet these are not going to be replacing any existing installations. The argument makes no sense in any case as these are multi-antenna towers, that will be putting out a variety of emissions, including 4G and WiFi.

Furthermore, measurements taken by citizen scientists in the streets of New York, showed that 5G installed streets consistently measured much higher in levels of radiation than parallel streets without 5G.[14] Other studies in cities throughout the world have demonstrated increased levels of radiation as antennas get closer, no matter if the actual power specs of the antenna are lower.[15]

On matters to do with the terms of the agreement itself: We are told that this new infrastructure will all be for free for New Yorkers, but if you look at the contract, you see that the fiber lines will not belong to the city, that the city will have to pay usage fees for whoever will be owning the lines after the expiration of the contract.[16] This appears like CityBridge is building a great big free highway, but then putting a little toll through which they can control access and pricing well into the future. Shouldn't this basic infrastructure be in the hands of the city? As it was supposed to be with Verizon's buildout of fiber, which used public utility status in order to raise the funds for the city wide buildout?

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[13] https://ethics.harvard.edu/files/center-for-ethics/files/capturedagency_alster.pdf

[14] https://globalemf.net/results/

[15] https://ehtrust.org/science-on-health-risks-of-cell-towers-5g-exposure-small-cell-densification-and-new-wireless-networks/

[16] https://www.nyc.gov/assets/oti/downloads/pdf/linknyc-franchises/linknyc-public-communications-structure-franchise-agreement.pdf Section 3.13.3

I urge the committee to please look into the Irregulators' work which brings all this to light, and especially their latest review of Verizon's 2022 Annual Report, and all the cross subsidy tactics that were use to dump corporate expenses onto the regular local phone service accounts.[17] This is actually FCC sanctioned, as in 2007 they granted the major telecoms 'forbearance' of Uniform System of Accounting rules, meaning, as Bruce Kushnick explains in The Book of Violations and Egregious Acts, that the rules would stay on the books but would not be enforced. This allowed the companies to not be in violation of section 254k of the Telecom Act that prohibits a company to subsidize other lines of business by charging the regular local phone customers. A practice they have been doing for years to their local New York phone customers and are probably continuing to this day.

Even though this exemption from proper business practices was allowed on the federal level, Verizon never applied for the privilege on the state level. And IRREGULATORS vs. FCC established that the states are free to challenge these accounting practices and cross-subsidies.[18] This means that there are billions of dollars that can be retrieved from Verizon. If we fail to act on this now, it seems that we are at risk of allowing the publicly funded fiber to disappear into private hands forever.

The disappearance seems well underway. At several of the community board meetings introducing Link5G we have been told that Verizon's fiber wires is a cable franchise, and is proprietary to Verizon's FiOS, and that it is not applicable to wireless phone service.[19] This seems worthy of investigation, since it was paid for by the local telephone customers, and Verizon must make use of it for its own wireless services.

The wireless industry expects to make some 13 Trillion in profits through Internet of Everything and Metaverse applications by 2030, more than half of current US GDP.[20] It will make some people much richer, but under the

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[17] https://kushnickbruce.medium.com/just-released-for-public-review-the-verizon-ny-2022-annual-report-shows-a-massive-corrupt-2eeeee1bbbcb

[18] https://law.justia.com/cases/federal/appellate-courts/cadc/19-1085/19-1085-2020-03-13.html

[19] https://youtu.be/aoM0u5uScdg?t=3854

[20] Pekka Lundmark's keynote speech at the Brooklyn 6G Summit 2022 https://youtu.be/sAF-qDC91M0?t=415

circumstances, it appears that it will all be at the expense of our health and our privacy. And will still not solve the problem of the digital divide.

Hot spots on the street are a poor solution for the digital divide, and talking about fiber to the premises—at some point in the future—seems like we are making the same mistakes all over again.

Back in 2008 we had been told before that a commercial franchise (ie. FiOS) will open up great opportunities for universal broadband. And we can see how that turned out.[21]

I urge the committee to please have a look at the Irregulators' work and listen to their proposed solutions. We must go after all the misappropriated money, which the court system has allowed for State comptrollers to now do. This will give us the money to build out a proper municipal fiber system. If Verizon refuses to do it, give the contracts to smaller fiber buildout companies.

Thank you very much for all your careful consideration,

Julie Mardin

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[21] https://cdn.arstechnica.net/wp-content/uploads/2017/03/nyc-vs-verizon-complaint.pdf, The City of New York vs. Verizon New York, Inc., and Verizon Communications, Inc., Summons, pg. 3

Statement of Lauren Bond
Manhattan, New York
Committee on Technology Hearing
June 7, 2023

I am Lauren Bond, I lived West side midtown 14 yrs, 4th district.

Feb. 21, 2020, nine "5G" cell towers began operating on the rooftop 325 W. 37th St, 40 and 90 feet from my windows. I had a safe place to live before cell towers were installed, changing my life overnight.

With concern regarding the Giant 5G tower installations:
I know of 2 buildings in Manhattan, East Village and Manhattan Plaza, with tenants suffering constant exposure to emf from small 5g cell towers, whether from the roofs on their buildings, or nearby. These people are living in their bathrooms, sleeping on their floors, closets, in their cars, seeking a way to escape the painful exposure. Please know, along with immediate emf from local towers, radiation from more distant small 5g towers increase the total emf levels of exposure people are receiving.

My own experience,
On Feb. 21, 2020, nine "5G" cell towers began operating outside my apartment windows on the roof of the building across to my apartment. Six towers were approx.40 feet, and three were within 90 feet distance from my windows, in contrast to the proposed 10 feet distance Giant 5G Towers are to be installed by buildings throughout New York City.

During these first two weeks of these 9 small cell towers operating, I experienced severe symptoms, which my doctor confirmed:

• Constant tinnitus	• Burning skin	
• Shortness of breath	• Palpitations	
• Increased pain in eyes, limiting visual function • Insomnia • Severe migraines	• Vertical disturbances through cranium and occipital region simultaneous with horizontal intercranial disturbances extending through the ear canal and sharp stabbing pains extending into all 4 extremities	

Chronology

The injuries started on Feb 21, 2020. My injuries from my contemporaneous notes at the time:
- 2/21/20 Very loud tinnitus began immediately and has continued to present.
- 2/25/20 Began waking after only 3 hours. Unable to return to sleep each night.

On 3/1/20 at 2 AM, I am wakened from a deep sleep gasping for breath.Something heavy is rhythmically pressing on my chest. My heart is racing. I am now sharply alert and not knowing why.

I am seemingly paralyzed. Then, a strong, fiery energy core feeling 6 inches in diameter, enters with a sharp, searing stab through the top of my head. It is excruciating. I observe it surging through the center of my brain. Next it begins searing outward through my ear canals with long-burning razor-like piercing through my head. My brain feels sectioned in 4 quadrants. I remain flattened and pinned on the mattress despite efforts to move and run out of the room. I want to move and can't.

I am horrified, this fiery surge is now continuing to course through my neck to the heart. How far is this going? The fiery searing energy core is so large, charges through and around my heart at once, as though no vessel is there, and now to my arms and hands. It continues straight down the core of my torso. It is extending through my legs. I am fully engulfed in burning, piercing energy.

It isn't over. It now flows up through my body in reverse, and surges down through my body again. This wave descends and ascends through me in the same sequence through my entire body as it had begun, in large, repeated surges. Still, as much as I try, I can't move.

This lasted a half hour. The pain is so much, I can't return to sleep after it stops. It feels unsafe to sleep. My skin is burning. My ears are ringing and burning. I don't know what happened, nor the source of this and how to protect myself, and when it might happen again. I am awake for the rest of the night and unable move. I am very weak.

The following days, burning skin and ringing in my ears are constant, and increase when I am inside the apartment. The intensity of energy present in the apartment is like being inside a fire and incredibly challenging to concentrate on any matter or to sleep.

Now eyes burn with increased intensity and does not abate with more applications of eyedrops. Focusing is more painful. Concentration is strenuous. There is heavy pressure on my heart.

The only changes in this building's vicinity are the cell towers. I identify the company and research the purposes of these cell towers across from me; pursue the owner of that building; and, inquire with my apartment manager in getting information. After multiple tries, we get no response from the owner. I continue researching.

Opening the door to the apartment and walking in, I'm met with a wave of constant sense of fire to the skin, heavy pressure on the heart, rapid heart rate, and an electrical burning and pressure through the brain, and shortness of breath. This was not present in the hall. Each time stepping into apartment, immediate burning, sharp needles, strong pressure on the heart, difficult concentration ensues. Stepping out into the hall, it stops. Being inside the apartment, my condition worsened and I could not continue living in my apartment. The severe damage to my central nervous system and pain continued to increase. My apartment was not safe.

The following days I'm extremely concerned being inside the apartment and stay out. I arrange bedding on the bathroom floor, very nervous to sleep in the bedroom any more. Trying for a couple of nights, the wave is present there, and I was still waking after 3 hours. Reading on ways to deflect, I gather all items that I have, setting them in

the bedroom to secure relief from the constant wave penetrating the apartment and trying sleeping in the bed once more. I'm looking into what to purchase as it is affordable, none of it is, and how to work with the open air HVAC units under my windows. Learning more on this radiation, I discover there is no protection that can be designed to prevent its passage as these HVAC units must remain open.

- 3/5/20 After 3 hours sleep, again, I am awakened gasping for breath. The full event repeats exactly as it occurred 3/1/20 for one half hour. I was truly hoping that night March 1st, was a one-off. It is clear this is a schedule. I am not in any way, prepared for this and have yet a place to go. I need more time. I'm harmed and weaker. I cannot live through a third night of this. I'm seriously injured now, and I don't know that I could survive one more event with this. After spending days researching ways to address or accommodate this environment I'm finding none. I've been continuing contact with the building management with these concerns and seeking a safe room however temporary. They have nothing.
- 3/10/20 Contacts inquiring about cell towers and protections and recourse of safety for New York City residents:

1/ Emailed Mayor DeBlasio, no phone number available. Received case # email.
2/ Called Speaker Corey Johnson's office; referred me to DOITT
3/ Left message: Commissioner Bret Sikoff, DOITT. No response was ever given
4/ Left message: Asst Commissioner for Franchise Andrew Manshel. Responded after one week. Explained DOITT expressly for city properties, not residential.
5/ Spoke with DOITT Imani Charles, explained DOITT information from City Council ofc inaccurate, as it involves city properties, not residential. Recommends 311.
6/ Emailed Manhattan Borough office. Left message. No response was ever given.
7/ Called 311. They refer to DOITT although I explain DOITT states city properties only, not residential. Manager at 311 viewed resources and suggested:
a/ Dept of Bldg, special investigation unit 212-825 2413 for permits and zoning/ No response was ever given.
b/ NYS Pub Serv Commission 800-342-3377 m-f 8:30-4/ No response was ever given.
c/ Community Board #4 212 736 4536:
Delores Rubin, Dist. Mgr, Manhattan Community Board. No response was ever given.
Jesse Bodine Manhattan Community Board. jbodine@cb.nyc.gov 1st Wed @ 6:30, 3rd Wed 10 am Emailed/ No response was ever given. Left phone messages. No response.

- 4/21/2020

Called ADA DOJ ofc, 800-514-0301 directed to HUD Regional NYC ofc
LM HUD Regional NYC ofc 212 264-8000 Spoke a few times with staff and their suggestions toward housing issues. No recommendations regarding cell towers.

- 4/23/2020

1/ Sen Hoylman 212 633-8052 left message/emailed.
2/ Mayor's ofc disability Housing Coordinator Arthur Jacobs 212 788 8948 LM or email: ajacobs2@……
3/ Speaker Johnson 212-564-7757....Left message.
4/ Assembly. Gottfried 212-807-7900 ....Left message.

It is pandemic lockdown and I have no safe place to live.

Aftermath

March 11, within 2 wks of the initial occurrence, I secured temporary housing with a friend.

My sleep is restored. Yet injuries remain. I'm physically weaker, collapsing every day, a sensation of being neurologically sliced and burned. Migraines easily triggered, with nausea and constant painful sensitivity to light.

Passing rooftop cell towers is painful. I walk blocks around to avoid. My ear canal intensifies with sharp energy moving through my head. tinnitus gets louder My heart races, and feels pushed in, creating a sense of suffocation. Skin feels like burning brush of thin metal bristles.

Migraines with nausea are more easily triggered. Heightened sensitivity to light and tolerance heat also triggers migraines and nausea.

I continue to have a burning sensation 24/7 from my eyes through to the back of my head, and throbbing across to the lower back of my skull. There is constant painful, sharp pressure around the eyes limiting visual function.

Swift, painful intolerance of heat to the skin from lamps or furnace, within several feet distance, creates immediate palpitations, and sense of suffocation. There is constant sharpness at the crown of my skull. My brain now feels divided in 4 quadrants, along with the all-consuming electric pain, burning across my head through my ear canal.

My heart feels heavy pressure from the outside and sharpness internally. My heart has a sharp heartbeat and heavy ache. I'm physically weaker, collapsing every day. My body is heavier. I must lay down every hour. Over one year, organs are showing swift hormonal imbalance and challenge in function: kidneys, digestion, intestines, extremely dry skin.

What has now changed since 2/21/20 is that encountering a set of cell towers on buildings of any street, the painful hum penetrates my entire body. My ear canal intensifies with the sharp energy moving through my head. My heart races, and feels pushed in, creating a sense of suffocation. It feels as though there are hot, thin metal bristles pressing into my skin one inch deep, uniformly my entire body. This exposure continues to be strong and painful for many hours.

All of these areas are in deeper, constant pain now. I feel neurologically burned through my eyes and nervous system, living with this sensation of being neurologically sliced and burned, and experiencing weakened vitality.

Walking by cell towers before 2/21/20 did not produce these effects. There are some buildings having 6 or more cell towers, that beams a laser-sharp effect I feel immediately pressure to the heart and sharpness in the diaphragm, seemingly slicing through my body front to back. It hurts deeply for days after this exposure. Avoiding these towers requires several blocks added distance. Some areas there are multiple rooftops heavily-packed with cell towers.

Now I live East side district 6. Towers going up everywhere, every corner on my block. Walking 2nd ave 35th many towers there. I walked by and felt slicing as laser front through diaphragm and out my back, I was in bed for days.

I know 2 buildings of residents living in agony unable to lead normal lives.

There is no provision nor protection for individuals' rights and safety concerning cell towers or emf waves. And, these towers, small or large, are not safe. I was injured and also lost my home. Just like that.

Our City is installing Link5G cell towers only feet from homes and schools. Pentagon developed weaponry with 5G immobilizing people. I was immobilized. Years of studies. Now you know what can happen, cell towers shouldn't be used.

Wired broadband is safe, more reliable and adaptable than wifi, cheaper. City needs hearings on health effects of cell towers before a new pandemic -- disabling injury from "5G" cell towers, and increased homelessness.

Thank you for the opportunity of this hearing for our New York City.

Respectfully,

Lauren Bond

https://www.forbes.com/sites/michaelpeck/2021/03/02/the-pentagon-fears-that-deadly-microwave-weapons-are-undetectable/?sh=ccfac5bcc3f1

Statement of Minna Elias
Committee on Technology
June 7, 2023

Good afternoon. I am a resident of Community Board 7 and I am here to express my concerns about Citybridge's 5G Towers – they are a poor substitute for a comprehensive plan to ensure that all New Yorkers have affordable internet service. I am aware that there currently are no towers proposed in my neighborhood, but at a recent community board 7 meeting, OTI made clear that some of the 2000 or more towers that will be erected by 2026 will likely be sited in my area.

The towers are intrusive street furniture taking up space on our already crowded sidewalks. What's more, OTI says they can be placed as close as 8 feet from people's windows. Although siting most of the towers in underserved communities sounds like a way to bridge the digital divide, these towers are primarily designed to serve pedestrians and people in vehicles, not people at home. There is no comprehensive plan to ensure broadband for the 36% of New Yorkers who currently lack mobile or home broadband or both.

Many people lack broadband because of cost – and there are programs available to defray costs, including the federal Affordable Connectivity Program. One way to expand broadband adoption would be for the City to do more to educate people about the availability of that program.

Most New York City neighborhoods already have good 5G service and yet many of the Citybridge towers are slated for those areas. There has been very little consultation with the public about where the towers are needed. The City should demand fewer towers in neighborhoods that do not need additional service – these towers are gigantic, ugly and impossible to overlook. And for areas that lack service, there are better alternatives that do not require massive street furniture.

We need a better plan – one that is less reliant on placing towers at street level and more focused on ensuring that everyone who wants broadband can have it without going into debt.

Greetings, NYC Council Members,

I have always been sensitive to EMF (electromagnetic frequency) radiation. I feel an intense pressure in my head when I enter a room where there is strong EMF radiation. EMF radiation also disturbs my sleep. These issues clear up for me in buildings that are completely set up with fiber optics and cables without WIFI. I have made significant adjustments both at home and at the office to accommodate these sensitivities.

Please note that:

- Science is telling us that radiofrequency EMF exposure causes harm to all forms of life
- Oxidative stress is a key mechanism of this harm
- Human harm from EMF is common by often misdiagnosed
- Peer reviewed clinical practice guidelines for treatment of EMF associated illness were published in 2015

We need to make sure that these monopoles are placed at a safe distance from homes, schools and work sites.

Thank you,

Nada Khader

June 10, 2023

Hello, City Council.

My name is Olga Humphrey and I am a proud native New Yorker who always fights for the city and its wonderful people. I live on E. 76th Street, between First and Second Avenue, in a rent stabilized apartment. After having been there many years, I realized I needed to refresh my apartment with badly needed new furniture and other things. During this time, I saw that some construction workers were doing work on a light pole that is directly in front of my building. I asked them what they were doing and they told me it was something for "fast internet."

Cut to several months later. I now have a 5G cylinder directly facing into my third-floor living room window; it's less than 10-feet away. I read and learned about another 5G tower at a building on 90th Street. There, the cylinder faces the apartment where a baby lives. The 5G tower on E 76th Street is also near the District 2 Pre-K, which is next door to me.

I researched 5G – and, guess what? No one really knows very much. There is research by credible scientists who warn of health issues. I can't believe the city is allowing these cylinders to be placed on small side streets where they are so close to homes and schools. Clearly, it's an effort fueled by money, as so many things are, instead of what is the best thing for our citizens.

I got in touch with Community Board 8, my Council Person Julie Menin, my Assembly Person Rebecca Seawright and others. I spoke to someone from OTI who advised me to **get a radiation detector to keep tabs on radiation levels** from "my tower." I eventually discovered that there was NO community involvement when these towers were placed. Corners were cut in communications and in the rush to get 5G out; many official procedures that should have been undertaken and are mandatory were not done.

After living here for many years, I stopped my plans to refresh my apartment and now live in an uncomfortable limbo. I realized that I don't want to take a chance on my health and I want to move, but how can I afford to move in a city with outrageously high rents? We all know, if you are lucky to live in a rent stabilized apartment, you have security from huge rent increases. I keep asking: Why me? Why this spot? Why this bad luck? I look at unconverted light poles near me with envy.

I am asking the city to place a moratorium on raising new 5G towers and TO DEACTIVATE the ones that have gone up immediately so that this issue can be properly and thoroughly examined under the laws that exist and communities can have their say.

Thank you.

Olga Humphrey

June 5, 2023

I would like to offer my professional opinion on the impact of the proposed 32' 5G cell towers in the Carnegie Hill neighborhood. I have worked in Manhattan's residential real estate market continuously since 1971. I am a New York State licensed broker with Brown Harris Stevens and specialize in the Upper East Side and have sold many apartments in Carnegie Hill. Growing up, I lived on 92nd and Park Avenue and have lived at 1115 Fifth Avenue since 1991.

As a broker, I believe the proposed towers would negatively impact the value of the apartments, especially those below the 6th floor that would look directly at the towers. These towers should not be placed on solely residential streets, but belong on streets that are already commercially zoned with various other stores and signage.

Carnegie Hill is a sought-after neighborhood because of its quiet, tree lined streets. It boasts charming old-fashioned street lights that add to the overall ambience of the area. This atmosphere would be damaged by the installation of unattractive cell towers, which would make all apartments less desirable and, in some cases, could make the lower floor apartments facing the towers extremely difficult to sell, even at greatly reduced prices.

Sincerely,

Patricia Beckwith

As a therapist I have have/have had clients as well as know of those with electro-magnetic sensitivity (EMS) injury also known as Electro-Hypersensitivity (EHS). They live in constant pain and discomfort throughout their entire body. Tinnitus is one complication in which there is a constant ringing in their ears or they have a constant sound like "cicadas inside my head constantly making that shrill drone noise," as one of my clients expressed. They become isolated trying to find areas that will shield them from the EMFs, such as living in bathrooms, sleeping in cars parked in garages, or moving somewhere that they can find relief – even suicide. I have included the self-written obituary of Maria, a Buddhist from New York City who committed suicide because of her long-standing suffering. She hoped her plight could bring attention to the suffering that she, and many like her, endure(d).

The dangerous effects of the radio-frequency radiation (RFR) and microwave radiation (MR) in our atmosphere has been documented by many non-partisan organizations, scientists, doctors and mechanical engineers. The RFR is absorbed into our bodies. Children have higher rates of RFR exposure into their bodies and brains due to thinner skulls and smaller bodies. Besides the suffering of those sensitive to RFR exposure, other devastating effects such as cancer, neurological disorders, dementia/Alzheimer's, ADD/ADHD, sleep disturbances, diabetes and more can be caused by RFR/MR.

Article 1 Section 19 of the NY State Constitution's Bill of Rights states our "Environmental rights. Each person shall have a right to clean air and water, and a **healthful environment**." -- **This is NOT healthful.** As Maria, in her epitaph states, "Every person deserves a safe place to call home."

Also, reaching the goal of New York reaching the "Zero Point" in global warming, which is preached to us by many public servants, cannot be reached by implementing a multitude of cell towers and 5G, which is better known as an "Energy Hog":

"Wireless devices, antenna networks and data centers are consuming an ever-increasing portion of the global energy supply." – *"Re-Inventing Wires: The Future of Landlines and Networks"*

"The digital transition as it is currently implemented participates to global warming more than it helps in preventing it. The need for action is therefore urgent." – The Shift Project Report on the Environmental Impact of Information and Communication Technologies, 2019

"Our energy calculations show that by 2015, wireless cloud will consumer up to 43 TWh (tera watt hours), compared to only 9.2 TWh in 2012, **an increase of 460%**. This is an **increase in carbon footprint** from 6 megatonnes of CO2 in 2012 to up to 30 magatonnes of CO2 in 2015, the equivalent of adding 4.9 million cars to the roads." *[Another goal of New York City is to **decrease** the amount of cars coming and going in the city. With 5G and the towers we are only replacing physical cars with the pollution effects of what the "cloud" creates.]* "Up to 90% of this consumption is attributable to wireless access network technologies …"

"…wireless access networks are clearly the biggest and most inefficient consumer of energy in the cloud environment." – The Centre for Energy Efficient Telecommunications, 2013

Every public servant has sworn an Oath of Office – a contract – to the People to protect us and keep us safe from harm as is stated in the New York Constitution which includes the Nuremberg Code. From the mountains of evidence produced from years of research and public testimonies, it is obvious this means of communication is not safe.

The Solution: A national wireline system (fiber, cable, copper) can guarantee a superior foundation of Internet access for everyone, unequalled connectivity speed, safety, privacy, security, energy

efficiency and long-term sustainability. Verizon never finished installing the fiber optic cable system of which we, the taxpayers, already have already paid.

Here is the epitaph of Maria:

Maria (Sargent) August
Ani Thupten Tsondru
August 3, 1970 - March 12, 2019

On March 12th, I chose to end my Earth Walk and reunite with the Mother of All Things. I wanted to free myself from the straightjacket of electrifying pain and neurological debilitation of Electro-Hypersensitivity (EHS) and Epstein-Barr Virus (EBV). These hidden modern-day epidemics humbled me and connected me to the great suffering of others. Yet, they also shattered and dehumanized me. The constant tension of strange symptoms and crushing pain left me cut off from a life of embodied prayer and active altruism; I felt alienated from my true nature and impotent to be of service. I decided the greater good was to give my life with the aspiration to raise awareness and help others. As Thomas Merton said, "Man has no greater love than that he lay down his life for his friend."

If anyone asks, you can say I ended my own life. But it would be more accurate to say I died from Electromagnetic Field (EMF) poisoning. I am not ashamed of my actions. They were based on compassion for my own suffering and the desire to prevent more people from becoming sick.

I'm not the first person with Electro-Hypersensitivity (EHS) to die by their own hand, but perhaps I'm the first to publicize it. And that's my whole intention. Let me be the posterchild for this 21st century plague. Let me be the impetus for positive change. What sends a stronger message than death? The message is: seek the truth and learn how to protect yourselves. The message is: create housing opportunities for people with EHS.

Manmade Electromagnetic Fields (EMFs) at current astronomical levels are unprecedented in human history. And they are not safe. Human cells cannot function properly under this 24/7 radiation shower. That is why people are getting sick. I chose to die so you would know how important it is to reduce your exposure to this invisible toxin. I chose to die so the world would see that safe camps for EMF refugees are desperately needed.

EHS has all the ingredients of torture: cause someone intolerable pain, separate them from the community, and prevent them from sleeping. Is that a risk you are willing to take? Is that a life you want for your children? It's much, much easier to prevent than to cure. And those, like me, who get a severe case, find there is nowhere to live, detox, and recover. Let us care for this growing population of our society. Now is the time to start developing wilderness Safe Havens. Every person deserves a safe place to call home.

I do not want a funeral, memorial service, or life celebration. Instead, please help the living by honoring my three final wishes. Thank you and may you be well.

1. Take simple steps to lower your EMF exposure and stay healthy. Organize housing for people sick with EHS. Resources for this are: the fantastic book The Non-Tinfoil Guide to EMFs and the Safe Haven tab at www.HeartMind.info.
2. Cleanse your body of radiation, viruses, heavy metals, and pesticides, which cause EHS and other chronic illnesses, including lupus, Lyme, MS, RA, and cancer. It's fun and yummy! Read the beautiful book Life Changing Foods by Anthony William.

3. Take extra good care of each other. Spend time each week in loving service to a sick, injured, or housebound person. Let them know they are not forgotten. This is the true purpose of being human. Resources for this are: the books Everybody Always by Goff, Peace Pilgrim, and the TLC Book tab at www.HeartMind.info.

May my death usher in a new era, an era in which EHS and EBV are taken seriously, diagnosed correctly, treated immediately, and prevented widely. May this be an era of permaculture eco-villages, bountiful food forests, abundant altruism and safe technologies. I gladly sacrifice my life for that purpose. May it be so!

Visit my blog, www.HeartMind.info, for more information and continued updates from friends. Look for me in the sun, the moon, and the stars. Pray that I've melted into Mother Luminosity and am helping all beings, in all worlds, in all ways. May the bodhichitta flourish!

Posted by: isis feral <isisferal@yahoo.com>

romoandgianell@aol.com

New York City Council
Committee on Technology
June 7, 2023 1:00p
LinkNYC Scheduled Hearing

Written Testimony in lieu of scheduled Oral Testimony

Hello Council Members,

My name is Rue Parkin. I am a resident of the 16th Council District in the Morris Heights Neighborhood of The Bronx. I'm also the Executive Director of the helpNYC Corporation, a non-profit that connects underserved New Yorkers to low-barrier, verified sources of help in all five boroughs of New York City.

I apologize for not being able to attend this hearing in person. I am here today to support the rapid deployment of the new Link5Gs in underserved communities across New York City.

Internet access and connectivity are no longer a luxury but a necessity for all New Yorkers to carry out their daily routines.

Unfortunately, a huge digital divide exists in New York City. The LinkNYC kiosks and the new Link5G towers are critical infrastructures we can use to close the divide. LinkNYC provides a critical connection to high-speed broadband, and more importantly, they serve as an information access point for our most vulnerable neighbors—those who are experiencing shelter or street homelessness.

The NYC Taskforce on Racial Inclusion and Equity (TRIE) learned during the pandemic that when the City of New York invests in the underserved neighborhoods of New York City, outcomes change, and our neighbors become empowered to improve their lives and those of their neighbors. I believe this same empowerment can be amplified when we close the digital divide by deploying Link5Gs in every TRIE neighborhood across our city.

In November 2022, the helpNYC.info Resource Navigator was added to the LinkNYC tablet, bringing a New York City-based, peer-maintained resource navigator to our public infrastructure for the first time. Since then, the tool has connected New Yorkers in all neighborhoods where LinkNYC kiosks are located to direct service providers and programs that they need.

On behalf of over 68,000 New Yorkers who trusted helpNYC last year for access to information and those in the future, I hope you will again renew the City Council's support of the work LinkNYC does and help us close the digital divide for all New Yorkers! Thank you for your time and consideration.

Joshua "Rue" Parkin
Cedar Avenue
Bronx, New York 10453

NOTE:
Please accept my appologies for not being able to deliver this orally at the time of the hearing. I am traveling and lost data connection.

Dear Mayor Adams and members of the New York City Council,

I grew up on the streets of New York in the 1950's... scully champion of Stuytown, punch ball mvp, and dodgeball demon. My parents were NYC public school teachers... we didn't own a car... and I spent hot summer days swimming at the 23rd Street pool.

Years later… I moved with my husband and 2-year-old daughter to the suburbs. The new address didn't change me; I was a city kid to the core... hopping on the Harlem line to visit friends, relatives, and work as a writer... most recently, in the westside theater studios developing a musical with composer Shelton Becton about the life of Frederick Douglass.

That's where the action stops and the story falls apart. The last time I visited NYC in February of this year, I spent the next 24 hours curled in a ball, unable to do anything. To understand why, rewind to 8 years earlier.

On July 1, 2015, in one horrifying moment, I became sensitized to radiofrequency radiation. This injury occurred when I was standing next to a "smart meter," which had been installed on my home to measure electricity. Little did I know that in order to collect data, these devices connect with the home wiring, generating hotspots of microwave radiation throughout the living space. With a personal history of allergies, I was set up for the kill. Since that date, I've been unable to use cell phones, smart devices, wifi, or be close to a small wireless cell facility, without experiencing massive headaches, nerve pain, and overall physical debilitation. On my recent visit to NYC in February, I walked in the vicinity of a 5G monopole.

The condition I have is called EMS (Electromagnetic Sensitivity). I am not a rarity. Millions of Americans (and countless others throughout the world) have a similar condition, with our numbers increasing by the day. We are the living proof that the seeds of a major health disaster are being sown. Those who are not impacted by EMS in the short-term, will be vulnerable to cancer, Alzheimer's, brain tumors, and other diseases in the long-term... in the same way 9/11 first-responder injuries continue to rise precipitously more than 20 years later.

Where are your assurances of safety coming from? What Adam Smith, the Father of Modern Capitalism, said in 1776 is still true today: *"To widen the market and to narrow the competition, is always the interest of the dealers... The proposal of any new law or regulation of commerce which comes from this order ought always to be listened to with great precaution and ought never to be adopted till after having been long and carefully examined, not only with the most scrupulous, but with the most suspicious attention. It comes from an order of men, whose interest is never exactly the same with that of the public, who have generally an interest to deceive and even oppress the public, and who accordingly have, upon many occasions, both deceived and oppressed it."*

You don't have to look far to see the deception and verify that a large-scale disaster awaits us. The NIH's own database of peer-reviewed science lists thousands of studies

linking radiofrequency radiation to significant health effects, including cancer. This certain future is one that the profit-driven telecom industry has declined to notice.

Council Members, 5G will not take New York City into the future. It will take it down a very bad and irreversible path. In the words of Frank Clegg, former President of Microsoft Canada, *"I've met with scientific experts from around the world and have concluded wireless technology is not safe. I am especially concerned with 5G, and the impact of wireless technologies on children. The industry will grumble, but they will pivot... if they are incented to do so. It is up to government to provide this motivation. By restricting placement of telecommunication antennas near homes, schools, and other sensitive areas... industry will be forced to investigate safer alternatives. Based on my experience, industry will create solutions that are not only safer but in most instances cheaper in the long run."*

Technology has brought us into the future... but that future will not be realized if the technology that surrounds us isn't safe. For this city kid, and for generations beyond, NYC is transforming into a 24/7 danger zone. Mayor Adams and Council Members, you are holding the greatest City in the world in your hands. Please take action immediately to keep it that way.

Sincerely yours,
Ruth F. Moss

Dear Members of the City Council,

I respectfully as that •you stop the installation of the 5G Link Towers in the west village. There is no clear process in place to govern decisions about where these towers should be located and the siting guidelines established by the NYC Office of Technology and Innovation (OTI) are being routinely ignored.

The OTI has failed to respond in any meaningful way to the resolution that Community Board 2 passed describing in detail the reasons it is asking for a moratorium on construction of LinkNYC 5G towers in our area.

The OTI has likewise failed to respond in any meaningful way to the letters sent by all of our local elected officials that describe in detail the reasons they are asking for a moratorium on the construction of these towers in our area.

The current placement of these towers does not help bridge the digital equity gap that the city claims is the main goal of the project.

In addition, they will be eyesores in our historic neighborhood as well as possibly causing significant health problems.

Sincerely,

Sharon Smith
Greenwich St.
NY, NY. 10014

To: Committee on Technology

Re: Objection to 5 G Towers

As a long time resident and community activist in NYC, I highly object to the installation of 2,000 LinkNYC 5G Monopoles around New York City. I am very well of some of the scientific studies and fear that long term exposure to electromagnetic radiation such as emitted via 5G technology may cause blindness, hearing loss, skin cancers, male infertility and thyroid issues. These huge, obtrusive towers should not be placed in residential areas. No government entity has the right to force harmful technology upon its citizens.

Thank you for you your consideration on this very urgent issue.

stefography@gmail.com

Susan Foster

PO Box 1444
Lyons, Colorado 80540
susan.foster04@gmail.com

June 9, 2023

The New York City Council Committee on Technology

Honorable Councilmembers:

I am following up on your meeting of Wednesday, June 7 with the following written testimony regarding the fire risks inherent in telecommunications equipment.

I am a Fire and Utility Consultant based in Colorado, and an Honorary Firefighter with the San Diego Fire Department. I'm writing to you today regarding fire risks associated with telecommunications equipment/kiosks you are placing on the sidewalks in New York City.

You have heard for years now that cell towers cannot be denied placement based on health concerns. However, what you may be unaware of is that **safety is yours to regulate**. Safety takes the form of requiring a robust application checklist that includes sound electrical, structural, building and fire safety code requirements.

The FCC has repeatedly stated that safety belongs to the municipalities to regulate. *In the Matter of Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies; Acceleration of Broadband Deployment: Expanding the Reach and Reducing the Cost of Broadband Deployment by Improving Policies Regarding Public Rights of Way and Wireless Facilities Siting; 2012 Biennial Review of Telecommunications Regulations,* 29 FCC Rcd 12865, 12945, ¶188 (2014).

I work as a consultant for McCollough Law Firm in Texas. Scott McCollough is the former Assistant Attorney General for the state of Texas on Telecommunications and Utilities. We very often employ an electrical engineer when we go into cities to evaluate their local zoning ordinances including design criteria. In this context I am referring specifically to engineering design as it pertains to electrical engineering, structural engineering, and fire and building code adherence.

The majority of cell tower engineering designs on applications coming into the cities where we have worked – for small cells and macro towers – are deficient. You can and must require more for New York City. Telecom has been left to police telecom when it comes to engineering design and the consequences can be disastrous.

We did a thorough investigation of Southern California wildfires and found that in the last 15 years alone four (4) major wildfires have been caused, in whole or in part, by

telecommunications equipment causing over $6 billion in damages, lives lost, and lives destroyed. If you think that can't happen in New York City as a result of telecommunications equipment, you are wrong. Telecom will not tell you about the fires they start, but I will.

As a very brief example of East Coast cell tower fires:

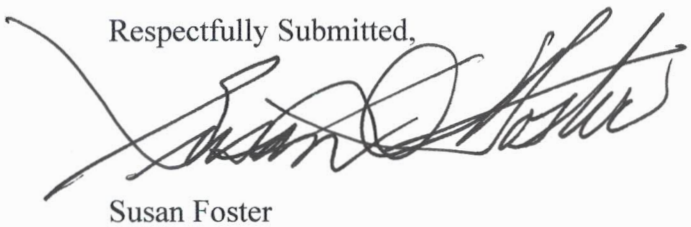
- June 2015, Newport News, Virginia – A cell phone tower near Virginia Heritage High School caught on fire according to the Newport News Fire Department. The company was working on the tower doing routine maintenance when welding sparks ignited insulation encasing electrical wires.
- June 2020, Hanover County, Virginia – A 125-foot bell cell tower adjacent to a church was a total loss following an electrical fire.
- April 2021, New York City, New York – A fire broke out on the roof of an apartment building between Kingston and Brooklyn in New York City. Multiple firetrucks and dozens of firefighters arrived at the scene. The fire was caused by an electrical malfunction of a cell tower on the roof of the building.

All cell tower fires, and this would include your kiosks, are electrical fires. Electrical fires cannot be fought through conventional means until the entire grid has been cut. That is not a simple flip of a switch. It must be shut down systematically. In the meantime, fire can spread and residents will undoubtedly be at risk.

In the city of Los Angeles, a small cell very close to a downtown office building spontaneously caught fire. The small cell was located on the sidewalk – similar placement to what you are rolling out for your kiosks. While someone filmed this action, a gentleman in an office building grabbed a container and threw water into the fire. Gratefully, he was not electrocuted. Had there been a steady, unbroken stream of water from the gentleman thinking he was doing a good deed to the burning telecommunications equipment the man would have been electrocuted.

The placement for these kiosks is dangerous and I cannot fathom why New York City has not availed itself of the state and federal monies available to close the digital divide using fiber optics. The placement of these kiosks is fraught with danger, chief among them fire, and then 24/7 RF-EMF radiation exposure to the residents and tourists of New York City.

Respectfully Submitted,



Susan Foster

My name is Virginie Glaenzer, and I am a member of a family of five residing at 520 E 90th Street. Recently, a 5G wireless facility was installed by ExteNet on top of a city-owned light pole located less than 10 feet away from our living room blocking our view.

We are facing issue with OTI's lack of communication. Regrettably, our community board did not receive the required 15-day notice to discuss or dispute the installation of this pole, despite its proximity to our main living space. Consequently, Community Board 8 has called for a moratorium on all 5G pole installations within our district.

Moreover, this pole obstructs our view of a Nationally Registered Historic site, namely The Municipal Asphalt Plant. We are currently investigating whether or not Section 106 was properly completed. Finally, this pole is impacting our property value decreasing its value significantly.

To address this issue, we sought the support of Council Member Menin, Borough President Mark Levine, Senator Liz Kreuger, and Assembly Member Rebecca Seawright, who all co-signed a letter addressed to ExteNet and OTI. The letter requested the removal of the pole due to the failure to notify constituents and its close proximity to our building.

In response to the aforementioned letter, ExteNet and OTI stated that they would conduct a field RF Emissions test once the site becomes operational. They believe that this test will affirmatively demonstrate that the site adheres to all Federal RF Emissions safety standards.

However, both OTI and ExteNet have failed to fulfill their promises of transparent and necessary communication, both prior to and after the installation of the pole.

Therefore, I am here today, pleading with OTI for information regarding when the pole will be activated, when the tests will be conducted, how and when we will receive the test results, and if there is any possibility of relocating this single pole.

Our primary concern is the safety of our family.

Thank you.
Virginie Glaenzer

Testimony

Thank you to the Chair of the Committee, Councilmember Gutierrez, for holding this important hearing.

My name is Yesenia Mata and I am the Executive Director of La Colmena, an immigrant and workers rights organization based in Staten Island.

I wanted to take this opportunity to discuss the partnership between La Colmena and Link NYC. Together we created the Gigabit Center in Staten Island to bring wifi to the immigrant community.

La Colmena currently is a Satellite for the city of New York to provide support and services to new arrivals around workforce development. -- The type of support that La Colmena has provided to new arrivals is around legal orientations, construction classes, pre-apprenticeship programs, ESL and digital classes.

As a Gigabit Center we have been able to reach many new arrivals. You see, the way that many of them communicate is through WhatsApp, also the way they are able to stay in tune on the services that are available to them, and even further do their check-ins with ICE or the Courts. -- Through the Gigabit Center, many new arrivals go to La Colmena, a place where they feel safe and have the opportunity to use the free wifi.

With all the many services that we have, and the amount of people that we see, the free wifi received through Link NYC has become very useful.

We all know that wifi opportunities in low income / BIPOC communities are very low and the Gigabit Center at La Colmena is currently providing those types of opportunities.

Looking forward to being part of this conversation that will bring digital justice in BIPOC/ and immigrant communities. Thank you for your time.

From: Tom Edwards <tomvedwards@gmail.com>
Sent: Wednesday, June 7, 2023 7:16 AM
To: Testimony
Subject: [EXTERNAL] 5 G towers in west village meeting wed

Dear City Council,

Please don't do this to the West Village! These 5G towers are ugly, unnecessary, and will disrupt our lives - and negatively affect the appeal of our SCENIC little Village.

If you think graffiti is an eyesore, (which it is!) wait till you start hearing the complaints about these monolithic Modern hideous towers.

I've lived here for 20 years, and I have not heard a single person say that our Internet speed is lacking. If you look at the demographics of the West Village, it is largely well to do people.
Of course, there are other areas of the city that need very good Internet… this, however, is not one of those areas.

If we follow the money for this plan, it is obvious what is happening. And we beg you to stop it. Even our local Spectrum repairman told me that residential apartments and homes DO NOT NEED 5G!
He told me it's mainly for big businesses.

We voted for you for many reasons, not the least of which is to protect our community from exactly this sort of thing.

Yours truly,
T. Edwards

ENVIRONMENTAL HEALTH TRUST

Matthew C. Fraser
Chief Technology Officer

Brett Sikoff
Executive Director, Franchise Administration
bsikoff@doitt.nyc.gov

Stacy Gardener
Senior Director, External Affairs
New York City Office of Technology and Innovation
SGardener@oti.nyc.gov
(212) 863 6140

sent January 31, 2023,
sent updated February 8, 2023,
sent updated again February 16,
sent updated March 9, 2023

Questions regarding 4G/5G cell antenna installations in New York City

Dear Mr. Matthew C. Fraser and Ms. Stacy Gardener, New York City Office of Technology and Innovation,

We have some questions that we have repeatedly emailed to the City in regards to the new 5G poles. Specifically please respond to each question, one by one for clarity, with links or attachments to sources. We also note inaccurate information has been put forward regarding the FCC's review of the science on cell tower and 5G radiation (question 6).

The City should be ensuring compliance with RF regulations for human exposure by requiring independent (not the carriers nor their consultants) pre installation RF tests, preinstallation RF modeling tests and after installation RF tests. These measurements should not only be simulations but they should be real world actual measurements of the actual levels to get a baseline. *All of this information should be publicly posted for full transparency.*

The public deserves full transparency regarding the type of installation, radiation levels and oversight for health and safety issues.

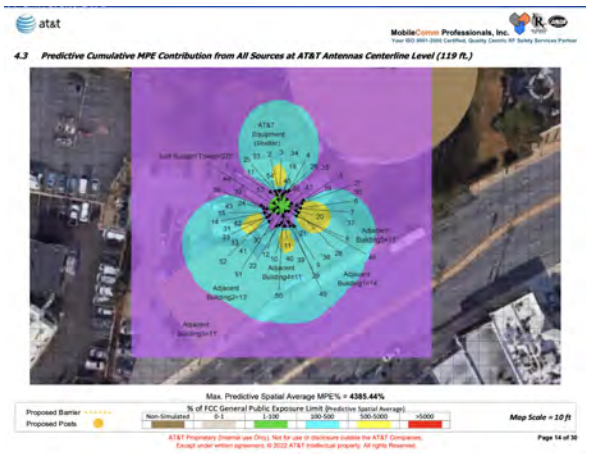
In short here is the data needed:

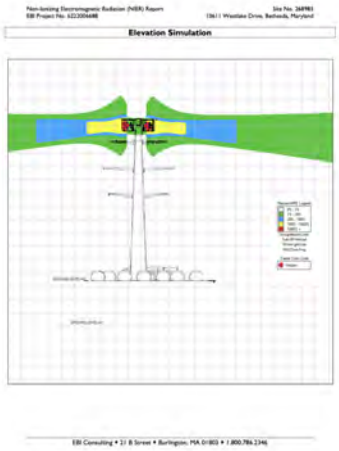
1. Reports on RF Radiation levels that are and will be emitted from the wireless antennas when they are fully operational.
2. Safety data regarding long term exposure from a US government agency that includes all the scientific evidence such as cancer, impacts to the brain/nervous system, genotoxicity and oxidative stress.
3. A complete and up to date registry (online map) of all wireless facilities as well as proposed installations in the City. (The current map is not complete)

Here are my questions to OTI. Please answer them one by one for clarity.

1. For each proposed wireless installation, **where can the public access the full details (and/or permit application** by carriers that includes these details) for each specific installation which includes 1. the type of antennas make/model, 2. modulations and 3. power output with all technical specifications. For each installation, please also specify the 4. specific companies and carriers that wll have antennas on the facility 5. what exact services they are offering via the equipment for all networks on the particular installation.

2. **For each proposed and installed wireless installation, where are the full reports and measurements on Radiofrequency (RF) radiation compliance to ensure FCC limits are adhered to?** This should include not just the 5G jumbo poles but also the other small cell facilities (Examples would look like this, this and this as these reports are generally public knowledge in other Cities.) See image examples below from Kensington Maryland and Bethesda Maryland . It was stated on February 13, 2023 that there are 2000 poles already up and transmitting according to OTI. The RF reports for these installations should be provided.





3. For each proposed and installed wireless installation in New York City please clarify if RF measurements are taken in rooms (like bedrooms with windows facing installations) adjacent to the wireless antenna and/or in line of sight or just on the ground? Sometimes the RF measurements are taken on the ground when they should also be taken in the homes and living spaces of people closest to the transmitting antennas. Specify the protocol for these reports.

4. For each proposed and installed wireless installation in the City, *how often* are RF compliance checks done? Please send the plan for oversight and compliance to ensure that the RF levels are compliant with FCC limits (be these limits outdated and unchanged since 1996). For example, are RF measurements done preinstallation, post installation, on modification? Also clarify if they are simulations or real world RF measurements and please provide the link to where the public can access these RF compliance reports?

5. Does City Bridge and OTI have insurance that covers long term health damages from the radiofrequency radiation?
6. Why is OTI communicating that the FCC did a comprehensive review of the human exposure limits when the US Court of Appeals, DC Circuit judgment was that the FCC had ignored scientific evidence in the FCC's so called "review"? The inaccurate statements and half truths regarding the level of health

impact review by federal agencies[1] communicates inaccurate information to the public. We ask that inaccurate statements to community boards be corrected by OTI related to our lawsuit EHT et al v. the FCC against the FCC. The OTI needs to provide factual information when people ask questions, stating that federal limits have remained unchanged since 1996 and that a lawsuit has mandated the FCC to respond on issues such as children, long term health effects and environmental. So far the FCC has not responded to the court order.

a. **FALSE: That the FCC has repeatedly reviewed the RF limits**.Minute 1:10:17 Nick Colvin states *"The FCC sets limits that are based on scientific study, those, contrary to some statements, have been reviewed repeatedly over the years by the FCC. the FDA has also looked into this."* This is inaccurate. The FCC only opened up one Inquiry in 2013 (FCC's Inquiry Asking if RF Limits Should be Updated DA/FCC #: FCC-13-39 Docket/RM: 13-84, 03-137), a process requesting comments on the question of if a review is needed, and the FCC decided in 2019 there was no need to review limits. However, in 2021, the United States Court of Appeals for the District of Columbia Circuit ruled that the 2019 decision by the FCC to retain its 1996 safety limits for human exposure to wireless radiation was "arbitrary and capricious," because the FCC did not show evidence of reviewing record evidence (read evidence on the docket here) related to long term exposure, children's vulnerability, non cancer harms (such as impacts to brain development and reproductive organs, wildlife and environment).

b. **FALSE: That our lawsuit was not about the FCC's 2019 determination. (**Minute 52:12) Robert Sokota states, *"it was not an attack indicating that the 2019 reaffirmation of the limits set by the FCC were wrong…"* The FCC was found to have broken the law in its determination that its limits did not need to be updated. It was ordered to respond and so far has not responded with any documentation regarding how it made the determination. Read court ruling. The 2021 court judgment ordered the FCC to

    1. "provide a reasoned explanation for its decision to retain its testing procedures for determining whether cell phones and other portable electronic devices comply with its guidelines"
    2. "address the impacts of RF radiation on children, the health implications of long-term exposure to RF radiation, the ubiquity of wireless devices, and other technological developments that have occurred since the Commission last updated its guidelines"
    3. "address the impacts of RF radiation on the environment."

    Thus, the FCC 2019 decision cannot be considered one which met obligations of the law and it also cannot be referred to as proof that the FCC has properly reviewed the issue to ascertain safety as they were found to have violated the APA.

c. **FALSE: That the FDA has reviewed cell tower radiation studies to make a safety determination.** 2/13/2014 Meeting CB 3 Manhattan Nick Colvin stated that, "T*he impacts of of cellular radios on health has been studied for for decades um and is uh you know there are there are safety standards and limits set by the the FCC and that have been corroborated by the FDA …"* However this is inaccurate as the FDA has no authority nor research activities related to cell tower radiation.

    The lack of FDA health risk assessment in regards to cell towers was confirmed in a January 11, 2022 letter by Ellen Flannery of the Director of the FDA Office of Policy Center for Devices and Radiological Health who was asked about the safety of a cell tower outside a California mother's window and stated, "*The FDA does not regulate cell*

[1]2/13/2014 Meeting CB 3 Manhattan statements were made that the FDA somehow has found FCC limits to be safe include "The impacts of of cellular um radios on health has been studied for for decades um and is uh you know there are there are safety standards and limits set by the the FCC and that have been corroborated by the FDA um and numerous other um organizations governmental and non-governmental as being safe within these limits…" and statements that inaccurately characterize the FCCs level of review such as (minute 1:10:17), "The FCC sets limits that are based on scientific study those contrary to some statements have been reviewed repeatedly over the years by the FCC. the FDA has also looked into this… I was just looking at a published review " statements that accurately characterize the court judgment in EHT et al v FCC judgment

towers or cell tower radiation. Therefore, the FDA has no studies or information on cell towers to provide in response to your questions." Link to FDA Letter.

On March 29, 2022 Laurie Lenkel FDA Ombudsman also confirmed that the FDA could not respond to questions regarding 5G.

In follow-up to our initial conversation, FDA is responsible for protecting the public health from hazardous or unnecessary radiation from radiation emitting *electronic products*. The Federal Communication Commission (FCC) has jurisdiction over all radiofrequency transmitting structures in the United States. Therefore, the 5G tower you inquired about is under the authority of the FCC, not the FDA. I have copied Howard Griboff on this message so that he is aware of the limitation of FDA's authority.

When I inquired into your concerns I found that a few months ago the Deputy Director of FDA's Center for Devices and Radiological Health (CDRH) explained the scope of FDA's regulatory authority as well as responded to your questions. In addition, the Ombudsman for CDRH offered to be your contact if you had any new questions that had not been answered by the Center.

I understand that this issue is very important to you. I hope this information is helpful.

Laurie

Laurie Lenkel
FDA Ombudsman
https://www.fda.gov/about-fda/office-chief-scientist/fda-ombudsman

The FDA also stated on June 20, 2016 that "We don't have jurisdiction over cellphone towers since those are environmental emitters."

From: Kassiday, Daniel F. H.
Sent: Monday, June 20, 2016 2:36 PM
To: Nambiar, Madhusoodana; Loloei Marsal, Ana; Pastel, Mary; O'Hara, Michael D; McFarland, Scott
Cc: Pirt, Nancy
Subject: RE: FDA Citizens Petition on Cell Phones, Docket # FDA-2013-P-1374

(b)(5) Deliberative Process . We have already considered the NTP study partial result draft which was released. We don't have jurisdiction over cell phone towers since those are environmental emitters.

Daniel Kassiday
SME: Electronic Product Radiation Control
U.S. Food and Drug Administration / Center for Devices and Radiological Health /
Office of In Vitro Diagnostics and Radiological Health / Division of Radiological Health
10903 New Hampshire Ave., Silver Spring, MD 20993
Ph. (301) 796-5865
Daniel.kassiday@fda.hhs.gov
This communication is consistent with 21 CFR 10.85(k) and constitutes an informal communication that represents my best judgment at this time but does not constitute an advisory opinion, does not necessarily represent the formal position of FDA

FACT: The fact is that no federal agency has reviewed 5G's unique modulation, nor has any federal agency reviewed the totality of the science on the health effects of cell tower radiation, nor has the FDA scientifically reviewed the issue of 5G or cell tower radiation to make a health risk assessment to opine on the safety of chronic full body exposure to RF as you would get from the proposed 4G/5G facilities in New York.

To anyone reading this letter who believes such an assessment by a federal agency exists, we request that you see if you can find the actual U.S. government scientific research review/risk assessment that does address the health effects of 4G/5G radiation from base stations *including of course endocrine impacts, reproductive impacts, oxidative stress and impacts to brain development.*

7. What agency with health, environment or public health expertise is ensuring that 5G and 4G installations are safe for the public? Is there a research report that has reviewed the latest science, and done a risk assessment to ensure safety? If so, please send it.
8. Are there any restrictions for wireless installations near schools in regards to these installations in NYC? Many cities and towns have policies to restrict cell antennas near schools (see here).

9. Once a facility is approved by the City, can more antennas be added later in time? If so, what is the process for this? How tall could the installation get after such modification? Is there a public process for these additional antennas?

10. How are trees protected? Please see research on damage to trees at Waldmann-Selsam et al 2016 and Kaur et al 2021). Are there any setbacks for the root zone or tree canopy? (Many other communities have setbacks for trees.) Are there any restrictions in place to minimize tree trimming?

11. What environmental review was done and please do share the reports. Normally you at least provide an Environmental Assessment Statement for citywide wireless franchise installations. *Why can no EAS be found for these new much more dense provider installations?*

12. How can the public be assured that the installation of antennas emitting higher frequencies will not impact bees and insects? Research does indicate that higher frequencies uniquely impact insects. (Balmori 2015, Levitt et al, 2022, Levitt et al., 2021a, Levitt et al., 2021b, Levitt et al., 2021c, Thielens et al, 2018, Favre 2011). What evaluation has been performed to ensure no harm to pollinators?

13. What OSHA safety precautions are you instituting for those who are pruning the trees and/or workers (painters, window washers) will be in close proximity to the antennas?

14. The City keeps stating that these installations are important to fill data gaps. Where can we find the reports on needs assessment in terms of broadband in the City and where is the data showing that these wireless installations outside residences *will actually connect the unconnected? Did the reports on needs investigate or offer solutions to connect those who lack service?*

15. **Where is the report that shows what residents need affordable fiberoptic into their home?** We see that there are reports presented by OTI about households that lack broadband but what is the cause of this? Is it a lack of affordable service for the household or that fiberoptics and internet connections are not available? This is an important difference as the current model purports to bridge the digital divide by offering wireless, rather than simply ensuring affordable broadband to households, along with affordable devices and training (measures shown to actually support connectivity).

16. Please provide the input you received, in consulting with industry, in order to shape the design of these installations. In addition to today's services, what future uses are they foreseeing? And hoping to provide?
17. Where is the master plan on the deployment of this infrastructure? If one does not exist then why not? Master plans are done with other infrastructure, why not this?

In this letter we also request the test reports (including simulations) for RF radiation emission compliance with FCC limits that have been done in the past and also for newly proposed sites. OTI staff had made a variety of conflicting statements regarding the existence of testing for radiofrequency

radiation[2] level compliance. Where is the transparency in such reports that supposedly exist per the statements of OTI staff.

The entire New York City community should have access to reports on the current levels of RF as well as the emissions when 5G poles are turned on and emitting at full capacity. In addition, the community should have full reports for antenna installations that are currently installed.

Thank you very much for your consideration of these questions

Theodora Scarato
Executive Director
Environmental Health Trust

Please see research questioning 5G safety assumptions here.

- European Parliament requested a research report "Health Impact of 5G" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.
- A review paper entitled "Limiting liability with positioning to minimize negative health effects of cellular phone towers" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes and within 500 meters of schools and hospitals to protect companies from future liability (Pearce 2020).
- A review entitled "Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer reviewed the existing scientific literature and found radiofrequency sickness, cancer and changes in biochemical parameters (Balmori 2022).
- An analysis of 100 studies published in Environmental Reviews found ~80% showed biological effects near towers. "As a general guideline, cell base stations should not be located less than 1500 ft from the population, and at a height of about 150 ft." (Levitt 2010)

2

1. On 1/25/23 at a 6:30 pm presentation at Queens Community Board 1, OTI's Stacey Gardener stated that RF radiation measurements were done for the 5G and wireless facilities by an independent individual. Start here at minute 2:32 . When Board members asked if they could see the results of the RF Radiation safety tests they were told by Stacey Gardner "We could share an example of one… we'll follow up with you."
2. However later in a February 8, 2023 community board meeting with BKCB4 Bushwick the OTI stated that they had seen such RF compliance reports from wireless installations in the city but that none had been done for their installations. Please correct me if I am wrong.
3. In a February 9th CB meeting, it was stated by Brett Sikoff that "we will test" for RF compliance.
4. New York Open records shows a FOIL request FOIL-2022-858-00288 regarding RF compliance reports on 5G filed in December 2022 but so far there has been no response.
5. In a 2/16/23 Queens Community Board 6 Executive Committee meeting Brett Sikoff stated, "We ensure that our franchisees follow those guidelines and maintain compliance .. and all the tests that we have performed using an independent expert on the light poles have come in that the RF emissions are multiple times below FCC maximum permissible exposure and… we fully expect that they will be in compliance with federal guidelines."
6. In a March 8, 2023 meeting Brett Sikoff stated at the 1:25:39 minute mark that RF Radiation tests have been done for some installations, not for the 5G jumbo poles as the carriers are not on them yet.





NEW YORK CITY



THE NEED FOR ACCOUNTABILITY ON WIRELESS SAFETY

EXPERT VOICES





"The National Toxicology Program studies clearly showed that non-ionizing cell phone radiofrequency radiation radiation can cause cancers and other adverse health effects. An important lesson that should be learned is that we cannot assume any current or future wireless technology such as 5G is safe without adequate testing."
— Ronald Melnick PhD 28 year scientist at National Institutes of Health

"I recommend public health organizations raise awareness and educate the public on why and how to reduce our daily exposure to wireless radio frequency radiation. Protective public health policy is needed now. It is time for regulatory bodies to fully evaluate the research and develop science based exposure limits that truly protect the public and the environment."
— Linda S. Birnbaum, PhD, Former Director, National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health.

"Now we have 5G rolling out in massive quantities, without due diligence to determine are these sources of radiation safe not only for humans but for wildlife. And the answer is, no, they are not."
— Albert M. Manville II, Ph.D. Adjunct Professor, Johns Hopkins University, Wildlife Biologist (17 years), retired from Division of Migratory Bird Management, U.S. Fish & Wildlife Service

"Given the human, animal and experimental evidence, I assert that, to a reasonable degree of scientific certainty, the probability that RF exposure causes gliomas and neuromas is high."
— Christopher Portier PhD former Director of the United States National Center for Environmental Health at the CDC, former Director of the U.S. Agency for Toxic Substances and Disease Registry.

"We should not wait to protect children's brains. The science is now clear and compelling indicating that wireless technology is harmful to health, especially to for children. Wireless radiation is repeating the history of lead, tobacco and DDT."
— Devra Davis PhD, MPH, President of Environmental Health Trust, founding director of the Board on Environmental Studies and Toxicology of the U.S. National Research Council, National Academy of Sciences, and a member of the team of the Intergovernmental Panel on Climate Change scientists who were awarded the Nobel Peace Prize in 2007

THE URGENT NEED FOR SAFER TECHNOLOGY

EXPERT VOICES

"I am calling on my industry to bring safer technology to market. The current implementation of technology is not safe. Take a good look at the science. This is about our children's future. Do not be lulled into believing that 25-year-old standards can protect the youngest and most vulnerable. They simply cannot."
— Frank Clegg, Former President of Microsoft Canada, CEO of Canadians for Safe Technology

"A moratorium is urgently needed on the implementation of 5G for wireless communication."
— Lennart Hardell, MD, PhD , advisory to World Health Organization international Agency for Research on Cancer, Department of Oncology, University Hospital, Örebro, Sweden (retired) , leads the Environment and Cancer Research Foundation

"The evidence indicating wireless is carcinogenic has increased and can no longer be ignored. If the World Health Organization International Agency for Research on Cancer were to meet to review all of the evidence, we believe the weight of evidence supports a new determination- that wireless radiofrequency radiation is a human carcinogen."
— Anthony B. Miller MD, Professor Emeritus, Dalla Lana School of Public Health of the University of Toronto. Former Senior Epidemiologist for the International Agency for Research on Cancer and former Director of the Epidemiology Unit of the National Cancer Institute of Canada

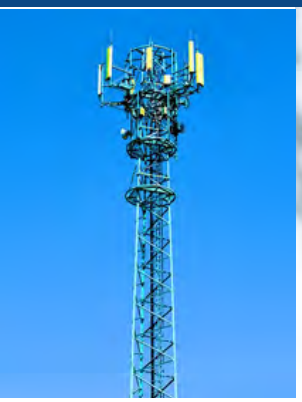
"Most parents believe that cellphones were safety-tested before they came on the market. We assume that our federal health and environmental agencies regularly review the latest research and ensure that these incredible devices are safe. They do not. Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible."
— Jerome Paulson, MD , Professor Emeritus, George Washington University, Milliken School of Public Health, former Chair of American Academy of Pediatrics Committee on Environmental Health

"The exposure levels of the Federal Communications Commission are totally outdated and do not protect the health of the public, especially of children. I urge you to take strong and active steps to reduce exposure of children and staff to excessive levels of radiofrequency EMFS within your schools."
— David O. Carpenter, M.D. Director, Institute for Health and the Environment University at Albany





CHILDREN'S VULNERABILITY TO WIRELESS RADIOFREQUENCY (RF) RADIATION





The American Academy of Pediatrics states:

"In recent years, concern has increased about exposure to radio frequency (RF) electromagnetic radiation emitted from cell phones and phone station antennas. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment."

–American Academy of Pediatrics
HealthyChildren.org

Cell towers and cell phones emit wireless radiofrequency (RF) radiation.

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They have proportionately more exposures to RF compared to adults. More importantly, even very low exposures to children can have serious impacts later in life because their nervous and immune systems are still in development.

Children absorb higher levels of RF radiation deeper into their brains and bodies because they have:

- Thinner skulls allow RF radiation to move easier into the brain.
- Higher water content in brain tissue which is more conductive to electricity.
- Smaller heads result in a shorter distance for the RF to travel from the skull to critical brain regions important for learning and memory.

Children are more sensitive to RF impacts because:

- Their brains are still developing.
- Children have more active stem cells- a type of cell scientifically found to be uniquely impacted by RF.
- Children will have a longer lifetime of higher exposures, starting from before they are born.

CELL TOWER RF RADIATION AND CANCER



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 – The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

The World Health Organization International Agency for Research on Cancer Classified Radiofrequency Radiation as a "Possible" Carcinogen in 2011

In 2011, radiofrequency electromagnetic fields (RF-EMF) were classified as a Group 2B possible carcinogen by the World Health Organization's International Agency for Research on Cancer (WHO/IARC).

The WHO/IARC scientists clarified that this determination was for RF-EMF from any source be it cell phones, wireless devices, cell towers or any other type of wireless equipment.

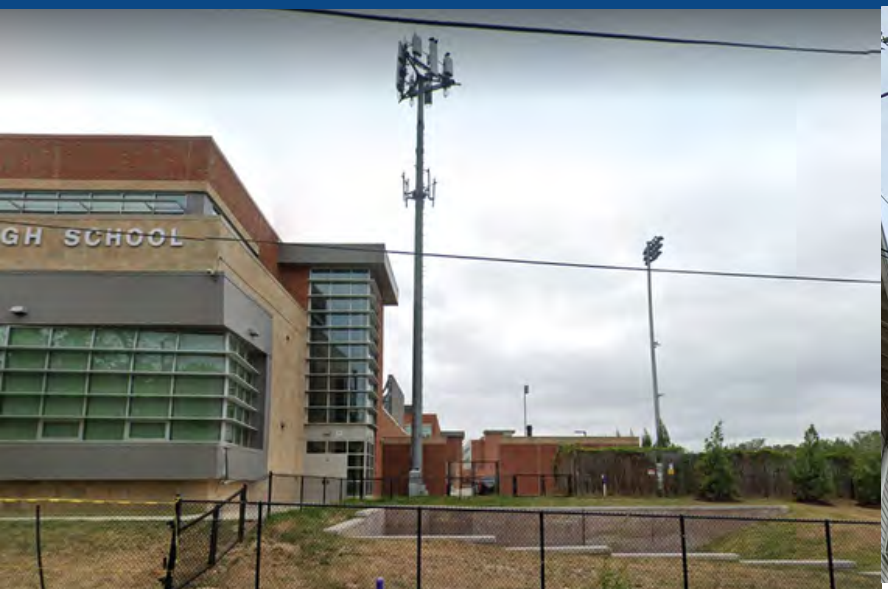
Since 2011, the published peer-reviewed scientific evidence associating RF-EMF (also known as RF-EMR and RFR) to cancer and other adverse effects has significantly increased.

A large-scale animal study published in Environmental Research found rats exposed to RF levels comparable to cell tower emissions had elevated cancers, the very same cancers also found in the US National Toxicology Program animal study of cell phone level RF that found "clear evidence" of cancer in carefully controlled conditions (Falcioni 2018).

In 2019, the WHO/IARC advisory committee recommended that radiofrequency radiation be re-evaluated as a "high" priority in light of the new research. The date of the re-evaluation has not been set.

Currently, several scientists conclude that the weight of currently available, peer-reviewed evidence supports the conclusion that radiofrequency radiation is a proven human carcinogen (Hardell and Carlberg 2017, Peleg et al. 2022, Miller et al. 2018).

PUBLISHED RESEARCH STUDIES





RESEARCHERS RECOMMEND CELL TOWERS BE DISTANCED AWAY FROM HOMES AND SCHOOLS

The review paper entitled "**Limiting liability with positioning to minimize negative health effects of cellular phone towers**" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes, and restricting antennas within 500 meters of schools and hospitals to protect companies from future liability (**Pearce 2020**).

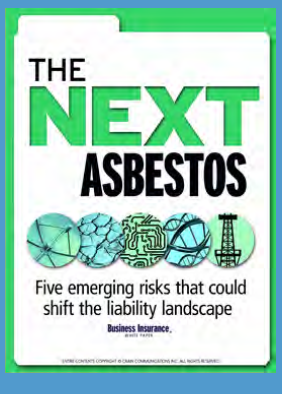
An **analysis** of 100 studies published in *Environmental Reviews* found approximately 80% showed biological effects near towers. "As a general guideline, cell base stations should not be located less than 1500 ft from the population, and at a height of about 150 ft" (**Levitt 2010**).

A **review** published in the *International Journal of Occupational and Environmental Health* found people living less than 500 meters from base station antennas had increased adverse neuro-behavioral symptoms and cancer in eight of the ten epidemiological studies (**Khurana 2010**).

A **paper** by human rights experts published in *Environment Science and Policy* documented the accumulating science indicating safety is not assured, and considered the issue within a human rights framework to protect vulnerable populations from environmental pollution. "We conclude that, because scientific knowledge is incomplete, a precautionary approach is better suited to State obligations under international human rights law" (**Roda and Perry 2014**, **PDF**).

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES SHAREHOLDER WARNINGS



"Some research has shown biological effects from lower -level "non thermal" exposure and people exposed at lower levels have reported headaches, dizziness, nausea, mood disorders, mental slowing and memory loss."
Business Insurance White Paper, The Next Asbestos: Five Emerging Risks That Could Shift the Liability Landscape

Insurance Companies Have Electromagnetic Field Exclusions
Electromagnetic field exclusions" are clear and common in most insurance companies. It is applied as a market standard. This exclusion serves to exclude cover for illnesses caused by long-term EMF (non-ionizing radiation) exposure." — Complete Markets

"Exclusions: This insurance does not apply to: Bodily injury, personal injury, advertising injury, or property damage arising directly or indirectly out of, resulting from, caused or contributed to by electromagnetic radiation, provided that such loss, cost or expense results from or is contributed to by the hazardous properties of electromagnetic radiation.
— Portland Oregon Public School Insurance (page 30)

Insurance Plans Not Only Exclude EMF Damages, But Some Even Exclude Defending Decision Makers From Their Actions in Regards to Their Actions on EMFS

"This policy does not apply to and we will not provide a defense for: a. bodily injury... arising out of ... exposure to or contact with electromagnetic radiation... b. costs of abatement .. of EMF" or c. any supervision, instruction, recommendation, warning or advice given or which should have been given in connection with a or b. above."- City of Ann Arbor Michigan Insurance Policy page 14.

Insurance Authorities Rate 5G as "High Risk."
5G mobile networks are classified as a "high," "off-the-leash" risk. "Existing concerns regarding potential negative health effects from electromagnetic fields (EMF) are only likely to increase. An uptick in liability claims could be a potential long-term consequence" and "[a]s the biological effects of EMF in general and 5G in particular are still being debated, potential claims for health impairments may come with a long latency."
— Swiss Re Institute (2019)

Wireless Companies Rank EMF as a Risk with High Impact
"Electro-magnetic signals emitted by mobile devices and base stations may be found to pose health risks, with potential impacts including: changes to national legislation, a reduction in mobile phone usage or litigation."
— Vodaphone 2017 Report ranks EMF as a "Principal Risk with "High" impact.

Wireless Companies Warn Shareholder About Risk But Not People Living Near Their Wireless Infrastructure

Crown Castle says:
"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

Wireless Companies Define Pollution in Their Own Policies as Including EMFs, Microwaves and Non-ionizing Radiation.

Verizons Total Mobile Protection Plan says: "Pollution" is defined as "any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste."

ENVIRONMENTAL HEALTH TRUST

T-Mobile on 5G: Possible Changes to FCC Human Exposure Limits for RF Could Impact Cash Flow



T-Mobile advertises to the public about going "live" but omits the warnings they give to shareholders regarding 5G, regulatory changes and risk perception.

T-Mobile

T-Mobile 10-K Report 2/2023

"Negative public perception of, and regulations regarding, the perceived health risks relating to 5G networks could undermine market acceptance of our 5G services" (page 13)

"We, along with equipment manufacturers and other carriers, are subject to current and potential future lawsuits **alleging adverse health effects arising from the use of wireless handsets or from wireless transmission equipment such as cell towers."**

"In addition, **the FCC has from time to time gathered data regarding wireless device emissions, and its assessment of the risks associated with using wireless devices may evolve based on its findings.** Any of these allegations or changes in risk assessments could result in customers purchasing fewer devices and wireless services, could result in significant legal and regulatory liability, and could have a material adverse effect on our business, reputation, financial condition, cash flows and operating results." (T- Mobile 10-K Report page 21)


Mobile Telecommunications and Health

Review of the Current Scientific Research in view of Precautionary Health Protection

A 2000 Ecolog Institute Report commissioned by T-Mobile and DeTeMobil Deutsche Telekom MobilNet recommended an exposure limit 1000x lower than the FCC's current power density limit after reviewing the research on biological effects, including impacts to the immune system, central nervous system, hormones, cancer, neurotransmitters and fertility.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

Verizon 10-K Report

"Our wireless business also faces personal injury and wrongful death lawsuits relating to alleged health effects of wireless phones or radio frequency transmitters. We may incur significant expenses in defending these lawsuits. In addition, we may be required to pay significant awards or settlements."

Crown Castle 10-K Report

"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

AT&T 10-K Report

"In the wireless area, we also face current and potential litigation relating to alleged adverse health effects on customers or employees who use such technologies including, for example, wireless devices. We may incur significant expenses defending such suits or government charges and may be required to pay amounts or otherwise change our operations in ways that could materially adversely affect our operations or financial results."

T- MOBILE 10-K Report

"Our business could be adversely affected by findings of product liability for health or safety risks from wireless devices and transmission equipment, as well as by changes to regulations or radio frequency emission standards."

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

American Tower 10-K

"If a scientific study or court decision resulted in a finding that radio frequency emissions pose health risks to consumers, it could negatively impact our tenants and the market for wireless services, which could materially and adversely affect our business, results of operations or financial condition. We do not maintain any significant insurance with respect to these matters."

Nokia 10-K

"Although our products are designed to meet all relevant safety standards and other recommendations and regulatory requirements globally, we cannot guarantee we will not become subject to product liability claims or be held liable for such claims, which could have a material adverse effect on us."

Qualcomm 10-K

"If wireless handsets pose health and safety risks, we may be subject to new regulations, and demand for our products and those of our licensees and customers may decrease."

Ericsson Annual Report

"Any perceived risk or new scientific findings of adverse health effects from mobile communication devices and equipment could adversely affect us through a reduction in sales or through liability claims."

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES





When a new cell tower or wireless network is proposed, the first question to ask is: "Do you have insurance for damages from long-term exposure to the radiofrequency radiation (RFR)?" Usually the answer is "No."

An Uninsurable Risk?

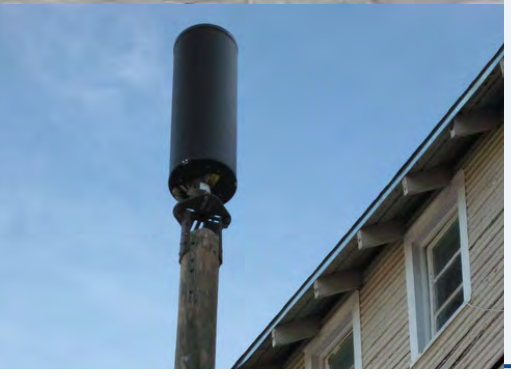
- Insurers rank wireless, cell tower, and 5G RFR non-ionizing electromagnetic field (EMF) radiation as a "high" risk, comparing the issue to lead and asbestos.
- Most insurance plans have "electromagnetic field exclusions" and do not insure for long-term RFR damages.
- Additionally, some insurance plans will not provide a defense for any supervision instruction or recommendation given *"or which should have been given"* in connection to EMFs.
- Wireless RFR and non-ionizing electromagnetic radiation are defined as a type of "pollution" by wireless companies themselves.
- U.S. mobile operators have been unable to get insurance to cover liabilities related to damages from long-term RFR exposure.
- Wireless companies warn their shareholders of RFR risk but do not warn users of their products, nor do the companies warn the people exposed to emissions from their infrastructure.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

APARTMENTS & CONDO BUILDINGS
INCREASED RF RADIATION FROM CELL ANTENNAS





The study "**Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**" published in *Oncology Letters* by **Koppel et al. (2019)** measured 2 apartments and found that the apartment with high RF levels had outdoor areas as close as 6 meters (about 19.6 feet) from transmitting base station cell antennas. In contrast, the apartment with low RF exposure had cell antennas at 40 meters (about 131 feet) away from the balcony.

Furthermore, the researchers also found that both high- and low-RF apartments had good mobile phone reception, and they concluded,"therefore, installation of base stations to risky places cannot be justified using the good reception requirement argument."

A measurement study by **Baltrėnas et al. (2012)** published in *Journal of Environmental Engineering and Landscape Management* investigated RF power density levels from cell phone antennas located 35 meters away from a 10-story apartment building. The transmitting antennas were approximately at the same height as the 6th floor of the building. The researchers found the highest RF levels at floors 5, 6 and 7. The RF at the 6th floor balcony was three times higher than the 3rd floor balcony. The RF power density at the 6th floor was about 15 times the RF measured at the first floor.

A **case report by Hardell et al. (2017)** of RF levels in an apartment in close proximity to rooftop cellular network antennas used an exposimeter to measure levels of different types of RF in the apartment and balconies including TV, FM, TETRA emergency services, 2G GSM, 3G UMTS, 4G LTE, DECT cordless, Wi-Fi 2.4 GHz and 5 GHz and WiMAX. The closest transmitting antennas were 6 meters away from the balcony. The researchers found 97.9% of the mean RF radiation was caused by downlink from the 2G, 3G and 4G base stations. (Downlink means frequencies emitted "down" from the base station cellular antennas.) The researchers found that if the base station RF emissions were excluded, the RF radiation in the children's bedrooms was reduced approximately 99%.

The researchers conclude, "due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults."

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ENVIRONMENTAL HEALTH TRUST

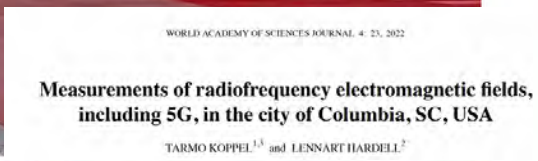
INCREASED EXPOSURE FROM 5G/4G "SMALL" CELL ANTENNAS LOCATED CLOSE TO PEOPLE

A study entitled "**Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**" published in *Environmental Research* by Koppel et al. (2022) created an RF heat map of RF measurements, finding that the highest RF measurements were in areas of close proximity to the base station antennas. The researchers concluded with recommendations to reduce close proximity placements such as positioning antennas "as far as possible from the general public" like in high-elevation locations or more remote areas.

A study entitled "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in the *World Academy of Sciences* Journal found the highest RF levels in areas where the cell phone base station antennas were placed on top of utility poles, street lamps, traffic lights or other posts near to the street. The scientists compared their **2022 findings** to an earlier **2019 published review** on the mean outdoor exposure level of European cities and they found the South Carolina measurements to be higher.

The researchers concluded that the highest exposure areas were due to two reasons: cell phone base antennas on top of high-rise buildings provide "good cell coverage reaching far away, but creating elevated exposure to the radiofrequency electromagnetic fields at the immediate vicinity; and cell phone base station antennas installed on top of utility poles have placed the radiation source closer to humans walking on street level."




WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.

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HEALTH SYMPTOMS REPORTED BY PEOPLE LIVING CLOSE TO CELL ANTENNAS



Image: Figure 1: Top floor apartment adjacent to base stations. Nilsson M, Hardell L. (2023) Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office. Ann Clin Case Rep

RESEARCH ON ANTENNAS CLOSE TO HOMES, SCHOOL AND WORK

Surveys of people living near cell tower antennas in **France**, **Spain**, **Iraq**, **India**, **Germany**, **Egypt**, **Poland** have found significantly higher reports of health issues including sleep issues, fatigue and headaches (See **Santini et al. 2003**, **López 2021**, **Alazawi 2011**, **Pachuau and Pachuaua 2016**, **Eger et al. 2004**, **Abdel-Rassoul et al. 2007**, **Bortkiewicz et al., 2004**).

A **study** published in *American Journal of Men's Health* linked higher cell tower RFR exposures to delayed fine and gross motor skills and to deficits in spatial working memory and attention in school adolescents (**Meo 2018**).

A **study** published in *Environmental Research and Public Health* found higher exposures linked to higher risk of type 2 diabetes (**Meo 2015**).

A study following people for 6 years linked increased cell phone and cell phone tower antenna exposure to altered levels of hormones including cortisol, thyroid, prolactin and testosterone (**Eskander et al. 2021**).

A **study** that followed people in a German town after a cell tower was erected found stress hormones adrenaline and noradrenaline significantly increased over the first 6 months after the antenna activation and decreased dopamine and PEA levels after 18 months (**Buchner 2011**).

Two published case report document illness that developed after 5G antennas were installed. In **Hardell and Nilsson 2023,** a couple developed microwave syndrome symptoms (e.g., neurological symptoms, tinnitus, fatigue, insomnia, emotional distress, skin disorders, and blood pressure variability) after a 5G base station was installed on the roof above their apartment.

Similarly, in **"Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office**" two men developed symptoms after 5G antennas were activated on the roof of their workplace. The symptoms disappeared in both men within a couple of weeks (case 1) or immediately (case 2) after leaving the office.

PUBLISHED RESEARCH ON 5G



New York City Jumbo 5G poles with 5 tiers to house transmitting antennas from numerous carriers.



New York City "small cell" antennas in front of living room window.

Scientists state that 5G's higher frequencies cannot be assumed safe.

5G systems are using low band frequencies well associated with harmful effects **(ICBE-EMF 2022, European Parliament 2021, Panagopoulos et al. 2021)**. However 5G networks are *also using higher frequencies* such as 3.5 GHz and into the mmWave range with 24 GHz and higher.

Contrary to claims that the 5G's higher frequencies simply "bounce" off the skin, researchers have documented that the coiled portion of the skin's sweat duct can be regarded as a helical antenna in the sub-THz band and the skin, our largest organ, can intensely absorb the higher 5G frequencies **(Feldman and Ben Ishai 2017).**

Reviews of 5G health effects caution that the expected real-world impact would be far more serious due to the complex waveforms and other combinations with other toxic stimuli in the environment **(Kostoff et al 2020, Russell, 2018, Belyaev 2019, McCredden et al 2023).**

Researchers will often experiment with zebrafish, rodents and fruit flies to gain data on potential health effects to humans. An Oregon State University study on zebrafish exposed to 3.5 GHz **(Dasgupta et al. 2022)** found "significant abnormal responses in RFR-exposed fish" which "suggest potential long-term behavioral effects. Yang et al 2022 found 3.5 GHZ induced oxidative stress in guinea pigs.

A study on 3.5 GHz exposure to both diabetic and healthy rats (**Bektas et al 2022)** found an increase in degenerated neurons in the hippocampus of the brains, changes in oxidative stress parameters and changes in the energy metabolism and appetite of both healthy and diabetic rats. The researchers conclude that, "5G may not be innocent in terms of its biological effects, especially in the presence of diabetes."

PUBLISHED RESEARCH ON 5G



5G's higher frequencies will be combined with the lower frequencies from current networks already present in the environment.

Studies on rats have found exposure to both 1.5 and 4.3 GHz microwaves induced: cognitive impairment and hippocampal tissue damage **(Zhu et al 2921)**; impairments in spatial learning and memory, *with the combined simultaneous exposures* resulting in the most most severe effects **(Wang et al 2022)**; and immune suppressive responses **(Zhao 2022)**.

Long-term exposure to 2.856 and 9.375 GHz microwaves impaired learning and memory abilities as well as EEG disturbance, structural damage to the hippocampus, and differential expression of hippocampal tissue and serum exosomes **Wang et al. 2023)**.

Studies on fruit flies exposed to 3.5 GHz have found the exposure led to increases in oxidative stress, changes in the microbial community **(Wang et al 2022)** and alterations of the expression of several types of genes (Wang et al 2021).

A review by **Russell 2018** found evidence for millimeter wave effects to the skin, eyes, immune system, gene expression, and bacterial antibiotic resistance.

Recent experimental research on high-band 5G impacts to animal fertility found that 27 GHz damages sperm quality in mussels **(Pecoraro et al 2023).**

Yet the US government is not funding any research on biological effects of frequencies at 3.5 GHz or above 6 GHz to humans.

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NEW HAMPSHIRE STATE COMMISSION

2020 REPORT: 5G HEALTH AND ENVIRONMENT

In 2020, the New Hampshire State Commission issued a Final Report with 15 recommendations to "to protect people, wildlife, and the environment from harmful levels of radiation" after a year-long investigation with numerous meetings and expert testimony.


State of New Hampshire

MEMORANDUM

"A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured."

Recommendations To Update RF Exposure Regulations With New Science

- A resolution to U.S. Congress to require the FCC to commission an independent health study and review of safety limits.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.

Recommendations To Address Impacts to Wildlife And Environment

- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.

Recommendations To Reduce Public Exposure

- Require setbacks of 1,640 feet for new wireless antennas from residences, businesses and schools.
- Cell phones and wireless devices should be equipped with updated software that stops cell phones from radiating when positioned against the body.
- Establish RF radiation-free zones in commercial and public buildings.
- New Hampshire health agencies should educate the public on minimizing RF exposure with public service announcements on radio, television, print.

Recommendations To Utilize Safer Alternatives

- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.

Recommendations To Increase Transparency

- State should measure RFR and post maps with RF measurements..
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer RF measurement education for home inspectors.
- Warning signs posted in commercial and public buildings.

European Parliament

Health impact of 5G

STUDY

Panel for the Future of Science and Technology

EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)

PE 690.012 – July 2021

Health impact of 5G

Current state of knowledge of 5G-related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies

The upcoming deployment of 5G mobile networks will allow for significantly faster mobile broadband speeds and increasingly extensive mobile data usage. Technical innovations include a different transmission system (MIMO: use of multiple-input and multiple-output antennas), directional signal transmission or reception (beamforming), and the use of other frequency ranges. At the same time, a change is expected in the exposure to electromagnetic fields (EMF) of humans and the environment. In addition to those used to date, the 5G pioneer bands identified at EU level have frequencies of 700 MHz, 3.6 GHz (3.4 to 3.8 GHz) and 26 GHz (24.25 to 27.5 GHz). The first two frequencies (FR1) are similar to those used for 2G to 4G technologies and have been investigated in both epidemiological and experimental studies for different end points (including carcinogenicity and reproductive/developmental effects), while 26 GHz (FR2) and higher frequencies have not been adequately studied for the same end points.

The International Agency for Research on Cancer (IARC) classified radiofrequency (RF) EMF as 'possibly carcinogenic to humans' (Group 2B) and recently recommended RF exposure for re-evaluation 'with high priority' (IARC, 2019). Since 2011 a great number of studies have been performed, both epidemiological and experimental. The present review addresses the current knowledge regarding both carcinogenic and reproductive/developmental hazards of RF as exploited by 5G. There are various *in vivo* experimental and epidemiological studies on RF at a lower frequency range (450 to 6000 MHz), which also includes the frequencies used in previous generations' broadband cellular networks, but very few (and inadequate) on the higher frequency range (24 to 100 GHz, centimetre/MMW).

The review shows: 1) 5G lower frequencies (700 and 3 600 MHz): a) limited evidence of carcinogenicity in epidemiological studies; b) sufficient evidence of carcinogenicity in experimental bioassays; c) sufficient evidence of reproductive/developmental adverse effects in humans; d) sufficient evidence of reproductive/developmental adverse effects in experimental animals; 2) 5G higher frequencies (24.25-27.5 GHz): the systematic review found no adequate studies either in humans or in experimental animals.

Conclusions: 1) cancer: FR1 (450 to 6 000 MHz): EMF are probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas; FR2 (24 to 100 GHz): no adequate studies were performed on the higher frequencies; 2) reproductive developmental effects: FR1 (450 to 6 000 MHz): these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, foetuses and newborns; FR2 (24 to 100 GHz): no adequate studies were performed on non-thermal effects of the higher frequencies.

SCIENTIFIC RESEARCH STUDIES





European Parliament requested a research report "**Health Impact of 5G**" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.

A review entitled "**Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**" reviewed the existing scientific literature and found radiofrequency sickness, cancer and changes in biochemical parameters (**Balmori 2022**).

A **study** published in Electromagnetic Biology and Medicine found changes in blood considered biomarkers predictive of cancer in people living closer to cell antenna arrays (**Zothansiama 2017**).

A **study** published in the International Journal of Environmental Research and Public Health found higher exposure to cell network arrays linked to higher mortality from all cancer and specifically lung and breast cancer (**Rodrigues 2021**).

A 10-year **study** published in Science of the Total Environment on cell phone network antennas by the local Municipal Health Department and several universities in Brazil found a clearly elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell phone towers (**Dode 2011**).

A **study** commissioned by the Government of Styria, Austria found a significant cancer incidence in the area around the RF transmitter as well as significant exposure-effect relationships between radiofrequency radiation exposure and the incidence of breast cancers and brain tumors (**Oberfeld 2008**).

A **review** published in Experimental Oncology found "alarming epidemiological and experimental data on possible carcinogenic effects of long term exposure to low intensity microwave (MW) radiation." A year of operation of a powerful base transmitting station for mobile communication reportedly resulted in a dramatic increase of cancer incidence among the population living nearby (**Yakymenko 2011**).

PUBLISHED RESEARCH STUDIES

OUTDOOR LEVELS OF RF ARE INCREASING DUE TO THE DENSIFICATION OF WIRELESS NETWORKS

An **article** published in *The Lancet Planetary Health* documents how RF exposures are increasing and so is the scientific research linking exposure to adverse biological effects. "It is plausibly the most rapidly increasing anthropogenic environmental exposure since the mid-20th century..."

A **2021 report** by the French government on 5G analyzed more than 3,000 measurements and found that while RF levels had *not yet* significantly increased, this was due to the lack of 5G traffic. Additional study specific to 5G in the 3500 MHz band with artificially generated traffic concluded that, "initial results suggest an eventual increase of about 20% in overall exposure."

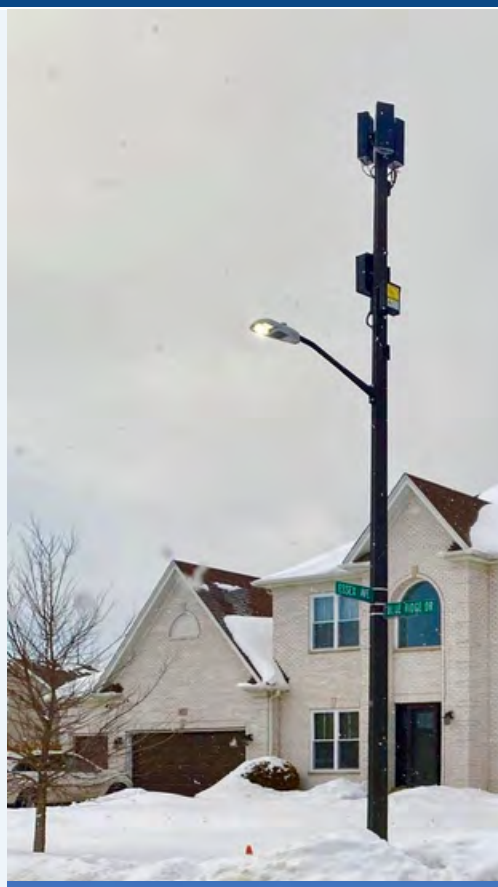
A **2018 multi-country study** published in *Environment International* measured RF in several countries and found cell tower/base station radiation to be the dominant contributor to RF exposure in most outdoor areas. Urban areas had higher RF.

A **study** measuring RF exposure in the European cities of Basel, Ghent and Brussels found the total RF exposure levels in outdoor locations had increased up to 57.1% in one year (April 2011 to March 2012) and most notably due to mobile phone base stations.

A **2018 study** published in *Oncology Letters* documented "unnecessarily high" RF levels in several locations in Sweden and concludes that "using high-power levels causes an excess health risk to many people."

A **2017 Swedish** study of Royal Castle, Supreme Court, three major squares and the Swedish Parliament found that despite the architecturally camouflaged RF-emitting antennas, the passive exposure was higher than RF levels associated with non-thermal biological effects. The researchers noted that the heaviest RF load falls on people working or living near hotspots.

A **2016 study** at Stockholm Central Railway Station in Sweden documented higher RF levels in areas where base station antennas were located closest to people. Importantly, the RF from the downlink of UMTS, LTE, GSM base station antennas contributed to most of the radiation levels.





Bold blue on this PDF are hyperlinked.

CELL TOWERS NEAR SCHOOLS

SCHOOL CELL TOWER SETBACKS

Many communities have policies, ordinances or zoning that ensures cellular antennas are restricted to a specific minimum distance from schools. Hempstead, New York requires a special use permit for cell towers near schools.

Examples of cell tower/4G/5G small cell setbacks/preferred placements for schools:

- Palo Alto, California: 1,500 feet
- Copake, NewYork :1500 feet
- Los Altos , California: 500 feet
- Walnut City, California: 1,500 feet
- Bar Harbor, Maine: 1,500 feet
- Sallisaw, Oklahoma: 1,500 feet
- Shelbourne , Massachusetts: 1,500 feet
- Stockbridge, Massachusetts: 1,500 feet
- San Diego County California 1,000 feet
- Encinitas California:500 feet
- Scarsdale New York: 500 feet
- Ithaca, New York: 250 feet

CELL TOWERS REMOVED FROM SCHOOL GROUNDS

- Milpitas California: School Board asked Crown Castle and T-Mobile to relocate the cell tower to remote location.
- Ripon California: Sprint moved the cell tower at elementary after students and staff developed cancer and parents argued children should not be guinea pigs.
- Alameda California cancelled cell tower contracts.
- Dekalb County Georgia dropped school tower plan.

SCHOOL BOARDS

- Palo Alto Unified School District Cell Tower Resolution supports the City 1,500 setback and opposes cell tower "on or in close proximity to schools to ensure individuals, especially children, are protected from the potential negative effects associated with radiation exposure."
- West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
- Vancouver School Boards Resolution: 1,000 feet
- Greenbelt Maryland Council opposes school towers.

DID YOU KNOW?

- The International Association of Firefighters passed a Resolution opposing cell towers on its stations in 2004 after a study found neurological damage in firefighters with antennas on their fire stations.

LOS ANGELES UNIFIED CA SCHOOL DISTRICT

- 3 resolutions opposing cell towers on school property.
- The District Office of Health and Safety developed a "cautionary level" for radiofrequency radiation 10,000 times lower than FCC regulations because, *"it is believed that a more conservative level is necessary to protect children, who represent a potentially vulnerable and sensitive population."*

SCHOOL BOARDS THAT REVERSED COURSE

- Montgomery County Maryland Schools policy does not allow cell towers on elementary schools.
- Prince George's County Maryland School Board decided not to renew a cell tower construction master leasing agreement that had allowed over 60 schools to be marketed as cell tower sites.
- Portland Oregon Schools ended new leases for cell towers.

EXPERT RECOMMENDATIONS

- The New Hampshire State Commission 5G Health and Environment Report recommends a setback of 1640 feet for schools.
- The Collaborative For High Performance Schools (Green building rating program) has LOW EMF Criteria which includes no cell towers on school property.

THE EPA SCHOOL SITING GUIDELINES

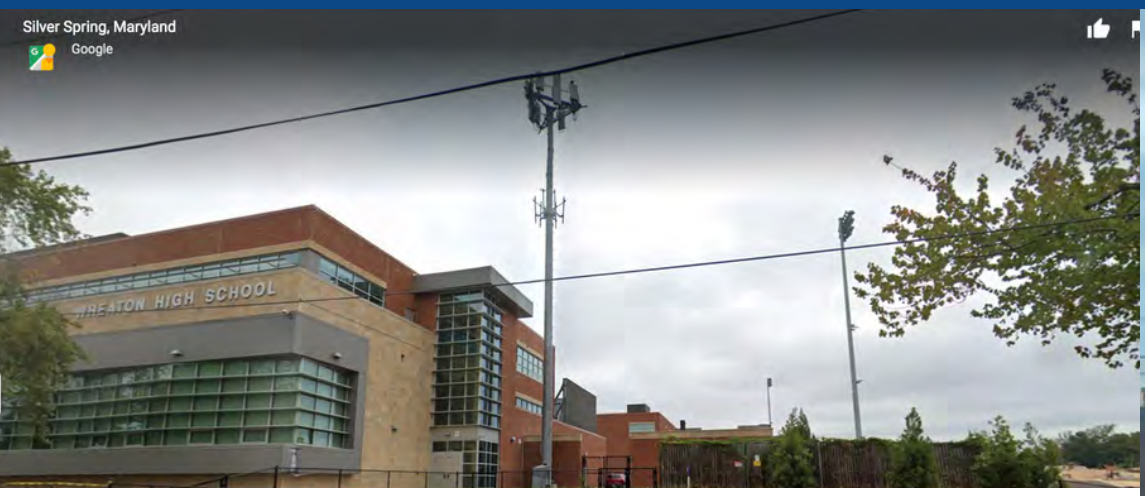
Lists exposure to electromagnetic fields and the fall distance as "potential hazards" from cell towers. The EPA guidelines recommend schools "identify and evaluate cell towers within ~200 feet of prospective school locations."

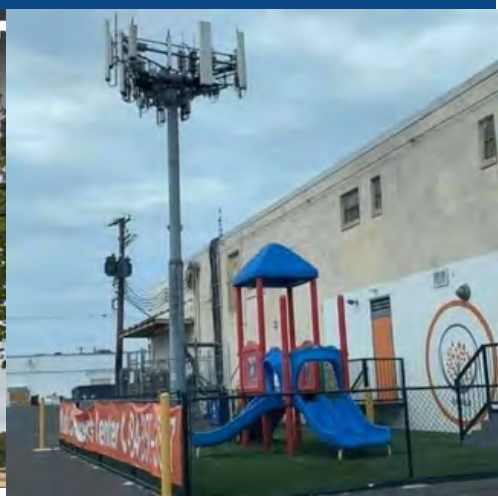
PUBLISHED RESEARCH

- 500 meter buffer recommended for schools to reduce liability and minimize risk (Pearce 2019)
- A moratorium on 5G pending safety research (Frank 2020)
- A precautionary approach is better suited to State obligations under international human rights law (Roda and Perry 2014)
- Increased cancer deaths near cell antennas (Rodrigues 2021)
- Studies find: DNA Damage(Zothansiama 2017), Diabetes (Meo 2015), Cognitive effects (Meo 2018), sleep problems and headaches (Abdel-Rassoul 2007, Levitt & Lai 2010, Shahbazi-Gahrouei 2013)

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS





CONEJO PTA WANTS CELL TOWER MOVED
Op-ed in Thousand Oaks Acorn Journal

The California PTA advocates on behalf of children and families. They advocate against electromagnetic field radiation your schools.

The Conejo PTA urges the use of the precautionary principle in making decisions regarding public health this means if something cannot be proven to be safe it is best to avoid exposure. Most people don't realize that the 1996 FCC state standards for safe levels of omission was actually based on a level set by the American national standards institute in 1982. Well this standard has not been changed in 30 years it has usurped all local authority."

"For this reason, Conejo Council PTA made up of 9000 parents and teachers has decided to take action. We're calling on our local leaders to put in place policies that would ensure parents are notified when cell towers are propose near schools and then encourage a buffer zone around schools."

-Kim Huber, legislative chair of the Conejo Council PTA.

NEW YORK STATE PTA
-Adopted TWO Resolutions 2014

"CELLULAR PHONE TOWERS – 2014 (R-'07, R-'00); Resolved that the New York State Congress of Parents and Teachers, Inc. support legislation that would encourage local communities, including parents and school officials, to regulate the placement of cell towers and cell tower antennas particularly in schools and areas where children congregate,

and be it further Resolved that the New York State PTA support continued research into the long-term effects of radio frequency and microwave frequencies on humans especially as they apply to children, and be it further Resolved that the New York State PTA seek to educate parents and school officials as to the current debate over the placement of cell towers and antennas."

NEELSVILLE MIDDLE SCHOOL PTA (MD)

- Voted to oppose proposed cell tower.
- Hosted parent information session with both the cell tower company and Environmental Health Trust.

HILLSMERE ELEMENTARY SCHOOL PTA (MD)

- Sent letters to the school board in opposition to cell towers near the school.

BRIARLAKE ELEMENTARY (GA)

- Voted to oppose cell tower after board approved towers on schools.

PACIFIC GROVE (CA) PTAs

- Forest Grove Elementary Pacific Grove Middle School and Pacific Grove High School PTAs sent a letter to City Council opposing a high school cell tower.

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS

Exhibit A

August 6, 2018

Pacific Grove City Council
City Hall
300 Forest Ave.
Pacific Grove, CA 93950

Dear members of Pacific Grove City Council,

I am writing you on behalf of Pacific Grove High School PTA in regard to the Pacific Grove Planning Commission's vote on July 26, 2018, which approved a request by Verizon Wireless to install and maintain a cell tower adjacent to Pacific Grove High School (PGHS). For the reasons described below, the Pacific Grove High School PTA **is strongly opposed** to the location of the Verizon cell tower and is requesting that the City Council consider and support the appeal that is being filed by a group of concerned parents who live in Pacific Grove and send their children to PG schools.

The installment of a cell tower adjacent to PGHS poses significant potential health dangers to both students and staff at PGHS. While some argue that radiation emitted from a cell tower is not a health danger, data from many studies indicate the opposite. Research shows that children and pregnant women are the most vulnerable – two demographics most likely to be on PGHS school grounds on a regular basis. The actual placement of the cell tower– near the back of PGHS and very close to Forest Grove Elementary School- only increases the concerns of the frequency in exposure.

Cell towers also pose a risk to students due to fire hazard. Many cell towers throughout the United States have caught fire and collapsed, posing a significant safety concern, especially in an area with young students walking to and from school every day.

The mission of all PTAs nationwide is to make every child's potential a reality by engaging and empowering families and communities to advocate for all children. Our local PTA is very active in expressing our support for or opposition to issues dealing with the health, safety, education, or general well-being of children and youth in our community.

The members of the Pacific Grove High School PTA strongly urge you to please reconsider the Pacific Grove Planning Commission's previous vote and rescind approval for the Verizon cell tower at Pacific Grove High School.

Sincerely,

Julie Kavanaugh
President, Pacific Grove High School PTA

Example of an EMF Exclusion in an Insurance Plan

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ELECTROMAGNETIC RADIATION EXCLUSION

This endorsement modifies insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
PUBLIC RISK GENERAL LIABILITY RETAINED LIMIT COVERAGE FORM
LAW ENFORCEMENT COVERAGE PART
LAW ENFORCEMENT LIABILITY RETAINED LIMIT COVERAGE FORM
PUBLIC OFFICIALS COVERAGE PART
PUBLIC OFFICIALS LIABILITY RETAINED LIMIT COVERAGE FORM
EMPLOYMENT PRACTICES LIABILITY COVERAGE PART
EMPLOYMENT PRACTICES LIABILITY RETAINED LIMIT COVERAGE FORM

The following **Exclusion** is added:

This policy does not apply to and we will not provide a defense for:

a. "Bodily injury," "property damage", "personal and advertising injury", "employee benefits wrongful acts", "personal injury", "law enforcement wrongful acts", "public officiels wrongful acts", "educator's legel wrongful acts", or "employment practices wrongful acts" arising out of, or which result in, the actual, alleged, threatened, perceived, latent, sudden and accidental or incidental exposure to or contact with electromegnetic radiation in any form, from any source.

b. The costs of abatement or mitigation of:

(1) Electromagnetic radiation; or

(2) Exposure to electromagnetic rediation.

c. Any supervision, instruction, recommendation, waming or advice given or which should have been given in connection with **a.** or **b.** above.

Electromagnetic radiation includes but is not limited to, magnetic energy, waves, fields or forces generated, produced, transmitted or maintained by the charges, currents, frequencies, energy or forces of electricity that is generated, flowing or otherwise transmitted through or via the medium, methods and equipment designed to generate, produce, distribute, trensport or transmit the electrical charges, currents, frequencies, energy or forces.



Verizon Total Mobile Protection Plan

16. Pollution

The discharge, dispersal, seepage, migration or escape of pollutants. Pollutants means any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste. Waste includes materials to be recycled, reconditioned or reclaimed.

CITIES AND TOWNS WITH STRONG ORDINANCES

SETBACKS FOR CELL ANTENNAS





Many communities have setbacks for cell towers and small cells.

Shelburne, MA: 3,000 feet for schools and 1,500 feet for homes; no new wireless antennas in residential zones
Copake, NY: 1,500 feet from homes, schools, churches or other buildings containing dwelling units
Sallisaw, OK: No commercial wireless telecommunications towers within 1,500 of homes.
Calabasas, CA: No "Tier 2" wireless telecommunications facilities within 1,000 feet of homes and schools
Bedford, NH: 750 feet from residentially-zoned property
Scarsdale, NY: No wireless facilities within 500 feet from homes, schools, parks, and houses of worship
Walnut City, California: 1,500 feet
Stockbridge, Massachusetts: 1,000 feet
San Diego County California: 1,000 feet (small cells)
Bar Harbor Maine: 1500 setback for schools

School Boards
Palo Alto, California: School Board supports the City of Palo Alto immediately establishing local municipal zoning setback rules of 1,500 feet or more from an operating wireless transmitter and a school site.
West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
Los Angeles California School District: Resolutions opposing cell towers on school property and a cautionary level for radiofrequency radiation 10,000 times lower than FCC limits.

Bold blue on this PDF are hyperlinked. For more setbacks go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

The 2022 study "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in World Academy of Sciences Journal authored by Tarmo Koppel and Lennart Hardell, MD of the Environment and Cancer Research Foundation found the highest RF exposure readings were registered close to cell phone base station antennas mounted on top of utility poles, street lamps or traffic lights.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 8. Gervais Street: Another cell phone base station antenna close to street level and causing high exposure to pedestrians (exposure scenario illustration). Note the antenna appears undistinguishable from the utility pole an unnoticeable between the trees.

5G, Small Cells & Cell Towers Can Drop Property Values

Would you buy a home with cell antennas outside the bedroom window?



Legal filings by cities and municipalities to the FCC highlight how small cell deployment could impact aesthetics and property values.

"many deployments of small cells could affect property values, with significant potential effect…"

— Reply Comments of Smart Communities Siting Coalition (local governments and associations representing 1,854 communities) 4/7/2017,Docket No. 16-421, April 7, 2017

"Considering that the Smart Communities' prior filings show that the addition of facilities of this size diminish property values, it is strange for the Commission to assume that approval can be granted in the regulatory blink of an eye…."

"…allowing poles to go up in areas where poles have been taken down has significant impacts on aesthetics (not to mention property values)."

— *Ex Parte* Submission of Smart Communities Letter to Ms. Marlene H. Dortch, Secretary, Federal Communications Commission, September 19, 2018

ENVIRONMENTAL HEALTH TRUST

5G, CELL TOWERS AND WIRELESS

DECREASED PROPERTY VALUE



"An overwhelming 94 percent of home buyers and renters surveyed by the National Institute for Science, Law & Public Policy (NISLAPP) say they are less interested and would pay less for a property located near a cell tower or antenna."

"of the 1,000 survey respondents, 79 % said that under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas, and almost 90% said they were concerned about the increasing number of cell towers and antennas in their residential neighborhood."

"Cell Towers, Antennas Problematic for Buyers" — Realtor Magazine

"...cell towers are concerning to many people and drop property values."

"While most states do not require disclosure of neighborhood nuisances, such as cell towers or noisy neighbors, a few states do, and more are likely to in the future."
— Real Estate Attorney, South Florida Sun Sentinel, 2021

The California Association of Realtors' Property Sellers Questionnaire specifically lists "cell towers" on the disclosure form for sellers of real estate.
— Click to go to the California Association of Realtors' Property Sellers Questionnaire
(p. 3-4 under K. Neighborhood)

"While the magnitude of the impact varies, the studies uniformly indicate that there is a significant impact on residential property values from installation of cell phone towers..."
— David E. Burgoyne, ASA, SR/WA Certified General Real Estate Appraiser

"In some areas with new towers, property values have decreased by up to 20%."

"Your new neighbor, a cell tower, may impact the value of your home" National Business Post, 2022.

PDF is hyperlinked. More on property values at ehtrust.org

ENVIRONMENTAL HEALTH TRUST

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION



FCC human exposure limits were adopted in 1996 after the EPA was defunded from creating safety limits. They have not properly reviewed these limits since 1996.

FCC's human exposure limits for the RF microwaves emitted by 5G, 4G, cell towers, cell phones, Wi-Fi, Bluetooth, smart devices and wireless networks are based on outdated science and faulty assumptions.

The limits are irrelevant to modern-day technologies and do not reflect the way people are exposed to RF and actually use technology in the 21st century.

Reasons Why FCC's 1996 Limits Do Not Protect:

Heating-Based Only

FCC limits are heat-based "thermal" limits. This means they primarily protect against the overheating of tissue from RF. FCC's limits are not based on protecting against non-heating biological effects such as cancer, oxidative stress, headaches, behavioral problems, memory damage, disrupting bee behavior, tree damage etc.

Short-Term Impacts Only

FCC limits are based on protecting against acute effects. No federal report or research review exists regarding safety from chronic, long-term RF exposures from cell towers, Wi-Fi and wireless networks in the home, school and workplace. The FDA nominated the National Toxicology Program (NTP) to perform animal studies designed to mimic a lifetime of human cell phone exposure. Cancer and DNA damage was found. Another large-scale animal study used cell tower level exposures and found the same tumors as the NTP. However, the FDA rejected these findings.

Children Are Not Protected

FCC limits are misleadingly presented as being "designed to protect children. When safety thresholds were developed decades ago, the science investigating RF impacts to children's developing brains did not exist. Current research concludes the limits should be hundreds of times more protective for children because they are more vulnerable.

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION

No Risk Analysis or Review of Totality of Science
No agency has reviewed all of the latest science. Usually the EPA and FDA use risk assessment to characterize the nature and magnitude of risks to human health for various populations such as children and pregnant women. The EPA also estimates ecological risks, including plants, birds, other wildlife and aquatic life. When groundbreaking studies are published, a quantitative risk analysis of the data is performed. This has never been done for RF.

"The FCC and FDA have failed in their obligation to prescribe safe RFR guidelines produced from wireless communication devices to protect the public health and safety. Devices are becoming more sophisticated, and their usage is as common to daily life as brushing your teeth."
— Pittsburgh Law Review "The FCC Keeps Letting Me Be: Why Radiofrequency Radiation Standards Have Failed to Keep Up With Technology" by Hala Mouzaffar

"The wireless industry reaction features stonewalling public relations and hyper aggressive legal action. It can also involve undermining the credibility and cutting off the funding for researchers who do not endorse cellular safety. It is these hardball tactics that look a lot like 20th century Big Tobacco tactics. It is these hardball tactics—along with consistently supportive FCC policies—that heighten suspicion the wireless industry does indeed have something to hide."

— Norm Alster in the Harvard Press Book "Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates"





ENVIRONMENTAL HEALTH TRUST

A REGULATORY GAP
No Federal Agency Ensuring Cell Tower Wireless Safety

There is no U.S. government agency with oversight for cell tower radiation health effects: no research reviews, no reports, no environmental monitoring, no risk mitigation and no post market health surveillance for the daily, full body radio-frequency (RF) radiation exposure from cell towers.

"The FDA does not regulate cell towers or cell tower radiation. Therefore, the FDA has no studies or information on cell towers to provide in response to your questions."
— Ellen Flannery, Director, FDA Policy Center for Devices and Radiological Health to a California mother with a cell tower on her street who asked the FDA about safety, July 11, 2022

"As a Federal research agency, the NCI is not involved in the regulation of radio frequency telecommunications infrastructure and devices, nor do we make recommendations for policies related to this technology"
— National Cancer Institute letter to Denise Ricciardi, member of the New Hampshire State Commission on 5G, July 30, 2020

The ACS does "not have any official position or statement on whether or not radiofrequency radiation from cell phones, cell phones towers, or other sources is a cause of cancer."
— American Cancer Society Website

"EPA's last review was in the 1984 document Biological Effects of Radiofrequency Radiation. The EPA does not currently have a funded mandate for radiofrequency matters."
— Lee Ann B. Veal Director, EPA Radiation Protection Division Office of Radiation and Indoor Air, July 8, 2020 Letter to Theodora Scarato

Fact: There are no scientific reports by the CDC on cell tower radiation safety, nor does the agency have staff with expertise monitoring the science and evaluating risk. Public information requests found that **several CDC website pages on radio frequency were found to be drafted with a wireless industry consultant.**

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today." **— U.S. Department of Interior Letter to FCC, 2014**

Fact: The World Health Organization (WHO) EMF Project has not reviewed the science since 1993. The WHO webpages on cell phones and cell towers are not based on a published scientific review. The WHO EMF Project webpages were written by a scientist who **used wireless industry money** to start the WHO EMF Project and who is now a consultant to industry. **In contrast, the WHO International Agency for Research on Cancer (a separate WHO entity vetted for conflicts of interest) determined RF radiation to be a Class 2 B "possible" carcinogen in 2011.** Many scientists now state **the evidence showing cancer has increased.**

Blue text *is hyperlinked to source.*

FACTSHEET: ENVIRONMENTAL HEALTH TRUST ET AL. V. FCC

COURT RULING ON FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS EXPOSURE LIMITS

LANDMARK FEDERAL COURT RULING AGAINST THE FCC

On August 13, 2021 the U.S. Court of Appeals for the D.C. Circuit ruled the Federal Communications Commission (FCC) ignored scientific evidence and failed to provide a reasoned explanation for its determination that its 1996 regulations adequately protect the public against all the harmful effects of wireless radiation.

FCC'S REFUSAL TO UPDATE 1996 LIMITS

The legal case challenged the FCC's 2019 decision not to update its 1996 regulations regarding allowable radiofrequency radiation (RF) exposures from wireless technologies - including 5G, cell phones, cell towers, Wi-Fi, and wireless networks.

EVIDENCE OF HARMFUL EFFECTS BELOW FCC LIMITS

FCC limits are based on the belief that heating is the only proven harm from RF. Over 11,000 pages of evidence - 447 exhibits in 27 Volumes - was submitted to the Court documenting biological effects and illness from wireless radiation exposure below heating levels. Research has found brain damage, headaches, memory problems, reproduction damage, synergistic effects, nervous system impacts, brain cancer, genetic damage, as well as harm to trees, birds, bees, and wildlife.

THE COURT FINDINGS

The ruling stated that the FCC's "arbitrary and capricious" decision to maintain their 25 year old exposure limits did not address evidence indicating "non-cancer" harm such as:

- impacts to children
- testimony of persons injured by wireless radiation
- impacts to the developing brain
- impacts to the reproductive system
- impacts to wildlife and the environment

THE COURT ORDER

The Court ordered the FCC to provide a reasoned determination as to whether the evidence warrants a change to 1996 RF limits especially in regards to:

- children's vulnerability
- long-term exposure
- environmental impacts
- new technological developments and the ubiquity of wireless
- how FCC's cell phone tests only measure heat and allow a space between the phone and body

TIMELINE

1980s: EPA had robust research program and was tasked to develop RF safety limits by U.S. Science Advisory Board.

1995: EPA presents to FCC on the EPA timeline for its development of human exposure RF limits which would include both thermal effects and non thermal effects.

1996: EPA is fully defunded by Congress amid heavy lobbying for Telecom Act and halts all research on RF.

1996: The FCC adopts RF limits developed by industry-tied groups - based on short term heating - thermal- effects from high power exposures (based on studies of small animals exposed to high RF levels for under an hour).

1999: FDA requests the National Toxicology Program (NTP) study RF because of the lack of safety data on long-term exposure.

2008/2009 Congressional Hearings

2011: Wireless RF classified as a "possible" Class 2B Carcinogen by International Agency for Research on Cancer.

2012: GAO Report recommends rules be reassessed to reflect current use patterns and recent science.

2013-2019: FCC opens record on RF limits - gets over 1000 submissions.

2018: NTP/NIH releases $30M animal study concluding "clear evidence" of cancer. FDA rejects the findings.

2019: FCC closes record, decides not to update its 1996 wireless RF limits.

2020: Cases filed against FCC.

2021: U.S. Court of Appeals, D.C Circuit ruled that the FCC decision not to change human exposure limits and regulations was "arbitrary and capricious." FCC ordered to respond.

2021: No FCC response to Court, so EHT and others filed request to refresh record.

Timeline is hyperlinked to sources.

FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS RADIATION EXPOSURE LIMITS

FCC Compliance Does Not Ensure Safety

Most of the public assumes that current FCC safety limits for cell phones, cell towers, Wi-Fi, 5G, and wireless networks are based upon an up to date robust review of all relevant research. This assumption of safety is now clearly documented to be erroneous.

Lack of Oversight by Health and Environmental Agencies

The ruling reveals a lack of accountability with our federal health agencies regarding wireless radiation. The EPA, CDC, NIOSH, and NCI did not submit any reports to the Court, revealing that none of these agencies has reviewed the science on health effects to ensure safety for the public. The U.S. has no pre- market safety testing for health effects, no post-market surveillance, no environmental monitoring, and no meaningful interagency coordination.

FDA's Dismissal of Harm Deemed Insufficient

The Court states the FCC improperly relied on the FDA's conclusions that RF limits did not need an update. The FDA's submissions were described by the Court as "cursory" and "insufficient." Although the FDA later released a literature review, it was only focused on cell phones, not cell towers, Wi-Fi nor 5G technology. It also was only focused on cancer, further confirming the fact that U.S. agencies have failed to evaluate the myriad of effects documented in scientific studies, such as brain, immune, fertility and endocrine impacts. A U.S. government review of *the full body of recent science* has simply never been done.

"the Commission's failure to provide a reasoned or even relevant explanation of its position that RF radiation below the current limits does not cause health problems unrelated to cancer renders its explanation as to the effect of RF radiation on children arbitrary and capricious. "

— 2021 EHT et al. v. FCC

The Court Did Not Agree That "Cell Phones Do Not Cause Cancer"

Contrary to the wireless industry's recent claims, the Court *did not make a scientific determination regarding cancer*. The ruling simply stated that in regards to cancer- the FCC passed the minimum legal requirement for adequate review because it (at least) referenced why the FCC dismissed cancer evidence. The FCC cited the rejections of NIH studies by the FDA and of ICNIRP (a small group with no oversight and whose members have a long history of industry ties).

Children's Vulnerability and Effects of Long Term Exposure Ignored by the FCC

The Court states the FCC "dismissed" the American Academy of Pediatrics recommendations to strengthen regs and ensure children and pregnant women are protected. The Court found the FCC failed to explain why it ignored research indicating children's developing brains are more sensitive. Children will have a lifetime of exposure, yet the FCC was found to ignore the issue of impacts *from long term exposure*.

Wildlife Remains Unprotected

FCC's limits were designed in 1996 to protect only humans, not flora or fauna. The Court found that the FCC had "completely failed" to address the "substantive evidence of potential environmental harms" on the record, which included science showing serious impacts to birds, bees, trees, and plants.

PETITIONERS: Environmental Health Trust, Consumers for Safe Cell Phones, Elizabeth Barris, Theodora Scarato, Children's Health Defense, Michelle Hertz, Petra Brokken, Dr. David Carpenter, Dr. Toril Jelter, Dr. Paul Dart, Dr. Ann Lee, Virginia Farver, Jennifer Baran, Paul Stanley M.Ed.

KEY RESOURCES: Court Ruling 8/13/2021, Evidence (11,000 pages), EHT Press Conference

Amicus Briefs

- Amicus of NRDC: Natural Resources Defense Council
- Amicus of Attorney Joe Sandri including declaration of Dr. Linda Birnbaum, former Director of the National Institute of Environmental Health Sciences
- Amicus of Catherine Kleiber
- Amicus of the Building Biology Institute

EHTrust.org for more.

REFERENCES/CITATIONS

Abdel-Rassoul, G., et al (2007). **Neurobehavioral effects among inhabitants around mobile phone base stations**. *NeuroToxicology*

Balmori A. (2002) **Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**. *Environmental Research*

Dode, A. C et al (2011). **Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil**. *Science of The Total Environment*

Hardell, L., & Carlberg, M. (2019). **Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz**. *International Journal of Oncology*

Hardell, L., & Koppel, T. (2022). **Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden**. *Reviews on Environmental Health*.

Khurana et al. (2010). **Epidemiological evidence for a health risk from mobile phone base stations**. *International Journal of Occupational and Environmental Health*

Koppel et al (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Levitt & Lai, H. (2011). **Corrigendum: Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays**. *Environmental Reviews*

López et al (2021). **What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid**. *Environmental Research*

Meo et al (2019). **Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health**. *American Journal of Men's Health*

Meo et al (2015a). **Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus**. *International Journal of Environmental Research and Public Health*

Pearce, J. M. (2020). **Limiting liability with positioning to minimize negative health effects of cellular phone towers**. *Environmental Research*

Roda, C., & Perry, S. (2014). **Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection**. *Environmental Science & Policy*

Rodrigues et al (2021). **The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil**. *International Journal of Environmental Research and Public Health*

Santini et al. (2003). **Survey Study of People Living in the Vicinity of Cellular Phone Base Stations**. *Electromagnetic Biology and Medicine*

Thamilselvan et al (2021) **Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study**. *Journal of International Oral Health*

Yakymenko et al (2011). **Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems**. *Experimental Oncology*

Zothansiama et al (2017). **Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations**. *Electromagnetic Biology and Medicine*

Belyaev et al (2022) **Possible health risks from exposure to microwaves from base stations**, Conference Paper Department of Radiobiology, Cancer Research Institute, Biomedical Research Center *Conference paper

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

5G

Betzalel et al. (2018). **The human skin as a sub-THz receiver—Does 5G pose a danger to it or not?** *Environmental Research*

Betzalel et al. 2017). **The Modeling of the Absorbance of Sub-THz Radiation by Human Skin**. *IEEE Transactions on Terahertz Science and Technology*

Dasgupta et al. (2022). **Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish**. *Environmental Science & Technology Letters*

Di Ciaula, A. (2018). **Towards 5G communication systems: Are there health implications?** *International Journal of Hygiene and Environmental Health*

Frank, J. W. (2021). **Electromagnetic fields, 5G and health: What about the precautionary principle?** *Journal of Epidemiology and Community Health*

Hardell, L., & Carlberg, M. (2020). **[Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest**. *Oncology Letters*

Hardell, L., & Nilsson, M. (2023). **Case Report: The Microwave Syndrome after Installation of 5G Emphasizes the Need for Protection from Radiofrequency Radiation.** Annals of Case Reports.

Nilsson M, Hardell L. (2023) **Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office.** Ann Clin Case Rep. 8: 2378.

Hinrikus et al. (2022). **Possible health effects on the human brain by various generations of mobile telecommunication: A review based estimation of 5G impact**. *International Journal of Radiation Biology*

Kostoff et al. (2020). **Adverse health effects of 5G mobile networking technology under real-life conditions**. *Toxicology Letters*

Nasim, I., & Kim, S. (2019). **Adverse Impacts of 5G Downlinks on Human Body**. *2019 SoutheastCon IEEE*

Russell, C. L. (2018). **5G wireless telecommunications expansion: Public health and environmental implications**. *Environmental Research*

Yang et al. (2022). **Effects of Acute Exposure to 3500 MHz (5G) Radiofrequency Electromagnetic Radiation on Anxiety-Like Behavior and the Auditory Cortex in Guinea Pigs**. *Bioelectromagnetics*

Increasing Exposures From Expanding 5G Networks and Close Proximity "Small Cell" Antennas

Baltrėnas et al.(2012). **Research and evaluation of the intensity parameters of electromagnetic fields produced by mobile communication antennas**. *Journal of Environmental Engineering and Landscape Management*

Bhatt et al. (2017). **Radiofrequency-electromagnetic field exposures in kindergarten children**. *Journal of Exposure Science & Environmental Epidemiology*

Bonato et al. (2022). **Computational Assessment of RF Exposure Levels due to 5G Mobile Phones**. *2022 Microwave Mediterranean Symposium*

Carlberg et al. (2019). **High ambient radiofrequency radiation in Stockholm city, Sweden.** *Oncology Letters*

El-Hajj et al. (2020). **Radiation Analysis in a Gradual 5G Network Deployment Strategy**. *2020 IEEE 3rd 5G World Forum (5GWF)*

Hardell et al. (2018). **Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report**. *Oncology Letters*

Hardell et al. (2017). **High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament**. *Molecular and Clinical Oncology*

Hardell, L., Koppel, T., Carlberg, M., Ahonen, M., & Hedendahl, L. (2016). **Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields**. *International Journal of Oncology*

Koppel et al. (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Koppel et al. (2019). **Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**. *Oncology Letters*

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

Koppel, T., & Hardell, L. (2022). **Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA**. *World Academy of Sciences Journal*

Mazloum et al. (2019). **RF-EMF exposure induced by mobile phones operating in LTE small cells in two different urban cities**. *Annals of Telecommunications*

Urbinello et al. (2014). **Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities**. *Environmental Research*, 134, 134–142.

4G LTE

Broom et al. (2019). **Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6J Mice**. *Bioelectromagnetics*

Choi et al. (2020). **Continuous Exposure to 1.7 GHz LTE Electromagnetic Fields Increases Intracellular Reactive Oxygen Species to Decrease Human Cell Proliferation and Induce Senescence**. *Scientific Reports*

Lv et al. (2014). **The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure**. *Clinical Neurophysiology*

Malik et al. (2021). **Short- and long-duration exposures to cell-phone radiofrequency waves produce dichotomous effects on phototactic response and circadian characteristics of locomotor activity rhythm in zebrafish, Danio rerio**. *Biological Rhythm Research*

Oh, J. J., Byun, S.-S., Lee, S. E., Choe, G., & Hong, S. K. (2018). **Effect of Electromagnetic Waves from Mobile Phones on Spermatogenesis in the Era of 4G-LTE**. *BioMed Research International*, 2018, 1801798.

Özdemir et al. (2021). **The effect of 4.5 G (LTE Advanced-Pro network) mobile phone radiation on the optic nerve**. *Cutaneous and Ocular Toxicology*

Souffi et al. (2022). **Exposure to 1800 MHz LTE electromagnetic fields under proinflammatory conditions decreases the response strength and increases the acoustic threshold of auditory cortical neurons**. *Scientific Reports*

Wei et al. (2019). **Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study**. *Bioelectromagnetics*

Yang et al. (2021). **Functional and network analyses of human exposure to long-term evolution signal**. *Environmental Science and Pollution Research International*

Yang et al. (2017). **Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands**. *Clinical EEG and Neuroscience*

Yu et al. (2020). **Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3–MMP2-BTB axis in the testes of adult rats**. *Science of The Total Environment*

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Electromagnetic Fields: A Hazard to Your Health?

In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.

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Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective☆

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ABSTRACT

Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the World Health Organization. There is strong evidence that excessive exposure to mobile phone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. *In vivo* and *in vitro* studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. There is increasing evidence the exposures can result in neurobehavioral decrements and that some individuals develop a syndrome of "electro-hypersensitivity" or "microwave illness", which is one of several syndromes commonly categorized as "idiopathic environmental intolerance". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that excludes the symptoms as being only psychosomatic. Unfortunately standards set by most national and international bodies are not protective of human health. This is a particular concern in children, given the rapid expansion of use of wireless technologies, the greater susceptibility of the developing nervous system, the hyperconductivity of their brain tissue, the greater penetration of radiofrequency radiation relative to head size and their potential for a longer lifetime exposure.

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Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.



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Case Report

How does long term exposure to base stations and mobile phones affect human hormone profiles?

Emad F. Eskander ✉, Selim F. Estefan, Ahmed A. Abd-Rabou

Objectives

This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations v human's hormone profiles.

Results

This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels.

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Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads

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Fig. 3. Street view on the Skeppsbron street with some of the mobile phone base station antennas pointed out with a circle; note the low placement of the antennas, where microwaves irradiate the pedestrian at close range.

A B S T R A C T

In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter. The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading from the entire area was 31.6 V m^{-1} (2648 mW m^{-2}). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.

Studies from recent decades have shown elevated health risk under long term exposure to such highly elevated radiofrequency fields.

A review by Khurana et al. (2010) found in 80% of the available studies neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations (Khurana et al., 2010). In another review exposure from base stations and other antenna arrays showed changes in immunological and reproductive systems as well as DNA double strand breaks, influence on calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells (Levitt and Lai, 2010).

When a GSM 900 MHz base station was installed in the village Rimbach in Germany it had an influence on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (Buchner and Eger, 2011). Influence on cortisol and thyroid hormones in people living near base stations was shown in other studies (Augner et al., 2010; Eskander et al., 2012).

Dode et al. (2011 compared base station (BS) clusters and cases of deaths by neoplasia in the Belo Horizonte municipality, Minas Gerais state, Brazil, from 1996 to 2006. In their study largest electric field was 12.4 V m^{-1} and the smallest was 0.4 V m^{-1}. They found cancer-related death rates be higher close to base stations. This finding confirmed earlier findings by Eger (Eger et al., 2004).

In a study from India, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. Genetic damage parameters of DNA migration length, damage frequency, and damage index were significantly ($p < 0.001$) elevated in the sample group compared to respective values in healthy controls (Gandhi et al., 2014).

The effect of RF radiation among 20 subjects living close to mobile phone base station compared with 20 subjects living with a distance of about 1 km was studied (Singh et al., 2016). The authors concluded that: "*It was unveiled that a majority of the subjects who were residing near the mobile base station complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties, and hypertension. A majority of the study subjects had significantly lesser stimulated salivary secretion ($p < 0.01$) as compared to the control subjects.*"

Zothansiama et al. (2017) in India inspected DNA damage a antioxidant status in cultured human peripheral blood lymphocy (HPBLs) of individuals residing in the vicinity of mobile phone b stations and compared it with healthy controls living further away. analyses of data from the exposed group (n = 40), residing withi perimeter of 80 m of mobile base stations, showed statistically sign cantly ($p < 0.0001$) higher frequency of micronuclei when compare the control group, residing 300 m away from the mobile base statio

The Ramazzini Institute findings (Falcioni et al., 2018) are suppor by the results in the USNTP study on rats and mice exposed to RF diation (National Toxicology Program, 2018a, 2018b). A clear evide of increased incidence of heart Schwannoma and some evidence glioma and tumours in the adreanal medulla in male rats was fo according to the expert panel, for further discussion see Hardell Carlberg (2019).

The study concluded that Skeppsbron street mobile phone base station antennas are examples of a poor radiofrequency infrastructure design with mobile phone base station antennas positioned into close range to the general public which brings upon high exposure levels. Given the low placement of the antennas (height from the street floor), the highest exposure was often registered at pedestrian head level. Given that head is one of most vulnerable parts of the body, these placements by mobile telephony service providers put pedestrians into unnecessary risk. Position of these antennas, can pose a health risk to people at close range. This is especially critical for people at particular risk, including persons with medical implants, pregnant women or chronically ill persons.

Based on the latest scientific literature regarding RF exposure and adverse health effects, this study recommends repositioning such base station antennas to areas away from the nearby inhabitants, workers and the general public. Alternatively, very low power antennas may also be considered to reduce the exposure. Occupational exposure of people

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MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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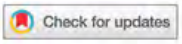
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The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines

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ABSTRACT

In this paper, we review the literature on three important exposure metrics that are inadequately represented in most major radiofrequency radiation (RFR) exposure guidelines today: intensity, exposure duration, and signal modulation. Exposure intensity produces unpredictable effects as demonstrated by nonlinear effects. This is most likely caused by the biological system's ability to adjust and compensate but could lead to eventual biomic breakdown after prolonged exposure. A review of 112 low-intensity studies reveals that biological effects of RFR could occur at a median specific absorption rate of 0.0165 W/kg. Intensity and exposure duration interact since the dose of energy absorbed is the product of intensity and time. The result is that RFR behaves like a biological "stressor" capable of affecting numerous living systems. In addition to intensity and duration, man-made RFR is generally modulated to allow information to be encrypted. The effects of modulation on biological functions are not well understood. Four types of modulation outcomes are discussed. In addition, it is invalid to make direct comparisons between thermal energy and radiofrequency electromagnetic energy. Research data indicate that electromagnetic energy is more biologically potent in causing effects than thermal changes. The two likely functionthrough different mechanisms. As such, any current RFR exposure guidelines based on acute continuous-wave exposure are inadequate for health protection.

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MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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REVIEW

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Genetic effects of non-ionizing electromagnetic fields

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ABSTRACT

This is a review of the research on the genetic effects of non-ionizing electromagnetic field (EMF), mainly on radiofrequency radiation (RFR) and static and extremely low frequency EMF (ELF-EMF). The majority of the studies are on genotoxicity (e.g., DNA damage, chromatin conformation changes, etc.) and gene expression. Genetic effects of EMF depend on various factors, including field parameters and characteristics (frequency, intensity, wave-shape), cell type, and exposure duration. The types of gene expression affected (e.g., genes involved in cell cycle arrest, apoptosis and stress responses, heat-shock proteins) are consistent with the findings that EMF causes genetic damages. Many studies reported effects in cells and animals after exposure to EMF at intensities similar to those in the public and occupational environments. The mechanisms by which effects are induced by EMF are basically unknown. Involvement of free radicals is a likely possibility. EMF also interacts synergistically with different entities on genetic functions. Interactions, particularly with chemotherapeutic compounds, raise the possibility of using EMF as an adjuvant for cancer treatment to increase the efficacy and decrease side effects of traditional chemotherapeutic drugs. Other data, such as adaptive effects and mitotic spindle aberrations after EMF exposure, further support the notion that EMF causes genetic effects in living organisms.

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Radiofrequency radiation; static/extremely low frequency EMF; genetic effects; genotoxicity; gene expression

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Article

The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil

Nádia Cristina Pinheiro Rodrigues [1,2,*], Adilza Condessa Dode [3], Mônica Kramer de Noronha Andrade [1], Gisele O'Dwyer [1], Denise Leite Maia Monteiro [4], Inês Nascimento Carvalho Reis [1], Roberto Pinheiro Rodrigues [5,6], Vera Cecília Frossard [1] and Valéria Teresa Saraiva Lino [1]

Abstract: Background: this study aims to estimate the rate of death by cancer as a result of Radio Base Station (RBS) radiofrequency exposure, especially for breast, cervix, lung, and esophagus cancers. Methods: we collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime. We investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers). Results: in capitals where RBS radiofrequency exposure was higher than 2000/antennas-year, the average mortality rate was 112/100,000 for all cancers. The adjusted analysis showed that, the higher the exposure to RBS radiofrequency, the higher cancer mortality was. The highest adjusted risk was observed for cervix cancer (rate ratio = 2.18). The spatial analysis showed that the highest RBS radiofrequency exposure was observed in a city in southern Brazil that also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancer. Conclusion: the balance of our results indicates that exposure to radiofrequency electromagnetic fields from RBS increases the rate of death for all types of cancer.

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Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission

A B S T R A C T

Background: In 2011, IARC classified radiofrequency radiation (RFR) as possible human carcinogen (Group 2B). According to IARC, animals studies, as well as epidemiological ones, showed limited evidence of carcinogenicity. In 2016, the NTP published the first results of its long-term bioassays on near field RFR, reporting increased incidence of malignant glial tumors of the brain and heart Schwannoma in rats exposed to GSM – and CDMA – modulated cell phone RFR. The tumors observed in the NTP study are of the type similar to the ones observed in some epidemiological studies of cell phone users.

Objectives: The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2448 animals. In this article, we reported the final results regarding brain and heart tumors.

Methods: Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day.

Results: A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of heart Schwann cells hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), although this was not statistically significant. An increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant.

Conclusions: The RI findings on far field exposure to RFR are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the re-evaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.

CELL TOWERS NEAR SCHOOLS

SCHOOL CELL TOWER SETBACKS

Many communities have policies, ordinances or zoning that ensures cellular antennas are restricted to a specific minimum distance from schools. Hempstead, New York requires a special use permit for cell towers near schools.

Examples of cell tower/4G/5G small cell setbacks/preferred placements for schools:

- Palo Alto, California: 1,500 feet
- Copake, NewYork :1500 feet
- Los Altos , California: 500 feet
- Walnut City, California: 1,500 feet
- Bar Harbor, Maine: 1,500 feet
- Sallisaw, Oklahoma: 1,500 feet
- Shelbourne , Massachusetts: 1,500 feet
- Stockbridge, Massachusetts: 1,500 feet
- San Diego County California 1,000 feet
- Encinitas California:500 feet
- Scarsdale New York: 500 feet
- Ithaca, New York: 250 feet

CELL TOWERS REMOVED FROM SCHOOL GROUNDS

- Milpitas California: School Board asked Crown Castle and T-Mobile to relocate the cell tower to remote location.
- Ripon California: Sprint moved the cell tower at elementary after students and staff developed cancer and parents argued children should not be guinea pigs.
- Alameda California cancelled cell tower contracts.
- Dekalb County Georgia dropped school tower plan.

SCHOOL BOARDS

- Palo Alto Unified School District Cell Tower Resolution supports the City 1,500 setback and opposes cell tower "on or in close proximity to schools to ensure individuals, especially children, are protected from the potential negative effects associated with radiation exposure."
- West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
- Vancouver School Boards Resolution: 1,000 feet
- Greenbelt Maryland Council opposes school towers.

DID YOU KNOW?

- The International Association of Firefighters passed a Resolution opposing cell towers on its stations in 2004 after a study found neurological damage in firefighters with antennas on their fire stations.

LOS ANGELES UNIFIED CA SCHOOL DISTRICT

- 3 resolutions opposing cell towers on school property.
- The District Office of Health and Safety developed a "cautionary level" for radiofrequency radiation 10,000 times lower than FCC regulations because, *"it is believed that a more conservative level is necessary to protect children, who represent a potentially vulnerable and sensitive population."*

SCHOOL BOARDS THAT REVERSED COURSE

- Montgomery County Maryland Schools policy does not allow cell towers on elementary schools.
- Prince George's County Maryland School Board decided not to renew a cell tower construction master leasing agreement that had allowed over 60 schools to be marketed as cell tower sites.
- Portland Oregon Schools ended new leases for cell towers.

EXPERT RECOMMENDATIONS

- The New Hampshire State Commission 5G Health and Environment Report recommends a setback of 1640 feet for schools.
- The Collaborative For High Performance Schools (Green building rating program) has LOW EMF Criteria which includes no cell towers on school property.

THE EPA SCHOOL SITING GUIDELINES

Lists exposure to electromagnetic fields and the fall distance as "potential hazards" from cell towers. The EPA guidelines recommend schools "identify and evaluate cell towers within ~200 feet of prospective school locations."

PUBLISHED RESEARCH

- 500 meter buffer recommended for schools to reduce liability and minimize risk (Pearce 2019)
- A moratorium on 5G pending safety research (Frank 2020)
- A precautionary approach is better suited to State obligations under international human rights law (Roda and Perry 2014)
- Increased cancer deaths near cell antennas (Rodrigues 2021)
- Studies find: DNA Damage(Zothansiama 2017), Diabetes (Meo 2015), Cognitive effects (Meo 2018), sleep problems and headaches (Abdel-Rassoul 2007, Levitt & Lai 2010, Shahbazi-Gahrouei 2013)

NEW HAMPSHIRE STATE COMMISSION

2020 REPORT: 5G HEALTH AND ENVIRONMENT

In 2020, the New Hampshire State Commission issued a Final Report with 15 recommendations to "to protect people, wildlife, and the environment from harmful levels of radiation" after a year-long investigation with numerous meetings and expert testimony.


State of New Hampshire

MEMORANDUM

"A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured."

Recommendations To Update RF Exposure Regulations With New Science

- A resolution to U.S. Congress to require the FCC to commission an independent health study and review of safety limits.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.

Recommendations To Address Impacts to Wildlife And Environment

- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.

Recommendations To Reduce Public Exposure

- Require setbacks of 1,640 feet for new wireless antennas from residences, businesses and schools.
- Cell phones and wireless devices should be equipped with updated software that stops cell phones from radiating when positioned against the body.
- Establish RF radiation-free zones in commercial and public buildings.
- New Hampshire health agencies should educate the public on minimizing RF exposure with public service announcements on radio, television, print.

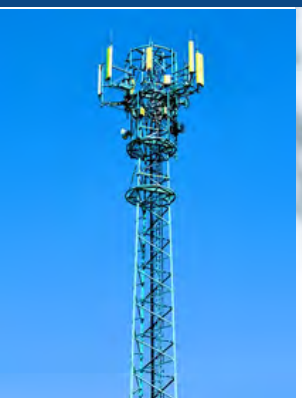
Recommendations To Utilize Safer Alternatives

- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.

Recommendations To Increase Transparency

- State should measure RFR and post maps with RF measurements..
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer RF measurement education for home inspectors.
- Warning signs posted in commercial and public buildings.

CHILDREN'S VULNERABILITY TO WIRELESS RADIOFREQUENCY (RF) RADIATION





The American Academy of Pediatrics states:

"In recent years, concern has increased about exposure to radio frequency (RF) electromagnetic radiation emitted from cell phones and phone station antennas. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment."

–American Academy of Pediatrics
HealthyChildren.org

Cell towers and cell phones emit wireless radiofrequency (RF) radiation.

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They have proportionately more exposures to RF compared to adults. More importantly, even very low exposures to children can have serious impacts later in life because their nervous and immune systems are still in development.

Children absorb higher levels of RF radiation deeper into their brains and bodies because they have:

- Thinner skulls allow RF radiation to move easier into the brain.
- Higher water content in brain tissue which is more conductive to electricity.
- Smaller heads result in a shorter distance for the RF to travel from the skull to critical brain regions important for learning and memory.

Children are more sensitive to RF impacts because:

- Their brains are still developing.
- Children have more active stem cells- a type of cell scientifically found to be uniquely impacted by RF.
- Children will have a longer lifetime of higher exposures, starting from before they are born.

CELL TOWER RF RADIATION AND CANCER



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 – The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

The World Health Organization International Agency for Research on Cancer Classified Radiofrequency Radiation as a "Possible" Carcinogen in 2011

In 2011, radiofrequency electromagnetic fields (RF-EMF) were classified as a Group 2B possible carcinogen by the World Health Organization's International Agency for Research on Cancer (WHO/IARC).

The WHO/IARC scientists clarified that this determination was for RF-EMF from any source be it cell phones, wireless devices, cell towers or any other type of wireless equipment.

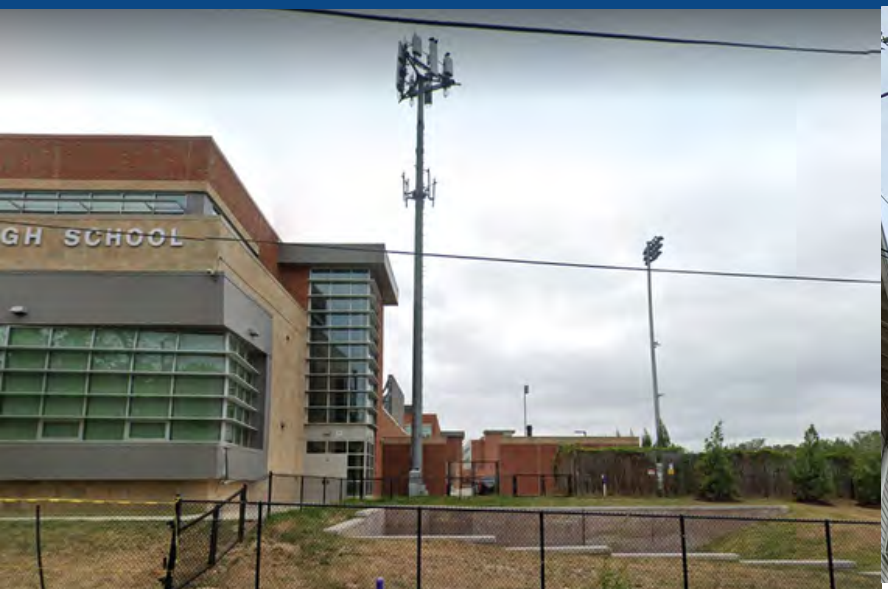
Since 2011, the published peer-reviewed scientific evidence associating RF-EMF (also known as RF-EMR and RFR) to cancer and other adverse effects has significantly increased.

A large-scale animal study published in Environmental Research found rats exposed to RF levels comparable to cell tower emissions had elevated cancers, the very same cancers also found in the US National Toxicology Program animal study of cell phone level RF that found "clear evidence" of cancer in carefully controlled conditions (Falcioni 2018).

In 2019, the WHO/IARC advisory committee recommended that radiofrequency radiation be re-evaluated as a "high" priority in light of the new research. The date of the re-evaluation has not been set.

Currently, several scientists conclude that the weight of currently available, peer-reviewed evidence supports the conclusion that radiofrequency radiation is a proven human carcinogen (Hardell and Carlberg 2017, Peleg et al. 2022, Miller et al. 2018).

PUBLISHED RESEARCH STUDIES





RESEARCHERS RECOMMEND CELL TOWERS BE DISTANCED AWAY FROM HOMES AND SCHOOLS

The review paper entitled "**Limiting liability with positioning to minimize negative health effects of cellular phone towers**" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes, and restricting antennas within 500 meters of schools and hospitals to protect companies from future liability (**Pearce 2020**).

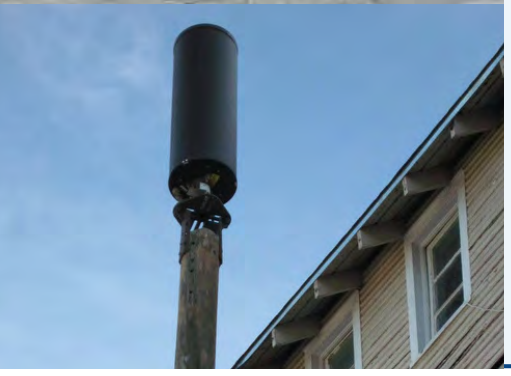
An **analysis** of 100 studies published in *Environmental Reviews* found approximately 80% showed biological effects near towers. "As a general guideline, cell base stations should not be located less than 1500 ft from the population, and at a height of about 150 ft" (**Levitt 2010**).

A **review** published in the *International Journal of Occupational and Environmental Health* found people living less than 500 meters from base station antennas had increased adverse neuro-behavioral symptoms and cancer in eight of the ten epidemiological studies (**Khurana 2010**).

A **paper** by human rights experts published in *Environment Science and Policy* documented the accumulating science indicating safety is not assured, and considered the issue within a human rights framework to protect vulnerable populations from environmental pollution. "We conclude that, because scientific knowledge is incomplete, a precautionary approach is better suited to State obligations under international human rights law" (**Roda and Perry 2014**, **PDF**).

APARTMENTS & CONDO BUILDINGS
INCREASED RF RADIATION FROM CELL ANTENNAS





The study "**Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**" published in *Oncology Letters* by **Koppel et al. (2019)** measured 2 apartments and found that the apartment with high RF levels had outdoor areas as close as 6 meters (about 19.6 feet) from transmitting base station cell antennas. In contrast, the apartment with low RF exposure had cell antennas at 40 meters (about 131 feet) away from the balcony.

Furthermore, the researchers also found that both high- and low-RF apartments had good mobile phone reception, and they concluded,"therefore, installation of base stations to risky places cannot be justified using the good reception requirement argument."

A measurement study by **Baltrėnas et al. (2012)** published in *Journal of Environmental Engineering and Landscape Management* investigated RF power density levels from cell phone antennas located 35 meters away from a 10-story apartment building. The transmitting antennas were approximately at the same height as the 6th floor of the building. The researchers found the highest RF levels at floors 5, 6 and 7. The RF at the 6th floor balcony was three times higher than the 3rd floor balcony. The RF power density at the 6th floor was about 15 times the RF measured at the first floor.

A **case report by Hardell et al. (2017)** of RF levels in an apartment in close proximity to rooftop cellular network antennas used an exposimeter to measure levels of different types of RF in the apartment and balconies including TV, FM, TETRA emergency services, 2G GSM, 3G UMTS, 4G LTE, DECT cordless, Wi-Fi 2.4 GHz and 5 GHz and WiMAX. The closest transmitting antennas were 6 meters away from the balcony. The researchers found 97.9% of the mean RF radiation was caused by downlink from the 2G, 3G and 4G base stations. (Downlink means frequencies emitted "down" from the base station cellular antennas.) The researchers found that if the base station RF emissions were excluded, the RF radiation in the children's bedrooms was reduced approximately 99%.

The researchers conclude, "due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults."

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ENVIRONMENTAL HEALTH TRUST

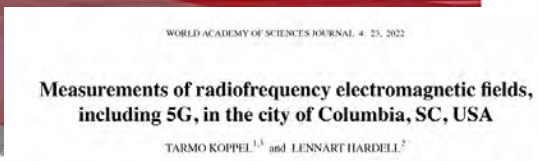
INCREASED EXPOSURE FROM 5G/4G "SMALL" CELL ANTENNAS LOCATED CLOSE TO PEOPLE

A study entitled "**Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**" published in *Environmental Research* by Koppel et al. (2022) created an RF heat map of RF measurements, finding that the highest RF measurements were in areas of close proximity to the base station antennas. The researchers concluded with recommendations to reduce close proximity placements such as positioning antennas "as far as possible from the general public" like in high-elevation locations or more remote areas.

A study entitled "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in the *World Academy of Sciences* Journal found the highest RF levels in areas where the cell phone base station antennas were placed on top of utility poles, street lamps, traffic lights or other posts near to the street. The scientists compared their **2022 findings** to an earlier **2019 published review** on the mean outdoor exposure level of European cities and they found the South Carolina measurements to be higher.

The researchers concluded that the highest exposure areas were due to two reasons: cell phone base antennas on top of high-rise buildings provide "good cell coverage reaching far away, but creating elevated exposure to the radiofrequency electromagnetic fields at the immediate vicinity; and cell phone base station antennas installed on top of utility poles have placed the radiation source closer to humans walking on street level."




WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.

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HEALTH SYMPTOMS REPORTED BY PEOPLE LIVING CLOSE TO CELL ANTENNAS



Image: Figure 1: Top floor apartment adjacent to base stations. Nilsson M, Hardell L. (2023) Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office. Ann Clin Case Rep

RESEARCH ON ANTENNAS CLOSE TO HOMES, SCHOOL AND WORK

Surveys of people living near cell tower antennas in **France**, **Spain**, **Iraq**, **India**, **Germany**, **Egypt**, **Poland** have found significantly higher reports of health issues including sleep issues, fatigue and headaches (See **Santini et al. 2003**, **López 2021**, **Alazawi 2011**, **Pachuau and Pachuaua 2016**, **Eger et al. 2004**, **Abdel-Rassoul et al. 2007**, **Bortkiewicz et al., 2004**).

A **study** published in *American Journal of Men's Health* linked higher cell tower RFR exposures to delayed fine and gross motor skills and to deficits in spatial working memory and attention in school adolescents (**Meo 2018**).

A **study** published in *Environmental Research and Public Health* found higher exposures linked to higher risk of type 2 diabetes (**Meo 2015**).

A study following people for 6 years linked increased cell phone and cell phone tower antenna exposure to altered levels of hormones including cortisol, thyroid, prolactin and testosterone (**Eskander et al. 2021**).

A **study** that followed people in a German town after a cell tower was erected found stress hormones adrenaline and noradrenaline significantly increased over the first 6 months after the antenna activation and decreased dopamine and PEA levels after 18 months (**Buchner 2011**).

Two published case report document illness that developed after 5G antennas were installed. In **Hardell and Nilsson 2023,** a couple developed microwave syndrome symptoms (e.g., neurological symptoms, tinnitus, fatigue, insomnia, emotional distress, skin disorders, and blood pressure variability) after a 5G base station was installed on the roof above their apartment.

Similarly, in **"Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office**" two men developed symptoms after 5G antennas were activated on the roof of their workplace. The symptoms disappeared in both men within a couple of weeks (case 1) or immediately (case 2) after leaving the office.

PUBLISHED RESEARCH ON 5G



New York City Jumbo 5G poles with 5 tiers to house transmitting antennas from numerous carriers.



New York City "small cell" antennas in front of living room window.

Scientists state that 5G's higher frequencies cannot be assumed safe.

5G systems are using low band frequencies well associated with harmful effects **(ICBE-EMF 2022, European Parliament 2021, Panagopoulos et al. 2021)**. However 5G networks are *also using higher frequencies* such as 3.5 GHz and into the mmWave range with 24 GHz and higher.

Contrary to claims that the 5G's higher frequencies simply "bounce" off the skin, researchers have documented that the coiled portion of the skin's sweat duct can be regarded as a helical antenna in the sub-THz band and the skin, our largest organ, can intensely absorb the higher 5G frequencies **(Feldman and Ben Ishai 2017).**

Reviews of 5G health effects caution that the expected real-world impact would be far more serious due to the complex waveforms and other combinations with other toxic stimuli in the environment **(Kostoff et al 2020, Russell, 2018, Belyaev 2019, McCredden et al 2023).**

Researchers will often experiment with zebrafish, rodents and fruit flies to gain data on potential health effects to humans. An Oregon State University study on zebrafish exposed to 3.5 GHz **(Dasgupta et al. 2022)** found "significant abnormal responses in RFR-exposed fish" which "suggest potential long-term behavioral effects. Yang et al 2022 found 3.5 GHZ induced oxidative stress in guinea pigs.

A study on 3.5 GHz exposure to both diabetic and healthy rats (**Bektas et al 2022)** found an increase in degenerated neurons in the hippocampus of the brains, changes in oxidative stress parameters and changes in the energy metabolism and appetite of both healthy and diabetic rats. The researchers conclude that, "5G may not be innocent in terms of its biological effects, especially in the presence of diabetes."

PUBLISHED RESEARCH ON 5G



5G's higher frequencies will be combined with the lower frequencies from current networks already present in the environment.

Studies on rats have found exposure to both 1.5 and 4.3 GHz microwaves induced: cognitive impairment and hippocampal tissue damage **(Zhu et al 2921)**; impairments in spatial learning and memory, *with the combined simultaneous exposures* resulting in the most most severe effects **(Wang et al 2022)**; and immune suppressive responses **(Zhao 2022)**.

Long-term exposure to 2.856 and 9.375 GHz microwaves impaired learning and memory abilities as well as EEG disturbance, structural damage to the hippocampus, and differential expression of hippocampal tissue and serum exosomes **Wang et al. 2023)**.

Studies on fruit flies exposed to 3.5 GHz have found the exposure led to increases in oxidative stress, changes in the microbial community **(Wang et al 2022)** and alterations of the expression of several types of genes (Wang et al 2021).

A review by **Russell 2018** found evidence for millimeter wave effects to the skin, eyes, immune system, gene expression, and bacterial antibiotic resistance.

Recent experimental research on high-band 5G impacts to animal fertility found that 27 GHz damages sperm quality in mussels **(Pecoraro et al 2023).**

Yet the US government is not funding any research on biological effects of frequencies at 3.5 GHz or above 6 GHz to humans.

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European Parliament

Health impact of 5G

STUDY

Panel for the Future of Science and Technology

EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)

PE 690.012 – July 2021

Health impact of 5G

Current state of knowledge of 5G-related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies

The upcoming deployment of 5G mobile networks will allow for significantly faster mobile broadband speeds and increasingly extensive mobile data usage. Technical innovations include a different transmission system (MIMO: use of multiple-input and multiple-output antennas), directional signal transmission or reception (beamforming), and the use of other frequency ranges. At the same time, a change is expected in the exposure to electromagnetic fields (EMF) of humans and the environment. In addition to those used to date, the 5G pioneer bands identified at EU level have frequencies of 700 MHz, 3.6 GHz (3.4 to 3.8 GHz) and 26 GHz (24.25 to 27.5 GHz). The first two frequencies (FR1) are similar to those used for 2G to 4G technologies and have been investigated in both epidemiological and experimental studies for different end points (including carcinogenicity and reproductive/developmental effects), while 26 GHz (FR2) and higher frequencies have not been adequately studied for the same end points.

The International Agency for Research on Cancer (IARC) classified radiofrequency (RF) EMF as 'possibly carcinogenic to humans' (Group 2B) and recently recommended RF exposure for re-evaluation 'with high priority' (IARC, 2019). Since 2011 a great number of studies have been performed, both epidemiological and experimental. The present review addresses the current knowledge regarding both carcinogenic and reproductive/developmental hazards of RF as exploited by 5G. There are various *in vivo* experimental and epidemiological studies on RF at a lower frequency range (450 to 6000 MHz), which also includes the frequencies used in previous generations' broadband cellular networks, but very few (and inadequate) on the higher frequency range (24 to 100 GHz, centimetre/MMW).

The review shows: 1) 5G lower frequencies (700 and 3 600 MHz): a) limited evidence of carcinogenicity in epidemiological studies; b) sufficient evidence of carcinogenicity in experimental bioassays; c) sufficient evidence of reproductive/developmental adverse effects in humans; d) sufficient evidence of reproductive/developmental adverse effects in experimental animals; 2) 5G higher frequencies (24.25-27.5 GHz): the systematic review found no adequate studies either in humans or in experimental animals.

Conclusions: 1) cancer: FR1 (450 to 6 000 MHz): EMF are probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas; FR2 (24 to 100 GHz): no adequate studies were performed on the higher frequencies; 2) reproductive developmental effects: FR1 (450 to 6 000 MHz): these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, foetuses and newborns; FR2 (24 to 100 GHz): no adequate studies were performed on non-thermal effects of the higher frequencies.

SCIENTIFIC RESEARCH STUDIES





European Parliament requested a research report "**Health Impact of 5G**" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.

A review entitled "**Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**" reviewed the existing scientific literature and found radiofrequency sickness, cancer and changes in biochemical parameters (**Balmori 2022**).

A **study** published in Electromagnetic Biology and Medicine found changes in blood considered biomarkers predictive of cancer in people living closer to cell antenna arrays (**Zothansiama 2017**).

A **study** published in the International Journal of Environmental Research and Public Health found higher exposure to cell network arrays linked to higher mortality from all cancer and specifically lung and breast cancer (**Rodrigues 2021**).

A 10-year **study** published in Science of the Total Environment on cell phone network antennas by the local Municipal Health Department and several universities in Brazil found a clearly elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell phone towers (**Dode 2011**).

A **study** commissioned by the Government of Styria, Austria found a significant cancer incidence in the area around the RF transmitter as well as significant exposure-effect relationships between radiofrequency radiation exposure and the incidence of breast cancers and brain tumors (**Oberfeld 2008**).

A **review** published in Experimental Oncology found "alarming epidemiological and experimental data on possible carcinogenic effects of long term exposure to low intensity microwave (MW) radiation." A year of operation of a powerful base transmitting station for mobile communication reportedly resulted in a dramatic increase of cancer incidence among the population living nearby (**Yakymenko 2011**).

PUBLISHED RESEARCH STUDIES

OUTDOOR LEVELS OF RF ARE INCREASING DUE TO THE DENSIFICATION OF WIRELESS NETWORKS

An **article** published in *The Lancet Planetary Health* documents how RF exposures are increasing and so is the scientific research linking exposure to adverse biological effects. "It is plausibly the most rapidly increasing anthropogenic environmental exposure since the mid-20th century..."

A **2021 report** by the French government on 5G analyzed more than 3,000 measurements and found that while RF levels had *not yet* significantly increased, this was due to the lack of 5G traffic. Additional study specific to 5G in the 3500 MHz band with artificially generated traffic concluded that, "initial results suggest an eventual increase of about 20% in overall exposure."

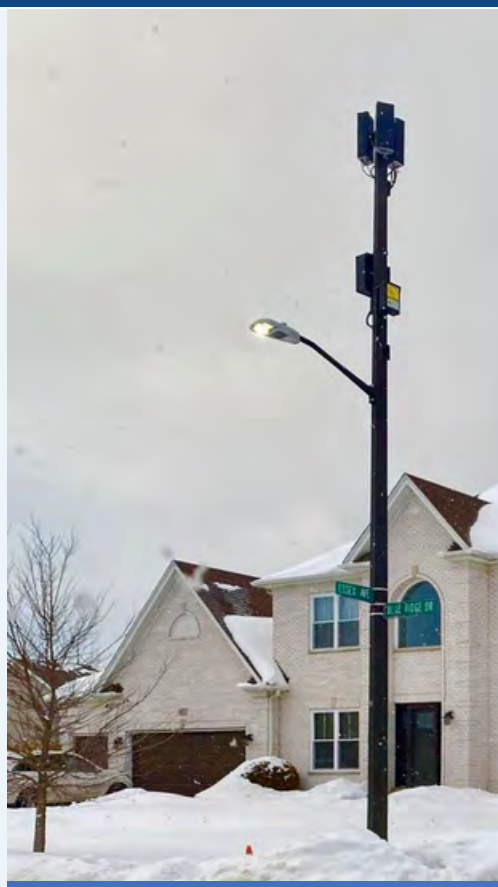
A **2018 multi-country study** published in *Environment International* measured RF in several countries and found cell tower/base station radiation to be the dominant contributor to RF exposure in most outdoor areas. Urban areas had higher RF.

A **study** measuring RF exposure in the European cities of Basel, Ghent and Brussels found the total RF exposure levels in outdoor locations had increased up to 57.1% in one year (April 2011 to March 2012) and most notably due to mobile phone base stations.

A **2018 study** published in *Oncology Letters* documented "unnecessarily high" RF levels in several locations in Sweden and concludes that "using high-power levels causes an excess health risk to many people."

A **2017 Swedish** study of Royal Castle, Supreme Court, three major squares and the Swedish Parliament found that despite the architecturally camouflaged RF-emitting antennas, the passive exposure was higher than RF levels associated with non-thermal biological effects. The researchers noted that the heaviest RF load falls on people working or living near hotspots.

A **2016 study** at Stockholm Central Railway Station in Sweden documented higher RF levels in areas where base station antennas were located closest to people. Importantly, the RF from the downlink of UMTS, LTE, GSM base station antennas contributed to most of the radiation levels.

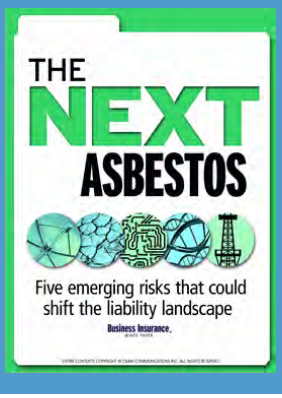




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5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES SHAREHOLDER WARNINGS



"Some research has shown biological effects from lower -level "non thermal" exposure and people exposed at lower levels have reported headaches, dizziness, nausea, mood disorders, mental slowing and memory loss."
Business Insurance White Paper, The Next Asbestos: Five Emerging Risks That Could Shift the Liability Landscape

Insurance Companies Have Electromagnetic Field Exclusions
Electromagnetic field exclusions" are clear and common in most insurance companies. It is applied as a market standard. This exclusion serves to exclude cover for illnesses caused by long-term EMF (non-ionizing radiation) exposure." — Complete Markets

"Exclusions: This insurance does not apply to: Bodily injury, personal injury, advertising injury, or property damage arising directly or indirectly out of, resulting from, caused or contributed to by electromagnetic radiation, provided that such loss, cost or expense results from or is contributed to by the hazardous properties of electromagnetic radiation.
— Portland Oregon Public School Insurance (page 30)

Insurance Plans Not Only Exclude EMF Damages, But Some Even Exclude Defending Decision Makers From Their Actions in Regards to Their Actions on EMFS

"This policy does not apply to and we will not provide a defense for: a. bodily injury... arising out of ... exposure to or contact with electromagnetic radiation... b. costs of abatement .. of EMF" or c. any supervision, instruction, recommendation, warning or advice given or which should have been given in connection with a or b. above."- City of Ann Arbor Michigan Insurance Policy page 14.

Insurance Authorities Rate 5G as "High Risk."
5G mobile networks are classified as a "high," "off-the-leash" risk. "Existing concerns regarding potential negative health effects from electromagnetic fields (EMF) are only likely to increase. An uptick in liability claims could be a potential long-term consequence" and "[a]s the biological effects of EMF in general and 5G in particular are still being debated, potential claims for health impairments may come with a long latency."
— Swiss Re Institute (2019)

Wireless Companies Rank EMF as a Risk with High Impact
"Electro-magnetic signals emitted by mobile devices and base stations may be found to pose health risks, with potential impacts including: changes to national legislation, a reduction in mobile phone usage or litigation."
— Vodaphone 2017 Report ranks EMF as a "Principal Risk with "High" impact.

Wireless Companies Warn Shareholder About Risk But Not People Living Near Their Wireless Infrastructure

Crown Castle says:
"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

Wireless Companies Define Pollution in Their Own Policies as Including EMFs, Microwaves and Non-ionizing Radiation.

Verizons Total Mobile Protection Plan says: "Pollution" is defined as "any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste."

ENVIRONMENTAL HEALTH TRUST

T-Mobile on 5G: Possible Changes to FCC Human Exposure Limits for RF Could Impact Cash Flow



T-Mobile advertises to the public about going "live" but omits the warnings they give to shareholders regarding 5G, regulatory changes and risk perception.

T-Mobile

T-Mobile 10-K Report 2/2023

"Negative public perception of, and regulations regarding, the perceived health risks relating to 5G networks could undermine market acceptance of our 5G services" (page 13)

"We, along with equipment manufacturers and other carriers, are subject to current and potential future lawsuits **alleging adverse health effects arising from the use of wireless handsets or from wireless transmission equipment such as cell towers."**

"In addition, **the FCC has from time to time gathered data regarding wireless device emissions, and its assessment of the risks associated with using wireless devices may evolve based on its findings.** Any of these allegations or changes in risk assessments could result in customers purchasing fewer devices and wireless services, could result in significant legal and regulatory liability, and could have a material adverse effect on our business, reputation, financial condition, cash flows and operating results." (T- Mobile 10-K Report page 21)


Mobile Telecommunications and Health

Review of the Current Scientific Research in view of Precautionary Health Protection

A 2000 Ecolog Institute Report commissioned by T-Mobile and DeTeMobil Deutsche Telekom MobilNet recommended an exposure limit 1000x lower than the FCC's current power density limit after reviewing the research on biological effects, including impacts to the immune system, central nervous system, hormones, cancer, neurotransmitters and fertility.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

Verizon 10-K Report

"Our wireless business also faces personal injury and wrongful death lawsuits relating to alleged health effects of wireless phones or radio frequency transmitters. We may incur significant expenses in defending these lawsuits. In addition, we may be required to pay significant awards or settlements."

Crown Castle 10-K Report

"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

AT&T 10-K Report

"In the wireless area, we also face current and potential litigation relating to alleged adverse health effects on customers or employees who use such technologies including, for example, wireless devices. We may incur significant expenses defending such suits or government charges and may be required to pay amounts or otherwise change our operations in ways that could materially adversely affect our operations or financial results."

T- MOBILE 10-K Report

"Our business could be adversely affected by findings of product liability for health or safety risks from wireless devices and transmission equipment, as well as by changes to regulations or radio frequency emission standards."

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

American Tower 10-K

"If a scientific study or court decision resulted in a finding that radio frequency emissions pose health risks to consumers, it could negatively impact our tenants and the market for wireless services, which could materially and adversely affect our business, results of operations or financial condition. We do not maintain any significant insurance with respect to these matters."

Nokia 10-K

"Although our products are designed to meet all relevant safety standards and other recommendations and regulatory requirements globally, we cannot guarantee we will not become subject to product liability claims or be held liable for such claims, which could have a material adverse effect on us."

Qualcomm 10-K

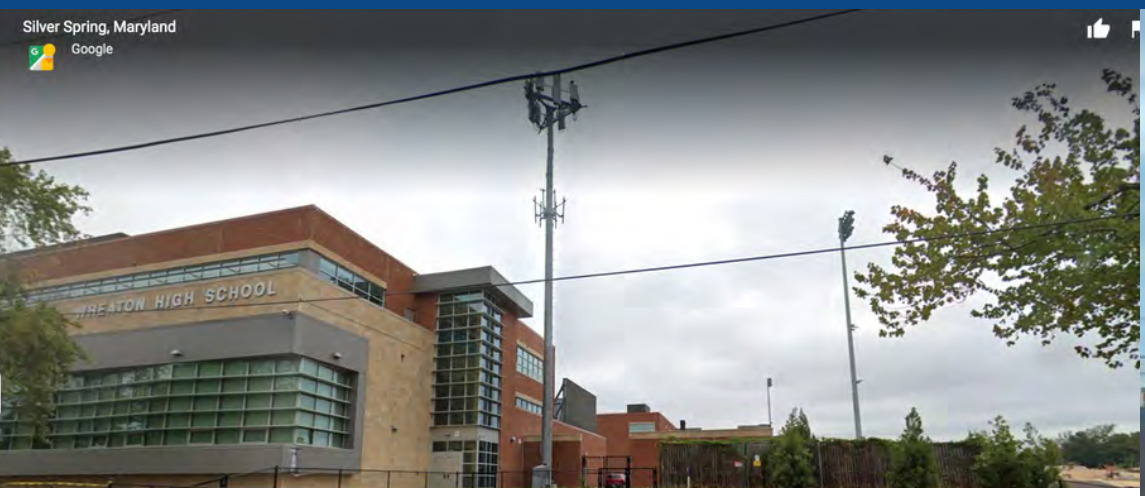
"If wireless handsets pose health and safety risks, we may be subject to new regulations, and demand for our products and those of our licensees and customers may decrease."

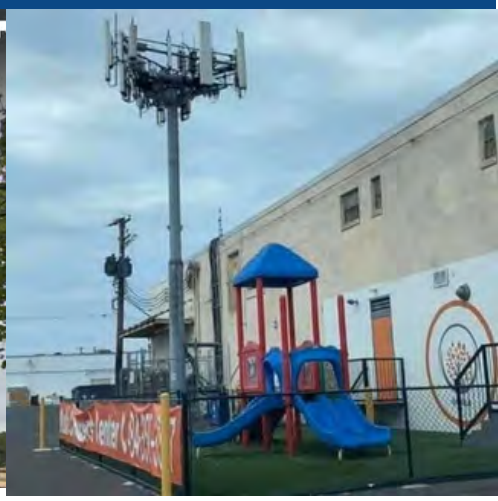
Ericsson Annual Report

"Any perceived risk or new scientific findings of adverse health effects from mobile communication devices and equipment could adversely affect us through a reduction in sales or through liability claims."

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS





CONEJO PTA WANTS CELL TOWER MOVED
Op-ed in Thousand Oaks Acorn Journal

The California PTA advocates on behalf of children and families. They advocate against electromagnetic field radiation your schools.

The Conejo PTA urges the use of the precautionary principle in making decisions regarding public health this means if something cannot be proven to be safe it is best to avoid exposure. Most people don't realize that the 1996 FCC state standards for safe levels of omission was actually based on a level set by the American national standards institute in 1982. Well this standard has not been changed in 30 years it has usurped all local authority."

"For this reason, Conejo Council PTA made up of 9000 parents and teachers has decided to take action. We're calling on our local leaders to put in place policies that would ensure parents are notified when cell towers are propose near schools and then encourage a buffer zone around schools."

-Kim Huber, legislative chair of the Conejo Council PTA.

NEW YORK STATE PTA
-Adopted TWO Resolutions 2014

"CELLULAR PHONE TOWERS – 2014 (R-'07, R-'00); Resolved that the New York State Congress of Parents and Teachers, Inc. support legislation that would encourage local communities, including parents and school officials, to regulate the placement of cell towers and cell tower antennas particularly in schools and areas where children congregate,

and be it further Resolved that the New York State PTA support continued research into the long-term effects of radio frequency and microwave frequencies on humans especially as they apply to children, and be it further Resolved that the New York State PTA seek to educate parents and school officials as to the current debate over the placement of cell towers and antennas."

NEELSVILLE MIDDLE SCHOOL PTA (MD)

- Voted to oppose proposed cell tower.
- Hosted parent information session with both the cell tower company and Environmental Health Trust.

HILLSMERE ELEMENTARY SCHOOL PTA (MD)

- Sent letters to the school board in opposition to cell towers near the school.

BRIARLAKE ELEMENTARY (GA)

- Voted to oppose cell tower after board approved towers on schools.

PACIFIC GROVE (CA) PTAs

- Forest Grove Elementary Pacific Grove Middle School and Pacific Grove High School PTAs sent a letter to City Council opposing a high school cell tower.

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS

Exhibit A

August 6, 2018

Pacific Grove City Council
City Hall
300 Forest Ave.
Pacific Grove, CA 93950

Dear members of Pacific Grove City Council,

I am writing you on behalf of Pacific Grove High School PTA in regard to the Pacific Grove Planning Commission's vote on July 26, 2018, which approved a request by Verizon Wireless to install and maintain a cell tower adjacent to Pacific Grove High School (PGHS). For the reasons described below, the Pacific Grove High School PTA **is strongly opposed** to the location of the Verizon cell tower and is requesting that the City Council consider and support the appeal that is being filed by a group of concerned parents who live in Pacific Grove and send their children to PG schools.

The installment of a cell tower adjacent to PGHS poses significant potential health dangers to both students and staff at PGHS. While some argue that radiation emitted from a cell tower is not a health danger, data from many studies indicate the opposite. Research shows that children and pregnant women are the most vulnerable – two demographics most likely to be on PGHS school grounds on a regular basis. The actual placement of the cell tower– near the back of PGHS and very close to Forest Grove Elementary School- only increases the concerns of the frequency in exposure.

Cell towers also pose a risk to students due to fire hazard. Many cell towers throughout the United States have caught fire and collapsed, posing a significant safety concern, especially in an area with young students walking to and from school every day.

The mission of all PTAs nationwide is to make every child's potential a reality by engaging and empowering families and communities to advocate for all children. Our local PTA is very active in expressing our support for or opposition to issues dealing with the health, safety, education, or general well-being of children and youth in our community.

The members of the Pacific Grove High School PTA strongly urge you to please reconsider the Pacific Grove Planning Commission's previous vote and rescind approval for the Verizon cell tower at Pacific Grove High School.

Sincerely,

Julie Kavanaugh
President, Pacific Grove High School PTA

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES





When a new cell tower or wireless network is proposed, the first question to ask is: "Do you have insurance for damages from long-term exposure to the radiofrequency radiation (RFR)?" Usually the answer is "No."

An Uninsurable Risk?

- Insurers rank wireless, cell tower, and 5G RFR non-ionizing electromagnetic field (EMF) radiation as a "high" risk, comparing the issue to lead and asbestos.
- Most insurance plans have "electromagnetic field exclusions" and do not insure for long-term RFR damages.
- Additionally, some insurance plans will not provide a defense for any supervision instruction or recommendation given *"or which should have been given"* in connection to EMFs.
- Wireless RFR and non-ionizing electromagnetic radiation are defined as a type of "pollution" by wireless companies themselves.
- U.S. mobile operators have been unable to get insurance to cover liabilities related to damages from long-term RFR exposure.
- Wireless companies warn their shareholders of RFR risk but do not warn users of their products, nor do the companies warn the people exposed to emissions from their infrastructure.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

Example of an EMF Exclusion in an Insurance Plan

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ELECTROMAGNETIC RADIATION EXCLUSION

This endorsement modifies insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
PUBLIC RISK GENERAL LIABILITY RETAINED LIMIT COVERAGE FORM
LAW ENFORCEMENT COVERAGE PART
LAW ENFORCEMENT LIABILITY RETAINED LIMIT COVERAGE FORM
PUBLIC OFFICIALS COVERAGE PART
PUBLIC OFFICIALS LIABILITY RETAINED LIMIT COVERAGE FORM
EMPLOYMENT PRACTICES LIABILITY COVERAGE PART
EMPLOYMENT PRACTICES LIABILITY RETAINED LIMIT COVERAGE FORM

The following **Exclusion** is added:

This policy does not apply to and we will not provide a defense for:

a. "Bodily injury," "property damage", "personal and advertising injury", "employee benefits wrongful acts", "personal injury", "law enforcement wrongful acts", "public officiels wrongful acts", "educator's legel wrongful acts", or "employment practices wrongful acts" arising out of, or which result in, the actual, alleged, threatened, perceived, latent, sudden and accidental or incidental exposure to or contact with electromegnetic radiation in any form, from any source.

b. The costs of abatement or mitigation of:

(1) Electromagnetic radiation; or

(2) Exposure to electromagnetic rediation.

c. Any supervision, instruction, recommendation, waming or advice given or which should have been given in connection with **a.** or **b.** above.

Electromagnetic radiation includes but is not limited to, magnetic energy, waves, fields or forces generated, produced, transmitted or maintained by the charges, currents, frequencies, energy or forces of electricity that is generated, flowing or otherwise transmitted through or via the medium, methods and equipment designed to generate, produce, distribute, trensport or transmit the electrical charges, currents, frequencies, energy or forces.



Verizon Total Mobile Protection Plan

16. Pollution

The discharge, dispersal, seepage, migration or escape of pollutants. Pollutants means any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste. Waste includes materials to be recycled, reconditioned or reclaimed.

THE NEED FOR ACCOUNTABILITY ON WIRELESS SAFETY

EXPERT VOICES





"The National Toxicology Program studies clearly showed that non-ionizing cell phone radiofrequency radiation radiation can cause cancers and other adverse health effects. An important lesson that should be learned is that we cannot assume any current or future wireless technology such as 5G is safe without adequate testing."
— Ronald Melnick PhD 28 year scientist at National Institutes of Health

"I recommend public health organizations raise awareness and educate the public on why and how to reduce our daily exposure to wireless radio frequency radiation. Protective public health policy is needed now. It is time for regulatory bodies to fully evaluate the research and develop science based exposure limits that truly protect the public and the environment."
— Linda S. Birnbaum, PhD, Former Director, National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health.

"Now we have 5G rolling out in massive quantities, without due diligence to determine are these sources of radiation safe not only for humans but for wildlife. And the answer is, no, they are not."
— Albert M. Manville II, Ph.D. Adjunct Professor, Johns Hopkins University, Wildlife Biologist (17 years), retired from Division of Migratory Bird Management, U.S. Fish & Wildlife Service

"Given the human, animal and experimental evidence, I assert that, to a reasonable degree of scientific certainty, the probability that RF exposure causes gliomas and neuromas is high."
— Christopher Portier PhD former Director of the United States National Center for Environmental Health at the CDC, former Director of the U.S. Agency for Toxic Substances and Disease Registry.

"We should not wait to protect children's brains. The science is now clear and compelling indicating that wireless technology is harmful to health, especially to for children. Wireless radiation is repeating the history of lead, tobacco and DDT."
— Devra Davis PhD, MPH, President of Environmental Health Trust, founding director of the Board on Environmental Studies and Toxicology of the U.S. National Research Council, National Academy of Sciences, and a member of the team of the Intergovernmental Panel on Climate Change scientists who were awarded the Nobel Peace Prize in 2007

CITIES AND TOWNS WITH STRONG ORDINANCES

SETBACKS FOR CELL ANTENNAS





Many communities have setbacks for cell towers and small cells.

Shelburne, MA: 3,000 feet for schools and 1,500 feet for homes; no new wireless antennas in residential zones
Copake, NY: 1,500 feet from homes, schools, churches or other buildings containing dwelling units
Sallisaw, OK: No commercial wireless telecommunications towers within 1,500 of homes.
Calabasas, CA: No "Tier 2" wireless telecommunications facilities within 1,000 feet of homes and schools
Bedford, NH: 750 feet from residentially-zoned property
Scarsdale, NY: No wireless facilities within 500 feet from homes, schools, parks, and houses of worship
Walnut City, California: 1,500 feet
Stockbridge, Massachusetts: 1,000 feet
San Diego County California: 1,000 feet (small cells)
Bar Harbor Maine: 1500 setback for schools

School Boards
Palo Alto, California: School Board supports the City of Palo Alto immediately establishing local municipal zoning setback rules of 1,500 feet or more from an operating wireless transmitter and a school site.
West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
Los Angeles California School District: Resolutions opposing cell towers on school property and a cautionary level for radiofrequency radiation 10,000 times lower than FCC limits.

Bold blue on this PDF are hyperlinked. For more setbacks go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

The 2022 study "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in World Academy of Sciences Journal authored by Tarmo Koppel and Lennart Hardell, MD of the Environment and Cancer Research Foundation found the highest RF exposure readings were registered close to cell phone base station antennas mounted on top of utility poles, street lamps or traffic lights.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 8. Gervais Street: Another cell phone base station antenna close to street level and causing high exposure to pedestrians (exposure scenario illustration). Note the antenna appears undistinguishable from the utility pole an unnoticeable between the trees.

5G, Small Cells & Cell Towers Can Drop Property Values

Would you buy a home with cell antennas outside the bedroom window?



Legal filings by cities and municipalities to the FCC highlight how small cell deployment could impact aesthetics and property values.

"many deployments of small cells could affect property values, with significant potential effect…"

— Reply Comments of Smart Communities Siting Coalition (local governments and associations representing 1,854 communities) 4/7/2017,Docket No. 16-421, April 7, 2017

"Considering that the Smart Communities' prior filings show that the addition of facilities of this size diminish property values, it is strange for the Commission to assume that approval can be granted in the regulatory blink of an eye…."

"…allowing poles to go up in areas where poles have been taken down has significant impacts on aesthetics (not to mention property values)."

— *Ex Parte* Submission of Smart Communities Letter to Ms. Marlene H. Dortch, Secretary, Federal Communications Commission, September 19, 2018

ENVIRONMENTAL HEALTH TRUST

5G, CELL TOWERS AND WIRELESS

DECREASED PROPERTY VALUE



"An overwhelming 94 percent of home buyers and renters surveyed by the National Institute for Science, Law & Public Policy (NISLAPP) say they are less interested and would pay less for a property located near a cell tower or antenna."

"of the 1,000 survey respondents, 79 % said that under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas, and almost 90% said they were concerned about the increasing number of cell towers and antennas in their residential neighborhood."

"Cell Towers, Antennas Problematic for Buyers" — Realtor Magazine

"...cell towers are concerning to many people and drop property values."

"While most states do not require disclosure of neighborhood nuisances, such as cell towers or noisy neighbors, a few states do, and more are likely to in the future."
— Real Estate Attorney, South Florida Sun Sentinel, 2021

The California Association of Realtors' Property Sellers Questionnaire specifically lists "cell towers" on the disclosure form for sellers of real estate.
— Click to go to the California Association of Realtors' Property Sellers Questionnaire
(p. 3-4 under K. Neighborhood)

"While the magnitude of the impact varies, the studies uniformly indicate that there is a significant impact on residential property values from installation of cell phone towers..."
— David E. Burgoyne, ASA, SR/WA Certified General Real Estate Appraiser

"In some areas with new towers, property values have decreased by up to 20%."

"Your new neighbor, a cell tower, may impact the value of your home" National Business Post, 2022.

PDF is hyperlinked. More on property values at ehtrust.org

ENVIRONMENTAL HEALTH TRUST

THE URGENT NEED FOR SAFER TECHNOLOGY

EXPERT VOICES

"I am calling on my industry to bring safer technology to market. The current implementation of technology is not safe. Take a good look at the science. This is about our children's future. Do not be lulled into believing that 25-year-old standards can protect the youngest and most vulnerable. They simply cannot."
— Frank Clegg, Former President of Microsoft Canada, CEO of Canadians for Safe Technology

"A moratorium is urgently needed on the implementation of 5G for wireless communication."
— Lennart Hardell, MD, PhD , advisory to World Health Organization international Agency for Research on Cancer, Department of Oncology, University Hospital, Örebro, Sweden (retired) , leads the Environment and Cancer Research Foundation

"The evidence indicating wireless is carcinogenic has increased and can no longer be ignored. If the World Health Organization International Agency for Research on Cancer were to meet to review all of the evidence, we believe the weight of evidence supports a new determination- that wireless radiofrequency radiation is a human carcinogen."
— Anthony B. Miller MD, Professor Emeritus, Dalla Lana School of Public Health of the University of Toronto. Former Senior Epidemiologist for the International Agency for Research on Cancer and former Director of the Epidemiology Unit of the National Cancer Institute of Canada

"Most parents believe that cellphones were safety-tested before they came on the market. We assume that our federal health and environmental agencies regularly review the latest research and ensure that these incredible devices are safe. They do not. Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible."
— Jerome Paulson, MD , Professor Emeritus, George Washington University, Milliken School of Public Health, former Chair of American Academy of Pediatrics Committee on Environmental Health

"The exposure levels of the Federal Communications Commission are totally outdated and do not protect the health of the public, especially of children. I urge you to take strong and active steps to reduce exposure of children and staff to excessive levels of radiofrequency EMFS within your schools."
— David O. Carpenter, M.D. Director, Institute for Health and the Environment University at Albany





FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION



FCC human exposure limits were adopted in 1996 after the EPA was defunded from creating safety limits. They have not properly reviewed these limits since 1996.

FCC's human exposure limits for the RF microwaves emitted by 5G, 4G, cell towers, cell phones, Wi-Fi, Bluetooth, smart devices and wireless networks are based on outdated science and faulty assumptions.

The limits are irrelevant to modern-day technologies and do not reflect the way people are exposed to RF and actually use technology in the 21st century.

Reasons Why FCC's 1996 Limits Do Not Protect:

Heating-Based Only

FCC limits are heat-based "thermal" limits. This means they primarily protect against the overheating of tissue from RF. FCC's limits are not based on protecting against non-heating biological effects such as cancer, oxidative stress, headaches, behavioral problems, memory damage, disrupting bee behavior, tree damage etc.

Short-Term Impacts Only

FCC limits are based on protecting against acute effects. No federal report or research review exists regarding safety from chronic, long-term RF exposures from cell towers, Wi-Fi and wireless networks in the home, school and workplace. The FDA nominated the National Toxicology Program (NTP) to perform animal studies designed to mimic a lifetime of human cell phone exposure. Cancer and DNA damage was found. Another large-scale animal study used cell tower level exposures and found the same tumors as the NTP. However, the FDA rejected these findings.

Children Are Not Protected

FCC limits are misleadingly presented as being "designed to protect children. When safety thresholds were developed decades ago, the science investigating RF impacts to children's developing brains did not exist. Current research concludes the limits should be hundreds of times more protective for children because they are more vulnerable.

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION

No Risk Analysis or Review of Totality of Science
No agency has reviewed all of the latest science. Usually the EPA and FDA use risk assessment to characterize the nature and magnitude of risks to human health for various populations such as children and pregnant women. The EPA also estimates ecological risks, including plants, birds, other wildlife and aquatic life. When groundbreaking studies are published, a quantitative risk analysis of the data is performed. This has never been done for RF.

"The FCC and FDA have failed in their obligation to prescribe safe RFR guidelines produced from wireless communication devices to protect the public health and safety. Devices are becoming more sophisticated, and their usage is as common to daily life as brushing your teeth."
— Pittsburgh Law Review "The FCC Keeps Letting Me Be: Why Radiofrequency Radiation Standards Have Failed to Keep Up With Technology" by Hala Mouzaffar

"The wireless industry reaction features stonewalling public relations and hyper aggressive legal action. It can also involve undermining the credibility and cutting off the funding for researchers who do not endorse cellular safety. It is these hardball tactics that look a lot like 20th century Big Tobacco tactics. It is these hardball tactics—along with consistently supportive FCC policies—that heighten suspicion the wireless industry does indeed have something to hide."

— Norm Alster in the Harvard Press Book "Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates"





ENVIRONMENTAL HEALTH TRUST

A REGULATORY GAP
No Federal Agency Ensuring Cell Tower Wireless Safety

There is no U.S. government agency with oversight for cell tower radiation health effects: no research reviews, no reports, no environmental monitoring, no risk mitigation and no post market health surveillance for the daily, full body radio-frequency (RF) radiation exposure from cell towers.

"The FDA does not regulate cell towers or cell tower radiation. Therefore, the FDA has no studies or information on cell towers to provide in response to your questions."
— Ellen Flannery, Director, FDA Policy Center for Devices and Radiological Health to a California mother with a cell tower on her street who asked the FDA about safety, July 11, 2022

"As a Federal research agency, the NCI is not involved in the regulation of radio frequency telecommunications infrastructure and devices, nor do we make recommendations for policies related to this technology"
— National Cancer Institute letter to Denise Ricciardi, member of the New Hampshire State Commission on 5G, July 30, 2020

The ACS does "not have any official position or statement on whether or not radiofrequency radiation from cell phones, cell phones towers, or other sources is a cause of cancer."
— American Cancer Society Website

"EPA's last review was in the 1984 document Biological Effects of Radiofrequency Radiation. The EPA does not currently have a funded mandate for radiofrequency matters."
— Lee Ann B. Veal Director, EPA Radiation Protection Division Office of Radiation and Indoor Air, July 8, 2020 Letter to Theodora Scarato

Fact: There are no scientific reports by the CDC on cell tower radiation safety, nor does the agency have staff with expertise monitoring the science and evaluating risk. Public information requests found that **several CDC website pages on radio frequency were found to be drafted with a wireless industry consultant.**

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today." **— U.S. Department of Interior Letter to FCC, 2014**

Fact: The World Health Organization (WHO) EMF Project has not reviewed the science since 1993. The WHO webpages on cell phones and cell towers are not based on a published scientific review. The WHO EMF Project webpages were written by a scientist who **used wireless industry money** to start the WHO EMF Project and who is now a consultant to industry. **In contrast, the WHO International Agency for Research on Cancer (a separate WHO entity vetted for conflicts of interest) determined RF radiation to be a Class 2 B "possible" carcinogen in 2011.** Many scientists now state **the evidence showing cancer has increased.**

Blue text *is hyperlinked to source.*

FACTSHEET: ENVIRONMENTAL HEALTH TRUST ET AL. V. FCC

COURT RULING ON FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS EXPOSURE LIMITS

LANDMARK FEDERAL COURT RULING AGAINST THE FCC

On August 13, 2021 the U.S. Court of Appeals for the D.C. Circuit ruled the Federal Communications Commission (FCC) ignored scientific evidence and failed to provide a reasoned explanation for its determination that its 1996 regulations adequately protect the public against all the harmful effects of wireless radiation.

FCC'S REFUSAL TO UPDATE 1996 LIMITS

The legal case challenged the FCC's 2019 decision not to update its 1996 regulations regarding allowable radiofrequency radiation (RF) exposures from wireless technologies - including 5G, cell phones, cell towers, Wi-Fi, and wireless networks.

EVIDENCE OF HARMFUL EFFECTS BELOW FCC LIMITS

FCC limits are based on the belief that heating is the only proven harm from RF. Over 11,000 pages of evidence - 447 exhibits in 27 Volumes - was submitted to the Court documenting biological effects and illness from wireless radiation exposure below heating levels. Research has found brain damage, headaches, memory problems, reproduction damage, synergistic effects, nervous system impacts, brain cancer, genetic damage, as well as harm to trees, birds, bees, and wildlife.

THE COURT FINDINGS

The ruling stated that the FCC's "arbitrary and capricious" decision to maintain their 25 year old exposure limits did not address evidence indicating "non-cancer" harm such as:

- impacts to children
- testimony of persons injured by wireless radiation
- impacts to the developing brain
- impacts to the reproductive system
- impacts to wildlife and the environment

THE COURT ORDER

The Court ordered the FCC to provide a reasoned determination as to whether the evidence warrants a change to 1996 RF limits especially in regards to:

- children's vulnerability
- long-term exposure
- environmental impacts
- new technological developments and the ubiquity of wireless
- how FCC's cell phone tests only measure heat and allow a space between the phone and body

TIMELINE

1980s: EPA had robust research program and was tasked to develop RF safety limits by U.S. Science Advisory Board.

1995: EPA presents to FCC on the EPA timeline for its development of human exposure RF limits which would include both thermal effects and non thermal effects.

1996: EPA is fully defunded by Congress amid heavy lobbying for Telecom Act and halts all research on RF.

1996: The FCC adopts RF limits developed by industry-tied groups - based on short term heating - thermal- effects from high power exposures (based on studies of small animals exposed to high RF levels for under an hour).

1999: FDA requests the National Toxicology Program (NTP) study RF because of the lack of safety data on long-term exposure.

2008/2009 Congressional Hearings

2011: Wireless RF classified as a "possible" Class 2B Carcinogen by International Agency for Research on Cancer.

2012: GAO Report recommends rules be reassessed to reflect current use patterns and recent science.

2013-2019: FCC opens record on RF limits - gets over 1000 submissions.

2018: NTP/NIH releases $30M animal study concluding "clear evidence" of cancer. FDA rejects the findings.

2019: FCC closes record, decides not to update its 1996 wireless RF limits.

2020: Cases filed against FCC.

2021: U.S. Court of Appeals, D.C Circuit ruled that the FCC decision not to change human exposure limits and regulations was "arbitrary and capricious." FCC ordered to respond.

2021: No FCC response to Court, so EHT and others filed request to refresh record.

Timeline is hyperlinked to sources.

FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS RADIATION EXPOSURE LIMITS

FCC Compliance Does Not Ensure Safety

Most of the public assumes that current FCC safety limits for cell phones, cell towers, Wi-Fi, 5G, and wireless networks are based upon an up to date robust review of all relevant research. This assumption of safety is now clearly documented to be erroneous.

Lack of Oversight by Health and Environmental Agencies

The ruling reveals a lack of accountability with our federal health agencies regarding wireless radiation. The EPA, CDC, NIOSH, and NCI did not submit any reports to the Court, revealing that none of these agencies has reviewed the science on health effects to ensure safety for the public. The U.S. has no pre- market safety testing for health effects, no post-market surveillance, no environmental monitoring, and no meaningful interagency coordination.

FDA's Dismissal of Harm Deemed Insufficient

The Court states the FCC improperly relied on the FDA's conclusions that RF limits did not need an update. The FDA's submissions were described by the Court as "cursory" and "insufficient." Although the FDA later released a literature review, it was only focused on cell phones, not cell towers, Wi-Fi nor 5G technology. It also was only focused on cancer, further confirming the fact that U.S. agencies have failed to evaluate the myriad of effects documented in scientific studies, such as brain, immune, fertility and endocrine impacts. A U.S. government review of *the full body of recent science* has simply never been done.

"the Commission's failure to provide a reasoned or even relevant explanation of its position that RF radiation below the current limits does not cause health problems unrelated to cancer renders its explanation as to the effect of RF radiation on children arbitrary and capricious. "

— 2021 EHT et al. v. FCC

The Court Did Not Agree That "Cell Phones Do Not Cause Cancer"

Contrary to the wireless industry's recent claims, the Court *did not make a scientific determination regarding cancer*. The ruling simply stated that in regards to cancer- the FCC passed the minimum legal requirement for adequate review because it (at least) referenced why the FCC dismissed cancer evidence. The FCC cited the rejections of NIH studies by the FDA and of ICNIRP (a small group with no oversight and whose members have a long history of industry ties).

Children's Vulnerability and Effects of Long Term Exposure Ignored by the FCC

The Court states the FCC "dismissed" the American Academy of Pediatrics recommendations to strengthen regs and ensure children and pregnant women are protected. The Court found the FCC failed to explain why it ignored research indicating children's developing brains are more sensitive. Children will have a lifetime of exposure, yet the FCC was found to ignore the issue of impacts *from long term exposure*.

Wildlife Remains Unprotected

FCC's limits were designed in 1996 to protect only humans, not flora or fauna. The Court found that the FCC had "completely failed" to address the "substantive evidence of potential environmental harms" on the record, which included science showing serious impacts to birds, bees, trees, and plants.

PETITIONERS: Environmental Health Trust, Consumers for Safe Cell Phones, Elizabeth Barris, Theodora Scarato, Children's Health Defense, Michelle Hertz, Petra Brokken, Dr. David Carpenter, Dr. Toril Jelter, Dr. Paul Dart, Dr. Ann Lee, Virginia Farver, Jennifer Baran, Paul Stanley M.Ed.

KEY RESOURCES: Court Ruling 8/13/2021, Evidence (11,000 pages), EHT Press Conference

Amicus Briefs

- Amicus of NRDC: Natural Resources Defense Council
- Amicus of Attorney Joe Sandri including declaration of Dr. Linda Birnbaum, former Director of the National Institute of Environmental Health Sciences
- Amicus of Catherine Kleiber
- Amicus of the Building Biology Institute

EHTrust.org for more.

REFERENCES/CITATIONS

Abdel-Rassoul, G., et al (2007). **Neurobehavioral effects among inhabitants around mobile phone base stations**. *NeuroToxicology*

Balmori A. (2002) **Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**. *Environmental Research*

Dode, A. C et al (2011). **Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil**. *Science of The Total Environment*

Hardell, L., & Carlberg, M. (2019). **Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz**. *International Journal of Oncology*

Hardell, L., & Koppel, T. (2022). **Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden**. *Reviews on Environmental Health*.

Khurana et al. (2010). **Epidemiological evidence for a health risk from mobile phone base stations**. *International Journal of Occupational and Environmental Health*

Koppel et al (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Levitt & Lai, H. (2011). **Corrigendum: Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays**. *Environmental Reviews*

López et al (2021). **What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid**. *Environmental Research*

Meo et al (2019). **Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health**. *American Journal of Men's Health*

Meo et al (2015a). **Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus**. *International Journal of Environmental Research and Public Health*

Pearce, J. M. (2020). **Limiting liability with positioning to minimize negative health effects of cellular phone towers**. *Environmental Research*

Roda, C., & Perry, S. (2014). **Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection**. *Environmental Science & Policy*

Rodrigues et al (2021). **The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil**. *International Journal of Environmental Research and Public Health*

Santini et al. (2003). **Survey Study of People Living in the Vicinity of Cellular Phone Base Stations**. *Electromagnetic Biology and Medicine*

Thamilselvan et al (2021) **Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study**. *Journal of International Oral Health*

Yakymenko et al (2011). **Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems**. *Experimental Oncology*

Zothansiama et al (2017). **Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations**. *Electromagnetic Biology and Medicine*

Belyaev et al (2022) **Possible health risks from exposure to microwaves from base stations**, Conference Paper Department of Radiobiology, Cancer Research Institute, Biomedical Research Center *Conference paper

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

5G

Betzalel et al. (2018). **The human skin as a sub-THz receiver—Does 5G pose a danger to it or not?** *Environmental Research*

Betzalel et al. 2017). **The Modeling of the Absorbance of Sub-THz Radiation by Human Skin**. *IEEE Transactions on Terahertz Science and Technology*

Dasgupta et al. (2022). **Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish**. *Environmental Science & Technology Letters*

Di Ciaula, A. (2018). **Towards 5G communication systems: Are there health implications?** *International Journal of Hygiene and Environmental Health*

Frank, J. W. (2021). **Electromagnetic fields, 5G and health: What about the precautionary principle?** *Journal of Epidemiology and Community Health*

Hardell, L., & Carlberg, M. (2020). **[Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest**. *Oncology Letters*

Hardell, L., & Nilsson, M. (2023). **Case Report: The Microwave Syndrome after Installation of 5G Emphasizes the Need for Protection from Radiofrequency Radiation.** Annals of Case Reports.

Nilsson M, Hardell L. (2023) **Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office.** Ann Clin Case Rep. 8: 2378.

Hinrikus et al. (2022). **Possible health effects on the human brain by various generations of mobile telecommunication: A review based estimation of 5G impact**. *International Journal of Radiation Biology*

Kostoff et al. (2020). **Adverse health effects of 5G mobile networking technology under real-life conditions**. *Toxicology Letters*

Nasim, I., & Kim, S. (2019). **Adverse Impacts of 5G Downlinks on Human Body**. *2019 SoutheastCon IEEE*

Russell, C. L. (2018). **5G wireless telecommunications expansion: Public health and environmental implications**. *Environmental Research*

Yang et al. (2022). **Effects of Acute Exposure to 3500 MHz (5G) Radiofrequency Electromagnetic Radiation on Anxiety-Like Behavior and the Auditory Cortex in Guinea Pigs**. *Bioelectromagnetics*

Increasing Exposures From Expanding 5G Networks and Close Proximity "Small Cell" Antennas

Baltrėnas et al.(2012). **Research and evaluation of the intensity parameters of electromagnetic fields produced by mobile communication antennas**. *Journal of Environmental Engineering and Landscape Management*

Bhatt et al. (2017). **Radiofrequency-electromagnetic field exposures in kindergarten children**. *Journal of Exposure Science & Environmental Epidemiology*

Bonato et al. (2022). **Computational Assessment of RF Exposure Levels due to 5G Mobile Phones**. *2022 Microwave Mediterranean Symposium*

Carlberg et al. (2019). **High ambient radiofrequency radiation in Stockholm city, Sweden.** *Oncology Letters*

El-Hajj et al. (2020). **Radiation Analysis in a Gradual 5G Network Deployment Strategy**. *2020 IEEE 3rd 5G World Forum (5GWF)*

Hardell et al. (2018). **Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report**. *Oncology Letters*

Hardell et al. (2017). **High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament**. *Molecular and Clinical Oncology*

Hardell, L., Koppel, T., Carlberg, M., Ahonen, M., & Hedendahl, L. (2016). **Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields**. *International Journal of Oncology*

Koppel et al. (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Koppel et al. (2019). **Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**. *Oncology Letters*

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

Koppel, T., & Hardell, L. (2022). **Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA**. *World Academy of Sciences Journal*

Mazloum et al. (2019). **RF-EMF exposure induced by mobile phones operating in LTE small cells in two different urban cities**. *Annals of Telecommunications*

Urbinello et al. (2014). **Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities**. *Environmental Research*, 134, 134–142.

4G LTE

Broom et al. (2019). **Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6J Mice**. *Bioelectromagnetics*

Choi et al. (2020). **Continuous Exposure to 1.7 GHz LTE Electromagnetic Fields Increases Intracellular Reactive Oxygen Species to Decrease Human Cell Proliferation and Induce Senescence**. *Scientific Reports*

Lv et al. (2014). **The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure**. *Clinical Neurophysiology*

Malik et al. (2021). **Short- and long-duration exposures to cell-phone radiofrequency waves produce dichotomous effects on phototactic response and circadian characteristics of locomotor activity rhythm in zebrafish, Danio rerio**. *Biological Rhythm Research*

Oh, J. J., Byun, S.-S., Lee, S. E., Choe, G., & Hong, S. K. (2018). **Effect of Electromagnetic Waves from Mobile Phones on Spermatogenesis in the Era of 4G-LTE**. *BioMed Research International*, 2018, 1801798.

Özdemir et al. (2021). **The effect of 4.5 G (LTE Advanced-Pro network) mobile phone radiation on the optic nerve**. *Cutaneous and Ocular Toxicology*

Souffi et al. (2022). **Exposure to 1800 MHz LTE electromagnetic fields under proinflammatory conditions decreases the response strength and increases the acoustic threshold of auditory cortical neurons**. *Scientific Reports*

Wei et al. (2019). **Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study**. *Bioelectromagnetics*

Yang et al. (2021). **Functional and network analyses of human exposure to long-term evolution signal**. *Environmental Science and Pollution Research International*

Yang et al. (2017). **Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands**. *Clinical EEG and Neuroscience*

Yu et al. (2020). **Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3–MMP2-BTB axis in the testes of adult rats**. *Science of The Total Environment*

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Electromagnetic Fields: A Hazard to Your Health?

In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.

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Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective☆

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ABSTRACT

Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the World Health Organization. There is strong evidence that excessive exposure to mobile phone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. *In vivo* and *in vitro* studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. There is increasing evidence the exposures can result in neurobehavioral decrements and that some individuals develop a syndrome of "electro-hypersensitivity" or "microwave illness", which is one of several syndromes commonly categorized as "idiopathic environmental intolerance". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that excludes the symptoms as being only psychosomatic. Unfortunately standards set by most national and international bodies are not protective of human health. This is a particular concern in children, given the rapid expansion of use of wireless technologies, the greater susceptibility of the developing nervous system, the hyperconductivity of their brain tissue, the greater penetration of radiofrequency radiation relative to head size and their potential for a longer lifetime exposure.

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Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.



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Case Report

How does long term exposure to base stations and mobile phones affect human hormone profiles?

Emad F. Eskander ✉, Selim F. Estefan, Ahmed A. Abd-Rabou

Objectives

This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations v human's hormone profiles.

Results

This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels.

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Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads

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Fig. 3. Street view on the Skeppsbron street with some of the mobile phone base station antennas pointed out with a circle; note the low placement of the antennas, where microwaves irradiate the pedestrian at close range.

A B S T R A C T

In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter. The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading from the entire area was 31.6 V m^{-1} (2648 mW m^{-2}). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.

Studies from recent decades have shown elevated health risk under long term exposure to such highly elevated radiofrequency fields.

A review by Khurana et al. (2010) found in 80% of the available studies neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations (Khurana et al., 2010). In another review exposure from base stations and other antenna arrays showed changes in immunological and reproductive systems as well as DNA double strand breaks, influence on calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells (Levitt and Lai, 2010).

When a GSM 900 MHz base station was installed in the village Rimbach in Germany it had an influence on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (Buchner and Eger, 2011). Influence on cortisol and thyroid hormones in people living near base stations was shown in other studies (Augner et al., 2010; Eskander et al., 2012).

Dode et al. (2011 compared base station (BS) clusters and cases of deaths by neoplasia in the Belo Horizonte municipality, Minas Gerais state, Brazil, from 1996 to 2006. In their study largest electric field was 12.4 V m^{-1} and the smallest was 0.4 V m^{-1}. They found cancer-related death rates be higher close to base stations. This finding confirmed earlier findings by Eger (Eger et al., 2004).

In a study from India, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. Genetic damage parameters of DNA migration length, damage frequency, and damage index were significantly ($p < 0.001$) elevated in the sample group compared to respective values in healthy controls (Gandhi et al., 2014).

The effect of RF radiation among 20 subjects living close to mobile phone base station compared with 20 subjects living with a distance of about 1 km was studied (Singh et al., 2016). The authors concluded that: "*It was unveiled that a majority of the subjects who were residing near the mobile base station complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties, and hypertension. A majority of the study subjects had significantly lesser stimulated salivary secretion ($p < 0.01$) as compared to the control subjects.*"

Zothansiama et al. (2017) in India inspected DNA damage a antioxidant status in cultured human peripheral blood lymphocy (HPBLs) of individuals residing in the vicinity of mobile phone b stations and compared it with healthy controls living further away. analyses of data from the exposed group (n = 40), residing withi perimeter of 80 m of mobile base stations, showed statistically sign cantly ($p < 0.0001$) higher frequency of micronuclei when compare the control group, residing 300 m away from the mobile base statio

The Ramazzini Institute findings (Falcioni et al., 2018) are suppor by the results in the USNTP study on rats and mice exposed to RF diation (National Toxicology Program, 2018a, 2018b). A clear evide of increased incidence of heart Schwannoma and some evidence glioma and tumours in the adreanal medulla in male rats was fo according to the expert panel, for further discussion see Hardell Carlberg (2019).

The study concluded that Skeppsbron street mobile phone base station antennas are examples of a poor radiofrequency infrastructure design with mobile phone base station antennas positioned into close range to the general public which brings upon high exposure levels. Given the low placement of the antennas (height from the street floor), the highest exposure was often registered at pedestrian head level. Given that head is one of most vulnerable parts of the body, these placements by mobile telephony service providers put pedestrians into unnecessary risk. Position of these antennas, can pose a health risk to people at close range. This is especially critical for people at particular risk, including persons with medical implants, pregnant women or chronically ill persons.

Based on the latest scientific literature regarding RF exposure and adverse health effects, this study recommends repositioning such base station antennas to areas away from the nearby inhabitants, workers and the general public. Alternatively, very low power antennas may also be considered to reduce the exposure. Occupational exposure of people

Current Alzheimer Research, 2022, *19*, 119-132

MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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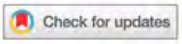
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The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines

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ABSTRACT

In this paper, we review the literature on three important exposure metrics that are inadequately represented in most major radiofrequency radiation (RFR) exposure guidelines today: intensity, exposure duration, and signal modulation. Exposure intensity produces unpredictable effects as demonstrated by nonlinear effects. This is most likely caused by the biological system's ability to adjust and compensate but could lead to eventual biomic breakdown after prolonged exposure. A review of 112 low-intensity studies reveals that biological effects of RFR could occur at a median specific absorption rate of 0.0165 W/kg. Intensity and exposure duration interact since the dose of energy absorbed is the product of intensity and time. The result is that RFR behaves like a biological "stressor" capable of affecting numerous living systems. In addition to intensity and duration, man-made RFR is generally modulated to allow information to be encrypted. The effects of modulation on biological functions are not well understood. Four types of modulation outcomes are discussed. In addition, it is invalid to make direct comparisons between thermal energy and radiofrequency electromagnetic energy. Research data indicate that electromagnetic energy is more biologically potent in causing effects than thermal changes. The two likely functionthrough different mechanisms. As such, any current RFR exposure guidelines based on acute continuous-wave exposure are inadequate for health protection.

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MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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REVIEW

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Genetic effects of non-ionizing electromagnetic fields

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ABSTRACT

This is a review of the research on the genetic effects of non-ionizing electromagnetic field (EMF), mainly on radiofrequency radiation (RFR) and static and extremely low frequency EMF (ELF-EMF). The majority of the studies are on genotoxicity (e.g., DNA damage, chromatin conformation changes, etc.) and gene expression. Genetic effects of EMF depend on various factors, including field parameters and characteristics (frequency, intensity, wave-shape), cell type, and exposure duration. The types of gene expression affected (e.g., genes involved in cell cycle arrest, apoptosis and stress responses, heat-shock proteins) are consistent with the findings that EMF causes genetic damages. Many studies reported effects in cells and animals after exposure to EMF at intensities similar to those in the public and occupational environments. The mechanisms by which effects are induced by EMF are basically unknown. Involvement of free radicals is a likely possibility. EMF also interacts synergistically with different entities on genetic functions. Interactions, particularly with chemotherapeutic compounds, raise the possibility of using EMF as an adjuvant for cancer treatment to increase the efficacy and decrease side effects of traditional chemotherapeutic drugs. Other data, such as adaptive effects and mitotic spindle aberrations after EMF exposure, further support the notion that EMF causes genetic effects in living organisms.

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The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil

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Abstract: Background: this study aims to estimate the rate of death by cancer as a result of Radio Base Station (RBS) radiofrequency exposure, especially for breast, cervix, lung, and esophagus cancers. Methods: we collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime. We investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers). Results: in capitals where RBS radiofrequency exposure was higher than 2000/antennas-year, the average mortality rate was 112/100,000 for all cancers. The adjusted analysis showed that, the higher the exposure to RBS radiofrequency, the higher cancer mortality was. The highest adjusted risk was observed for cervix cancer (rate ratio = 2.18). The spatial analysis showed that the highest RBS radiofrequency exposure was observed in a city in southern Brazil that also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancer. Conclusion: the balance of our results indicates that exposure to radiofrequency electromagnetic fields from RBS increases the rate of death for all types of cancer.

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Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission

A B S T R A C T

Background: In 2011, IARC classified radiofrequency radiation (RFR) as possible human carcinogen (Group 2B). According to IARC, animals studies, as well as epidemiological ones, showed limited evidence of carcinogenicity. In 2016, the NTP published the first results of its long-term bioassays on near field RFR, reporting increased incidence of malignant glial tumors of the brain and heart Schwannoma in rats exposed to GSM – and CDMA – modulated cell phone RFR. The tumors observed in the NTP study are of the type similar to the ones observed in some epidemiological studies of cell phone users.

Objectives: The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2448 animals. In this article, we reported the final results regarding brain and heart tumors.

Methods: Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day.

Results: A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of heart Schwann cells hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), although this was not statistically significant. An increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant.

Conclusions: The RI findings on far field exposure to RFR are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the re-evaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.

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Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer

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ABSTRACT

The objective of this work was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base station antennas on humans. Studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Overall results of this review show three types of effects by base station antennas on the health of people: radiofrequency sickness (RS), cancer (C) and changes in biochemical parameters (CBP). Considering all the studies reviewed globally (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters. Furthermore, studies that did not meet the strict conditions to be included in this review provided important supplementary evidence. The existence of similar effects from studies by different sources (but with RF of similar characteristics), such as radar, radio and television antennas, wireless smart meters and laboratory studies, reinforce the conclusions of this review. Of special importance are the studies performed on animals or trees near base station antennas that cannot be aware of their proximity and to which psychosomatic effects can never be attributed.

1. Introduction

During the last few decades, hundreds of thousands of mobile phone base stations and other types of wireless communications antennas have been installed around the world, in cities and in nature, including protected natural areas, in addition to pre-existing antennas (television, radio broadcasting, radar, etc.). Only the aesthetic aspects or urban regulations have been generally considered in this deployment, while the biological, environmental and health impacts of the associated non-ionizing electromagnetic radiation emissions have not been assessed so far. Therefore, the effects on humans living around these anthropogenic electromagnetic field sources (antennas) have not been considered.

In France, there is a significant contribution of mobile phone base stations in the exposure to radiofrequency electromagnetic fields (RF-EMF) of urban citizens living nearby (De Giudici et al., 2021). Some studies from India indicate that more than 15% of people have levels of EMF strength above 12 V/m due to their proximity to antennas (Premlal and Eldhose, 2017). Exposure estimates have shown that RF-EMF from mobile telephone systems is stronger in urban than in rural areas. For instance, in Sweden the levels of RF radiation have increased considerably in recent years, both outdoor and indoor, due to new telecommunication technologies, and the median power density measured for RF fields between 30 MHz and 3 GHz was 16 $\mu W/m^2$ in rural areas, 270 $\mu W/m^2$ in urban areas and 2400 $\mu W/m^2$ in city areas (Hardell et al., 2018). Total exposure varies not only between urban and rural areas but also, depending on residential characteristics, between different floors of a building, with a tendency for building exposure to increase at higher floors (Breckenkamp et al., 2012).

Over the past five decades, and more intensively since the beginning of this century, many studies and several reviews have been published on the effects of anthropogenic electromagnetic radiation on humans living around the antennas. The first studies were carried out with radio and television antennas, investigating increases in cancer and leukaemia (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; Michelozzi et al., 1998; Altpeter et al., 2000), as well as around radars (Kolodynski and Kolodynska, 1996; Goldsmith, 1997).

Regarding base station antennas, there are scientific discrepancies in their effects: some studies concluded that there are no health-related effects (e.g. Augner and Hacker, 2009; Blettner et al., 2009; Röösli et al., 2010; Baliatsas et al., 2016) whereas others found increases in cancer and other health problems in humans living around antennas (e.g. Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004;

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Eger et al., 2004; Wolf and Wolf, 2004; Abdel-Rassoul et al., 2007; Khurana et al., 2010; Dode et al., 2011; Shinjyo and Shinjyo, 2014; Gandhi et al., 2015; López et al., 2021; Rodrigues et al., 2021). There is a specific symptomatology linked to radar and RF exposure at low levels, characterized by functional disturbances of the central nervous system (headache, sleep disturbance, discomfort, irritability, depression, memory loss, dizziness, fatigue, nausea, appetite loss, difficulty in concentration, dizziness, etc.), that has been termed 'RF sickness' (Lilienfeld et al., 1978; Johnson Lyakouris, 1998; Navarro et al., 2003).

The objective of this study was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base stations on humans living around the antennas.

2. Methods

A search was performed in the EMF portal, Google Scholar and PubMed databases with the words: "mobile phone base station and health" or "cell tower and health".

Only studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Studies conducted in larger regions with numerous antennas, based on surveys and geographic data, were also included.

On the contrary, studies were excluded that considered different sources of electromagnetic radiation, such as mobile phone base stations together with broadcast transmitters (TV and radio), radar, mobile phones, cordless phones, Wi-Fi or wireless smart meters. Also excluded were those that included antennas and powerlines jointly. Studies that only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with health effects, were excluded, as were surveys on risk perception and the nocebo effect, modelled radiofrequency electromagnetic field exposure from mobile-phone base stations or perceived exposure. All experimental laboratory studies, experiments in an exposure chamber or adapted room were also excluded. Finally, the comments or criticism of previously published studies were also excluded. However, due to their importance the conclusions of some of the excluded studies will be discussed in the corresponding section.

3. Results

The studies that met the selected criteria are presented in chronological order in Table 1, catalogued as Y/N depending on whether or not they found effects. The selected studies cover three types of effects: radiofrequency sickness (RS) (according to Lilienfeld et al., 1978; Johnson Lyakouris, 1998), cancer (C) and changes in biochemical parameters (CBP). Table 1 also includes the authors, year and country, antenna type, study design, diseases and symptoms found/not found and the main conclusions of each study.

Considering all the selected studies (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters (Fig. 1). Therefore, most of the studies carried by research groups from twenty different countries reach the same conclusions.

For the reasons previously explained, the following studies (n = 85) were not considered in this review, even though the conclusions of some of these studies will be discussed later due to their importance regarding the similarities of the electromagnetic radiation types involved and the health effects found in many cases. Several studies only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with the effects on health (e.g. Aniołczyk, 1999; Henderson and Bangay, 2006; Keow and Radiman, 2006; Neitzke et al., 2007; Bürgi et al., 2008; Augner et al., 2009; Chen and Chuang, 2009; Schmiedel et al., 2009; Viel et al., 2009; Hansson et al., 2011; Alhekail et al., 2012; Breckenkamp et al., 2012; Beekhuizen et al., 2013; Bürgi et al., 2014; Lyare et al., 2019; Urbinello et al., 2014; Lemaire et al., 2016; Admawi, 2021; De Giudici et al., 2021; Kazaure et al., 2021; Yetiş and Kayili, 2021). Some were surveys on risk perception and the nocebo effect, modelled RF-EMF exposure from mobile-phone base stations or perceived exposure (Wiedemann et al., 2006; Dohle et al., 2012; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Martens et al., 2017; Koh et al., 2020). Others jointly considered various sources of electromagnetic fields such as telephone antennas, mobile phones, cordless phones, Wi-Fi, powerlines or wireless smart meters (Seitz et al., 2005; Baliatsas et al., 2011; Atzmon et al., 2012; Eskander et al., 2012; Frei et al., 2012; Lamech, 2014; Singh and Pati, 2016; Boehmert et al., 2020; Akkam et al., 2020). Some studied the effects of radio or television antennas (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; McKenzie et al., 1998; Michelozzi et al., 1998; Altpeter et al., 2000; Hocking and Gordon, 2000; Boscolo et al., 2001; Cooper et al., 2001; Michelozzi et al., 2002; Hallberg and Johansson, 2002; Elwood, 2003; Ha et al., 2003; Park et al., 2004; Abelin et al., 2005; Altpeter et al., 2006; Ha et al., 2007; Satta et al., 2018). Others were radar studies (Kolodynski and Kolodynska, 1996; Goldsmith, 1997; Szmigielski et al., 2001; Yakymenko et al., 2011; Schoeni et al., 2016; Martens et al., 2018). Some studies performed experiments in a laboratory, exposure chamber or adapted room, with simulated or real electromagnetic radiation from base station antennas (e.g. Zwamborn et al., 2003; Hinrichs et al., 2005; Regel et al., 2006, 2007; Eltiti et al., 2007; Leitgeb et al., 2008; Riddervold et al., 2008; Augner et al., 2009; Augner et al., 2010; Wallace et al., 2010; Danker-Hopfe et al., 2010; Falcioni et al., 2018; Azimzadeh and Jelodar, 2019; Smith-Roe et al., 2020). Some reports were comments or criticisms of previously published studies (e.g. Coggon, 2006; Röösli and Huss, 2008; Bithell, 2010; Dode and Leão, 2012; Foster and Trottier, 2012; Mortazavi, 2014, 2017).

4. Discussion

The results of this review show three types of effects by base station antennas on the health of humans: radiofrequency sickness, cancer and changes in biochemical parameters (Fig. 1). From among all these studies, most of them found effects (73.6%). Thus, despite some limitations and differences in study design, statistical measures, risk estimates and exposure categories (Khurana et al., 2010), together they provide a consistent view of the effects on the health of people living in the vicinity of base station antennas.

Studies conducted in large regions with numerous antennas, based on surveys and geographic data (e.g. Augner and Hacker, 2009; Dode et al., 2011; Baliatsas et al., 2016; Martens et al., 2017; Dode et al. al., 2021), have the limitation that there may be many factors other than the base station antennas affecting the health of the population (environmental and occupational determinants of diseases and symptoms, individual characteristics such as food and life habits, activity level, smoking, self-medication, individual pathologies or genetic factors) that can act as confounding factors. It is important to mention here that the meters used for power density measurements in research papers should have more high quality equipment and better measurement methods.

On the other hand, some studies did not meet the strict conditions to be considered in this review, but due to their importance regarding the similarities of the electromagnetic radiation types involved and the effects found in many cases, they provide important supplementary evidence, as we will see in the next paragraphs.

For example, mobile phone users had an increased risk of headache (one of the typical symptoms for RF sickness near base station antennas) compared with non-users, and the risk of headache was also increased in those who had a longer daily call duration and higher daily call frequency (Wang et al., 2017). The same was also seen with cancer (Hardell et al., 2007). On the other hand, the symptoms caused by wireless smart meters were similar to those reported by people exposed to RF fields emitted by mobile phones (Lamech, 2014).

Table 1
Studies that met the selected criteria.

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
1 Y RS	Santini et al. (2002), 2003a and 2003b France	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 530 people	Effects found on: -tiredness -headache -sleep disturbance -discomfort -irritability -depression -memory loss -dizziness -libido decrease -visual perturbations	Effects occur up to a distance of 300 m from the antenna. Older subjects are more sensitive. Also, hat the facing location is the worst position for some symptoms s tudied, especially for distances till 100 m from base stations. The frequency of reported complaints is significantly higher for women in comparison with men
2 Y RS	Gómez-Perretta et al., 2013 Spain	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 101 people and electric field measurements	Effects found on: -fatigue -irritability -headache -nausea -appetite loss -discomfort -sleep disturbance -depression -difficulty in concentration -dizziness	Significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure. The incidence of most of the symptoms was related to exposure levels, independently of the demographic variables and some possible risk factors. Health changes related with GSM exposure seem to occur in a manner unrelated with those fears
3 Y RS	Bortkiewicz et al. (2004) Poland	Base station antennas	Review of previous publications	Effects found on: -circulatory system -sleep disturbances -irritability depression -blurred vision -concentration -difficulties nausea -lack of appetite -headache -vertigo	Relationship between the incidence of individual symptoms, the level of exposure, and the distance. This association was observed in both groups of persons, those who linked their complaints with the presence of the base station and those who did not notice such a relation.
4 Y C	Eger et al. (2004) Germany	2 Base station antennas	Number of cancer cases in the selected population (1045 resident) in Naila to compare results an inner area (within a distance of 400 m from the base station antennas) and outer area (beyond 400 m).	The number of newly developed cancer cases in the inner area is more than the expected number taken from the cáncer register, which represents the total population being irradiated. The group who had lived during the past five years within a distance of 400 m from the Base station antennas have a two times higher risk of developing cancer than that of the average population. The relative risk of getting cancer in the inner área compared with the Saarland cancer register is 1.7.	The risk of newly developing cancer was three times higher among those patients who had lived during past ten years (1994–2004), within a distance of 400 m From the cellular transmitter, in comparison to those who had lived further away.
5 Y C	Wolf and Wolf (2004) Israel	1 Base station antenna	A cancer incidence study to investigate the incidence of cancer cases of individuals (the cohort included 622 people) exposed to a Base station antenna, in comparison to those of a nearby clinic out of that area, to the national incidence rates of the whole country and to the incidence rates in the whole town of Netanya	There were 4.15 times more cases of cáncer in area A (breast carcinoma, ovary carcinoma, lung carcinoma, Hodgkin's disease, osteoid osteoma, and hypernephroma) than in the entire population.	The study indicates an association between an increased incidence of cancer and living in proximity to a Base station antenna.
6 Y RS	Hutter et al. (2006) Austria	10 Base station antennas in the 900 MHz band	Questionnaire survey in 365 subjects and exposure measurements	Effects found on: -headache -difficulties to concéntrate -Cold hands or feet No effects found on: -vertigo -palpitations -tremor -hot flushes -sweating -loss of apetite -loss of energy, -exhaustion -tiredness	Self-reported symptoms like headache and difficulties in concentrating show an association with microwave exposure from base stations, not attributable to subjects' fear of health effects from these sources. Other symptoms, like sleeping problems, seem to be more due to fear of adverse health effects than actual exposure.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-feeling strained -sleep	
7 Y RS	Abdel-Rassoul et al. (2007) Egypt	Base station antennas (GSM)	Questionnaire survey on 85 exposed persons and 80 controls	Effects found on: -headache -memory changes -dizziness -tremors -depressive symptoms -sleep disturbance No effects found on: -Blurred visión -Irritability -Lack of concentration	The prevalence of neuropsychiatric complaints were significantly higher among exposed inhabitants than controls. Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition.
8 N CBP	Augner and Hacker (2009) Austria	Base station antennas	Questionnaire survey on fifty-seven participants and saliva samples	Self-declared base station neighbors (≤100 m) had significantly higher concentrations of alpha-amylase in their saliva, higher rates in symptoms, somatization, obsessive-compulsive, anxiety, phobic anxiety. There were no differences in EMF-related health concern scales.	Self-declared base station neighbors are more strained than others. EMF-related health concerns cannot explain these findings.
9 N RS	Blettner et al. (2009) Berg-Beckhoff et al. (2009) Germany	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Questionnaire survey on 30,047 participants and geo-coding information on the residence distance (less or more than 500 m) to the nearest mobile phone base station. In a second phase RF measurements were conducted for a sub-sample in the households of 1500 persons	The mailed questionnaire included a list of 38 symptoms that have been reported in previous studies to be possibly associated with RF-EMF exposure	Participants who were concerned about or attributed adverse health effects to mobile phone base stations and those living in the vicinity of a mobile phone base station (500 m), reported slightly more health complaints tan others. The observed slightly higher prevalence of health complaints near base stations cannot be explained by attributions or concerns alone. The worries and health complaints of people living close to mobile phone base stations need to be taken seriously. Measured RF-EMFs emitted from mobile phone base stations were not associated with health disturbances. However, the study shows that sleep disturbances and health complaints are related to the attribution of adverse health effects to mobile phone base stations.
10 Y RS C	Kundi and Hutter (2009) Austria	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	There are indications from epidemiology that such exposures affect wellbeing and health weakly supported by human provocation studies and an inconclusive body of evidence from animal and in vitro studies. Cross-sectional investigations of subjective health as a function of distance or measured field strength, despite differences in methods and robustness of study design, found indications for an effect of exposure that is likely independent of concerns and attributions. Two ecological studies of cancer in the vicinity of base stations report both a strong increase of incidence within a radius of 350 and 400 m respectively. Due to the limitations inherent in this design no firm conclusions can be drawn, but the results underline the urgent need for a comprehensive investigation of this issue
11 Y C	Eger and Jahn (2010) Germany	Base station antennas	Questionnaire survey on 255 persons	Effects found on: -sleep problems -depression -headaches -cerebral affections -concentration difficulties -joint problems -infections -skin problems	A significant relationship between mean exposure levels of the study participants and reported health symptoms. Within the 400-m radius around the transmitter, a higher symptom rate could be documented for 14 out of 19 symptom groups in the highest exposure groups compared to groups

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-dizziness -cardiovascular problems -disturbance of equilibrium -visual problems -nosebleed -gastrointestinal problems No effects found on: -toothaches -hormonal imbalances -weight gain -weight loss	further away from the transmitter and the difference is statistically significant. Decreasing symptom scores in relation to decreasing mean exposure levels caused by cell phone transmitter emissions
12 N C	Elliott et al. (2010) Great Britain	Base station antennas	Data on all registered cases of cancer in children aged 0–4 in Great Britain and data on mobile phone base stations to investigate the risk of early childhood cancer associated with the mother's exposure to radiofrequency from and proximity to mobile phone base stations during pregnancy.	Of the 1397 cases, there were 251 brain and central nervous system cancers and 527 cases of leukaemia and non-Hodgkin's lymphoma. The study found no association between mobile phone base stations and risk of cáncer.	In this systematic national investigation the authors found no association between risk of cancer in young children and estimated exposures to radiofrequency from mobile phone base stations during pregnancy. However there is a research paper limitation on page 5: "our models did not include information on other sources of radiofrequency exposure, such as from microcells or picocells" and the city centers (especially) are full of these kind of antennas.
13 Y RS C	Khurana et al. (2010) international	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	The authors identified a total of 10 epidemiological studies that assessed for putative health effects of mobile pone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. The authors found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations.
14 N RS	Röösli et al. (2010) Switzerland	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Systematic review	There are no adverse effects	Not indication of an association between any health outcome and RF-EMF exposure from mobile phone base stations at levels typically found in our everyday environment. There is also no evidence that EHS individuals are more susceptible to base station radiation than the rest of the population. The evidence for the absence of long-term effects is limited.
15 N CBP C	Yildirim et al. (2010) Turkey	Base station antennas	Blood samples to analise the micronucleus (MN) frequency and chromosomal aberrations on blood in people living around mobile phone base stations and healthy controls.	There was not a significant difference of MN frequency and chromosomal aberrations between the two study groups.	Mobile phones and their base stations do not produce important carcinogenic changes.
16 Y RS	Alazawi, 2011 Iran	8 Base station antennas	Questionnaire survey on 375 subjects. Not measurements	Effects found on: -headaches -sleep disturbances -irritability -depressive -tendencies -feeling of discomfort, -difficulties in concentration -memory loss -lowering of libido	This study shows that inhabitants living nearby mobile phone base stations are at risk for developing non specific health symptoms, the facing position appears to be the worst one for distances from cellular phone base stations <100 m. It is advisable that cellular phone base stations should not be sited closer than 300 m to populations, as a precautionary measure, sitting of base stations should be such as to minimize exposure of neighbors.
17 Y C	Dode et al. (2011) Brazil	Base station antennas	This research was conducted in a broad environmental context, aiming to verify if there is a spatial correlation between the Base station antennas and the cases of death by neoplasia during the period between 1996 and 2006 in Belo Horizonte municipality (Brazil).	The mortality rates and the relative risk were higher for the residents inside a radius of 500 m from the Base station antennas, compared to the average mortality rate of the entire city, and a decreased dose– response gradient was observed for residents who lived farther away from these base stations.	The research showed the existence of a spatial correlation between cases of death by neoplasia and the locations of the Base station antennas, in the Belo Horizonte municipality from 1996 to 2006.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
18 Y C	Li et al. (2012) Taiwan	Base station antennas	Population-based case–control study in Taiwan considerering incident cases aged 15 years or less and admitted in 2003–2007 for all neoplasm (n = 3481 children). Exposure of each study subject to radio frequency (RF) was indicated by the averaged annual power density within 5 years prior to the neoplasm diagnosis. Controls were randomly selected.	Taiwanese children with higher-than median exposure of RF potentially emitted from Base station antennas were at significantly increased risk of all neoplasms combined. Although there were also positive associations between RF power density and risks of brain neoplasm and leukaemia in children, such associations did not reach statistical significance.	This study noted a significantly increased risk of all neoplasms in children with higher-than-median RF exposure to Base station antennas. The slightly elevated risk was seen for leukaemia and brain neoplasm, but was not statistically significant.
19 N C	Stewart et al. (2012) Great Britain	1 Base station antennas (GMS 1800)	Data on cancer incidence and mortality accessing the medical information of near residents	The study cannot conclude that the base station is responsible for the incidence of cancer in the local residents	Although the age range for local residents with cancer in the suspected cluster was younger than might be generally expected, there was no evidence that their cancer incidence is associated with the mobile phone base station. 10 cancers were registered after installation of the base station. However, the collection of cancers does not fulfil the criteria for a cancer cluster; the cases are a mixed variety of relatively common cancers. No single type of cancer was dominant, all but one were common types of cancer and none were seen in a group not usually affected by that cancer. Data from primary and secondary care also provide evidence that lifestyle and family history factors could have contributed to some individual cases.
20 N RS	Islam and Mohammed (2014) Bangladesh	Base station antennas	Questionnaire survey on 220 adults living near a Base station antenna for at least one year in two selected areas	Half of the respondents experienced problems in sleeping patterns, recent episodes of headache or dizziness and mood change, anxiety, or depression. 11 respondents experienced some generalized burning sensation and 4 reported episodes of shaking or fits. 48 respondents mentioned one or more other health effects, such as mood changes/problem, buzzing in the head, hopelessness, palpitation, tachycardia, heaviness of chest, anorexia, diarrhoea, and skin diseases.	From the results of the study cannot conclude that the health effects are direct results of the base station antennas. However, the complaints were similar to those of other studies, which shows the importance of conducting further research to determine the effects of electromagnetic radiarion from base station antennas on human health and should be considered as a public health concern.
21 Y RS	Pachuau and Pachuau (2014) India	Base station antennas (GSM 900)	Questionnaire survey conducted on 64 adults (31 female, 33 male) and electric field measurements. Health symptoms of RF exposure faced by the inhabitants within 50 m and outside 50 m from the tower were analysed and compared.	Effects found on: -Muscle pain -Fatigue -Sleep disorder -Nausea -Skin problema -Dizziness -Feeling of discomfort -Difficulty in concentration -Memory loss -Visual disruption	Inhabitants living within 50 m had more health complaints than those living outside 50 m. It was also found that females had more complaints than males
22 Y RS	Shinjyo and Shinjyo (2014) Japan	2 base station antennas (CDMA 800 MHz and 2 GHz)	Medical examinations and health questionnaires comparing the health of 107 residents during the base station's operation and after its removal. Measurement of the power density	Effects found on: -fatigue -eye problems -sleep disturbances -dizziness -headache -tinnitus -nasal bleeding No effects found on: -tachycardia -tumours -skin problems -rhinitis -angina pectoris -hearing loss	A total of 34 residents suffered from health problems after installation of the 800 MHz antennas. Three months after their removal this number decreased to 13. There were 41 residents who had health problems after installation of the 2 GHz antennas, and this number decreased to 15 after removal of the 2 GHz antennas. In total 49 residents suffered from health problems during operation of both the 800 MHz and the 2 GHz antennas. However, this number decreased to 25 after removal of both sets of antennas.The residents had no prior knowledge about possible adverse health effects of RF-EMFs. Health problems of the residents were associated with the operation of the

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
					mobile phone base station and these problems improved after its removal.
23 Y CBP	Gandhi et al. (2015) India	Base station antennas	Questionnaire survey and blood simples from 91 individuals, with 70% (63) residing in a populated area with a mobile phone base station (the sample group) and 30% (28) in a sparsely-populated zone without any nearby base stations (the control group). Radiofrequency field measurements	Effects found on: Genetic damage parameters of DNA migration length, damage frequency (DF) and damage index	Genetic damage was significantly increased in the sample group compared to that in the controls. The 2.5–4.5-fold increase in DNA damage in peripheral blood lymphocytes of persons staying near a mobile phone base station is of acute concern given that all neoplasia initiate via unrepaired DNA damage. In the light of the above observations and the statistically significant genetic damage observed in those residing within 300 m of a mobile phone base station in this study, it implies that the effects of radiations from mobile phone base stations cannot be overlooked, as unrepaired DNA damage can lead to cancer, precocious ageing and age-related effects.
24 Y CBP	Meo et al. (2015) Saudi Arabia	2 Base station antennas (925 MHz) near two schools	RF-EMF measurements and blood sample collection	Effects found on: -chronic hyperglycemia -increased HbA1c -diabetes mellitus	Students who were exposed to high EMFR generated by MPBS had significantly higher HbA1c and prevalence of pre diabetes mellitus compared to the students who exposed to low EMFR. EMFR appears to be another risk factor contributing to high levels of HbA1c and risk of type 2 diabetes mellitus.
25 Y RS	Pachuau et al. (2015) India	Base station antennas (GSM 900)	Questionnaire survey from 50 exposed and 50 control individuals. Power density measurements	Effects found on: -fatigue -sleep disruption -headache -dizziness -muscle pain -cramp No effects found on: -nausea -discomfort -difficulty in concentration -memory los -skin problems -visual disruption -hearing problem	Inhabitants living near mobile tower are having more health complaints than those inhabitants living in the area where there is no mobile tower
26 Y CBP	Al-Quzwini et al. (2016) Iraq	Base station antennas	Questionnaire survey. Two hundred couples (one hundred subfertile couples as a study group, and one hundred fertile couples as a control group. Semen analysis	Twenty-nine percentage of subfertile couples had exposure to environmental hazards (communication's tower beside their house-within 50 m), and 71% non-hazard. The duration of the exposure to the environmental factor ranged from 2 to 7 years.	The exposure to environmental hazards shows significant difference between the subfertile and the fertile men; as higher percentage of exposure to mobile phone tower among subfertile group, 29% versus 12% for the fertile group,
27 N RS	Baliatsas et al. (2016) The Netherlands	Base station antennas (GSM and UMTS)	Health records from 1069 adult participants, All participants were living within 500 m from the nearest bases station. A propagation model combined with a questionnaire was used to assess indoor exposure to RF-EMF from MPBS at T1. Estimation of exposure at T0 was based on number of antennas at T0 relative to T1.	Compared to the baseline period, there was a higher prevalence of symptoms theoretically relevant to EMF at T1. A significant increase was observed in the prevalence of ear symptoms and a two-fold (but not significant) increase in the prevalence of skin symptoms. Overall, the total prevalence was slightly lower at T1. A consistent association between UMTS exposure and different clusters of GP-registered symptoms, for the self-declared mobile phone base stations-sensitive group.	This before-after study found no evidence that RF-EMF exposure from mobile phone base stations is associated with the development of non-specific symptoms in the general population, corroborating recent observational studies. Subgroup analyses among people with self-reported sensitivity to base stations showed a higher prevalence for most symptoms at T1 compared to baseline and there was some indication for a higher risk of non-specific symptoms for the mobile phone base stations-sensitive group, in relation to exposure.
28 N RS	Klaps et al. (2016) Austria	Base station antennas	Meta-analysis based on the results of 17 studies	The effects of mobile phone base stations seem to be rather unlikely. However, nocebo effects occur.	It is unclear whether electromagnetic fields emitted by mobile phone base stations affect well-being in adults. The existing studies on this topic are highly inconsistent.
29 Y	Singh et al. (2016) India	4 Base station antennas		Effects found: -sleep disturbances	A majority of the subjects who were residing near the mobile base station

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
RS CBP			Questionnaire survey and salivary analysis in 20 individuals (case group) and 20 (control group)	-headache -dizziness -irritability -concentration difficulties -hypertension	had various complaints. A majority of the study subjects had significantly lesser stimulated salivary secretion as compared to the control subjects. The effects of prolonged exposure to EMRs from mobile phone base stations on the health and well-being of the general population cannot be ruled out.
30 Y RS	Premlal and Eldhose, 2017 India	14 Base station antennas	Questionnaire survey (229 persons) and power density measurements	Joint pain, sleep disorders, migraine related headaches and digestive problems	For 32 different diseases, only 4 were found to have obvious relation to the cell tower radiation. Females are more prone to the bad effects of cell tower radiation. The current Indian standard for cell tower exposure is inadequate for the safe living.
31 Y CBP	Taheri et al. (2017) Iran	Base station antennas	45 healthy individuals with their home near BTS antenna (exposed group) and 45 healthy subjects who were away from the antenna	In the exposed group, the whole number of white blood cells, the level of hematocrit, percent of monocytes, eosinophils and basophils were significantly lower than the control group. The number of red blood cells, their average volume and the mean concentration of hemoglobin were notably higher than the controls. There was not observed a significant difference between the two groups in hemoglobin, its mean concentration, platelet count, percent of lymphocytes and neutrophils as well as serum levels of cytokines IL-4, IL-10 and interferon γ.	The radiation of base station antennas influenced the blood and immune systems.
32 Y RS C	Vijay and Choudhary (2017) India	40 Base station antennas (900–1800 MHz)	Questionnaire survey	Effects found: - headache - depression - sleep disturbance - nausea - fatigue - asthma - cancer - Alzheimer's disease - multiple sclerosis - brain tumor.	The questionnaires show that people have some kind of physical or mental illness after the installation of mobile towers.
33 Y CBP	Zothansiama et al. (2017) India	6 Base station antennas (900–1800 MHz)	Questionnaire survey. Blood sample collection and lymphocyte culture. Power density measurement. Exposed group (n = 40) Control group (n = 40) The study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.	Effects found: -higher frequency of micronuclei -decreased antioxidants	The analyses of data from the exposed group residing within a perimeter of 80 m of mobile base stations, showed significantly higher frequency of micronuclei when compared to the control group, residing 300 m away from themobile base station. The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione concentration, activities of catalase and superoxide dismutase and rise in lipid peroxidation when compared to controls. Multiple linear regression analyses revealed a significant association among decreased antioxidants and elevated miconuclei frequency with increasing RF power density. The persistence of DNA unrepaired damage leads to genomic instability which may lead to several health disorders including the induction of cancer.
34 Y RS	Meo et al. (2019) Saudi Arabia	Two different schools both situated nearby base station antennas (925 MHz)	Cognitive function, motor screening task and spatial working memory were tested, and also RF measurements were made.	There was a statistically significant impairment in the motor screening task and spatial working memory among students who were exposed to high RF generated by base station antennas (School 2: 10.021 μW/cm^2) compared to students who were exposed to lower levels of RF (School 1: 2.010 μW/cm^2).	High exposure to RF-EMF produced by base station antennas is associated with a decrease in fine and gross motor skills and spatial working memory and attention in school adolescents compared to students who had been exposed to low RF-EMF.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
35 Y RS	Ali et al. (2021) Iraq	Base station antennas (900–1800 MHz)	Questionnaire survey comparing two groups. The first group (n = 79) was located in a town with three cell phone towers with less than a hundred meters apart. The second study group (n = 79) was limited to the area almost empty from cell phone towers. Electric field measurements were made.	There was a significant association between health problems (skin problem, hair loss issues, sleeping difficulties, and fertility issues) and distance to towers (less distance, more problems: P-value < 0.05). In regards to health problems (abnormalities, blood pressure issues, tumours cases, and memory and concentration difficulties), the obtained results were not statistically significant.	The results showed an increase in both short- and long-term health problems near base stations antennas in general.
36 Y RS C	López et al., 2021 Spain	9 Base station antennas	Questionnaire survey on 268 persons, 174 in exposed área and 94 in control área, and EMF measurements	Effects found on -headache -dizziness -instability -tachycardias -nightmares No effects found on: -fainting	People who are exposed to higher radiation values present more severe headaches, dizziness and nightmares. 5.6% cancer cases in the study population, a percentage 10 times higher tan that of the total Spanish population.
37 N RS	Martin et al. (2021) France	Base station antennas	Questionnaire survey in 354 residents from buildings located at a distance of 250 m or less from the base station antennas in the main transmit beam of the antennas and home exposure measurements	No significant association between RF-EMF exposure and the overall symptoms score, nor between RF-EMF exposure from MPBSs and insomnia-like symptoms. There was a significant association between RF-EMF exposure and insomnia-like symptoms only for participants who attributed their symptoms to radiofrequencies.	The findings of the study do not support the hypothesis of an association between RF-EMF exposure and health outcomes, such as self-reported non-specific or insomnia-like symptoms in the general population. However, they may suggest a possible association between such exposure and insomnia-like symptoms among people reporting environmental concerns.
38 Y C	Rodrigues et al. (2021) Brazil	Base station antennas	This is an ecological study using capitals as the unit of analysis. The authors collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime and investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers).	For all cancers and for the specific types investigated (breast, cervix, lung, and esophagus cancers), the higher the exposure to RBS radiofrequency, the higher the median of mortality rate.	The results indicates that the exposure to radiofrequency electromagnetic fields from an RBS increases the rate of mortality by all cancers and specifically by breast, cervix, lung, and esophageal cancers. These conclusions are based on the fact that the findings of the study indicate that, the higher the RBS radiofrequency exposure, the higher the cancer mortality rate, especially for cervix cancer. The spatial analysis showed that the highest radiofrequency exposure was observed in a city located in the southern region of Brazil, which also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancers.

4.1. Investigations with radar and radio/television antennas

In studies carried out in the last century, occupational exposure of people to microwave radiation (RF) related to military, industrial and radio uses, as well as radio waves, showed several types of effects: an increase in spontaneous abortions, changes in red and white blood cell counts and an increase in childhood, testicular and other cancers. These findings suggest that RF exposures are potentially carcinogenic and have other health effects; the author recommends precautionary measures to avoid unnecessary exposure (Goldsmith, 1997). An analysis of particular locations of diagnosed neoplasms indicates significantly higher morbidity rates in the military exposed to RF for alimentary tract cancers, skin tumours, neoplasms and cerebral and haematological/lymphatic malignancies. For haematological/lymphatic malignancies, the difference in morbidity between exposed and unexposed military was the largest. This may suggest that spontaneous neoplasms develop faster in the exposed group, with a shorter latency period than in those not exposed. In fact, in exposed subjects, the disease occurs 5–10 years earlier (Szmigielski et al., 2001). On the other hand, children exposed to radar electromagnetic radiation had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased (Kolodynski and Kolodynska, 1996).

In several studies performed around radio and television antennas, there was a significant decrease in the risk of cancer and leukaemia with increasing distance to the antennas (Maskarinec et al., 1994; Dolk et al., 1997a, 1997b; Hocking and Gordon, 2000; Michelozzi et al., 2002; Park et al., 2004). People exposed to a radio antenna shortwave broadcasting station in Schwarzenburg (Switzerland) had sleep disturbances, which were more frequent in exposed than in unexposed subjects (Altpeter et al., 2000).

Thus, the coincidences of similar effects from studies with different sources of electromagnetic radiation (but with similar pulsed, polarized and modulated radiation), such as radar or radio/television antennas, reinforce the conclusions of this review. Non-ionizing EMF are among the fastest growing forms of environmental pollution, its increase around the world in recent years has been exponential (Bandara and Carpenter, 2018) and symptoms reported today may be classic microwave/RF sickness (Levitt and Lai, 2010).

4.2. RF exposure incidents among diplomats (Havanna syndrome)

From late 2016 through August 2017, US government personnel on a diplomatic mission in Havana, Cuba, reported neurological symptoms, including cognitive, balance, visual and hearing disturbances, sleep

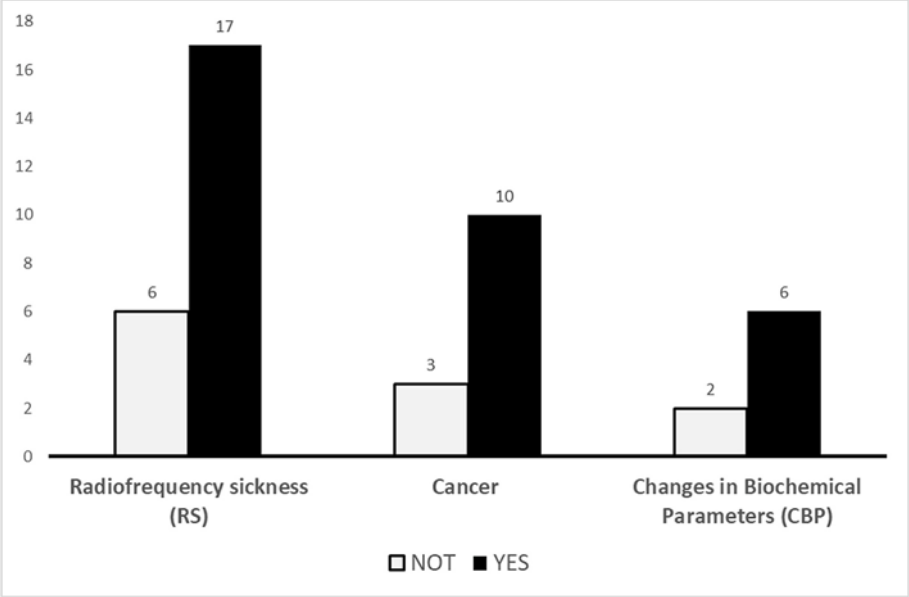


Fig. 1. Results on effects according to the study type considered.

disturbances and headaches. These individuals appeared to have sustained injuries to generalized brain networks with no associated history of head trauma (Swanson et al., 2018). They complained of cognitive decline, fatigue and headache, especially after cognitive exertion, and in some cases tinnitus, nausea and balance problems (Dyer, 2018). This mysterious disease that affected US and Canadian diplomats in Cuba (and later also in China) has confused the FBI, the State Department and US intelligence agencies.

The reported facts seem consistent with pulsed RF/microwave as the source of injuries to the affected diplomats (Golomb, 2018). The same conclusion was later reached by the National Academy of National Academies of Sciences (2020), who reported that many of the chronic or non-specific symptoms were consistent with known effects of RF, such as dizziness, headache, fatigue, nausea, anxiety, cognitive deficits and memory loss. In general, directed pulsed RF energy appears to be the most plausible mechanism to explain these cases. Such symptoms had already been described much earlier at the Moscow embassy (Lilienfeld et al., 1978; Johnson Lyakouris, 1998).

There are objective pathophysiological changes and health effects induced by EMF exposure that can biologically damage the organism and are noxious agents in healthy people (Belpomme and Irigaray, 2022).

4.3. Important laboratory studies

The United States National Toxicology Program (NTP) tested the two main modulation types used for mobile phones worldwide for GSM (2G) and UMTS (3G/4G), in a two-year rodent cancer bioassay under near-field exposure conditions; the experiments included additional assays for genotoxicity endpoints (Smith-Roe et al., 2020). They found clear evidence of carcinogenic activity, and more specifically malignant schwannomas of the heart, malignant gliomas of the brain and benign, malignant or complex pheochromocytomas (combined) of the adrenal medulla. They also found increased DNA damage (measured by the comet assay) in the frontal cortex of male mice, in the leukocytes of female mice and in the hippocampus of male rats, indicating that mobile phone EMF could cause DNA damage and consequent carcinogenesis. In a similar large carcinogenicity study by the Ramazzini Institute, Falcioni et al. (2018) examined far-field exposure to GSM 1800 MHz EMF and reported very similar results to the NTP study. Specifically, they also found increased incidence of tumours of the brain and heart in the mobile phone EMF-exposed Sprague-Dawley rats. Furthermore, these tumours are of the same histotype as those observed in some epidemiological studies on mobile phone users (Hardell et al., 2007).

Kostoff et al. (2020) emphasizes that most of the laboratory experiments conducted to date were not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate, as many experiments do not include pulsing and modulation of the carrier signal and the majority do not account for synergistic adverse effects of other toxic stimuli.

4.4. Importance of studies with biological parameters and those performed on animals and plants

Despite the scientific evidence shown in the studies carried out in many countries by different teams of researchers that we have reviewed, several studies conclude that no effects are found and blame it on risk perception and the nocebo effect (Wiedemann et al., 2006; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Koh et al., 2020). However, the nocebo effect is not supported by objective data (Belpomme and Irigaray, 2022), by the results of cancer studies (Eger et al., 2004; Wolf and Wolf, 2004; Dode et al., 2011; Li et al., 2012; Rodrigues et al., 2021), by studies on changes in haematological parameters (Gandhi et al., 2015; Meo et al., 2015; Taheri et al., 2017; Zothansiama et al., 2017), by hormonal changes after long-term exposure (Eskander et al., 2012), by salivary secretion (Singh et al., 2016) and by effects on fertility (Al-Quzwini et al., 2016). Many reviews on the health effects of mobile phones have reached the same conclusions regarding their effects on male infertility (El-Hamd and Aboeldahab, 2018). Unfortunately, the studies that allude to the nocebo effect seem to be the ones taken into account by the World Health Organization (World Health Organization, 2015).

On the other hand, studies performed on animals or trees near base station antennas are especially important, because animals and plants cannot be aware of their proximity and therefore nocebo or psychosomatic effects cannot be attributed (Balmori, 2005, 2010; Balmori and Hallberg, 2007; Hässig et al., 2012; Lázaro et al., 2016; Waldmann-Selsam et al., 2016; Levitt et al., 2021). In fact, a similar result of this study for humans was found in a review on the significant ecological effects of RF EMF in 65% of the studies on vertebrates, birds and plants (Cucurachi et al., 2013).

Moreover, for these effects, perfectly plausible mechanisms of action

have already been proposed. Plasma membrane calcium channels and other voltage-gated ion channels are irregularly activated/inactivated by man-made EMF in both animals and plants, increasing intracellular [Ca^{2+}] and altering intracellular ion concentrations (Panagopoulos et al., 2002, 2021; Pall, 2016).

Under the influence of non-thermal intensities of microwave radiation, often there are important signals of some hazardous changes in cell metabolism. A significant increase of reactive oxygen species and nitrogen oxide generation in cells under non-thermal intensities has been detected both in vivo and in vitro (Yakymenko et al., 2011; Belpomme and Irigaray, 2022). Thus, the different findings clearly argue for a causal role of EMF in inducing free radical species, including overproduction of reactive oxygen and nitrogen species or suppression of antioxidant defence in cells (Belpomme and Irigaray, 2022). Furthermore, this exposure can result in DNA damage through oxidative stress with reactive oxygen species/free radical overproduction (Yakymenko et al., 2011; Kıvrak et al., 2017; Panagopoulos et al., 2021).

5. The Precautionary Principle

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a private organization that issues exposure guidelines that are then adopted by governments, but it has been accused of having conflicts of interest (Hardell and Carlberg, 2020; Hardell et al., 2021). The ICNIRP (2010, 2020) limits are thousands of times above the levels where effects are recorded for both extremely low frequency and RF man-made EMF and account only for thermal effects, whereas the vast majority of recorded effects are non-thermal. These existing guidelines for public health protection only consider the effects of acute intense (thermal) exposures and do not protect from lower level long-term exposures (Israel et al., 2011; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016; Belpomme and Irigaray, 2022). The exposure duration is crucial to assess the induced effects.

The Precautionary Principle is one of the fundamental principles of the European Union, governing policies related to the environment, health and food safety (Harremoes et al., 2013). This principle enables decision-makers to adopt precautionary measures when the scientific evidence regarding an environmental or human health factor is not certain regarding its safety. Therefore, despite the existing ample and rapidly increasing scientific evidence, no significant progress has been made over all these years, at least at the level of guidelines issued by the responsible authorities and official regulatory bodies. Some authors have pointed out that the source of funding correlates with study findings, and many systematic reviews and meta-analyses in this field have failed to correct for this source of funding bias, which has likely underestimated the evidence for causation (Carpenter, 2019). A growing number of scientists have been calling internationally on governments to raise their safety standards for RF-EMF (Blank et al., 2015; Hardell and Nyberg, 2020; Frank, 2021). Thus, there is an urgent need to adopt the Precautionary Principle and impose more restrictive levels (Zinelis, 2010; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016).

6. Conclusion

In the current circumstances, it seems that the scientific experts in the field are very clear about the serious problems we are facing and have expressed this through important appeals (Blank et al., 2015; Hardell and Nyberg, 2020). However, the media, the responsible organizations (World Health Organization, 2015) and the governments are not transmitting this crucial information to the population, who remain uninformed. For these reasons, the current situation will probably end in a crisis not only for health but also for this technology itself, as it is unsustainable and harmful to the environment and the people.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abelin, T., Altpeter, E., Röösli, M., 2005. Sleep disturbances in the vicinity of the short-wave broadcast transmitter Schwarzenburg. Somnologie-Schlafforschung und Schlafmedizin 9 (4), 203–209.
Akkam, Y., A Al-Taani, A., Ayasreh, S., Almutairi, A., Akkam, N., 2020. Correlation of blood oxidative stress parameters to indoor radiofrequency radiation: a cross sectional study in Jordan. Int. J. Environ. Res. Publ. Health 17 (13), 4673.
Alazawi, S.A., 2011. Mobile phone base stations health effects. Diyala J. Med. 1 (1), 44–52.
Alhekail, Z.O., Hadi, M.A., Alkanhal, M.A., 2012. Public safety assessment of electromagnetic radiation exposure from mobile base stations. J. Radiol. Prot. 32 (3), 325.
Altpeter, E., Battaglia, M., Bader, A., Pfluger, D., Minder, C.E., Abelin, T., 2000, June. Ten years experience with epidemiological research in the vicinity of the short-wave broadcasting area Schwarzenburg: what does the story tell us. In: Proceedings of the International Conference on Cell Tower Siting. Salzburg, Austria, pp. 7–8.
Altpeter, E.S., Röösli, M., Battaglia, M., Pfluger, D., Minder, C.E., Abelin, T., 2006. Effect of short-wave (6–22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study. Bioelectromagnetics 27 (2), 142–150.
Abdel-Rassoul, G., Abou El-Fateh, O., Abou Salem, M., Michael, A., Farahat, F., El-Batanouny, M., Salem, E., 2007. Neurobehavioral effects among inhabitants around mobile phone base stations. Neurotoxicology 28 (2), 434–440.
Admawi, H.K., 2021. Assessment of electromagnetic pollution in some hospitals and schools in Al-najaf city. J. Eng. 27 (3), 1–14.
Ali, M.T., Muhsen, Y.R., Chisab, R.F., Abed, S.N., 2021. Evaluation study of radio frequency radiation effects from cell phone towers on human health. Radioelectron. Commun. Syst. 64 (3), 155–164.
Al-Quzwini, O.F., Al-Taee, H.A., Al-Shaikh, S.F., 2016. Male fertility and its association with occupational and mobile phone towers hazards: an analytic study. Middle East Fertil. Soc. J. 21 (4), 236–240.
Altpeter, E., Battaglia, M., Bader, A., Pfluger, D., Minder, C.E., Abelin, T., 2000. Ten years experience with epidemiological research in the vicinity of the short-wave broadcasting area Schwarzenburg: what does the story tell us. In: Proceedings of the International Conference on Cell Tower Siting, vol. 78. Salzburg, Austria, pp. 127–132.
Aniołczyk, H., 1999. Electromagnetic field pattern in the environment of GSM base stations. Int. J. Occup. Med. Environ. Health 12 (1), 47–58.
Atzmon, I., Linn, S., Richter, E., Portnov, B.A., 2012. Cancer risks in the druze isifya village: reasons and RF/MW antennas. Pathophysiology 19 (1), 21–28.
Augner, C., Hacker, G.W., 2009. Are people living next to mobile phone base stations more strained? Relationship of health concerns, self-estimated distance to base station, and psychological parameters. Indian J. Occup. Environ. Med. 13 (3), 141.
Augner, C., Florian, M., Pauser, G., Oberfeld, G., Hacker, G.W., 2009. GSM base stations: short-term effects on well-being. Bioelectromagnetics 30 (1), 73–80.
Augner, C., Hacker, G.W., Oberfeld, G., Florian, M., Hitzl, W., Hutter, J., Pauser, G., 2010. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed. Environ. Sci. 23 (3), 199–207.
Azimzadeh, M., Jelodar, G., 2019. Alteration of testicular regulatory and functional molecules following long-time exposure to 900 MHz RFW emitted from BTS. Andrologia 51 (9), e13372.
Baliatsas, C., van Kamp, I., Kelfkens, G., Schipper, M., Bolte, J., Yzermans, J., Lebret, E., 2011. Non-specific physical symptoms in relation to actual and perceived proximity to mobile phone base stations and powerlines. BMC Publ. Health 11 (1), 1–12.
Baliatsas, C., van Kamp, I., Bolte, J., Kelfkens, G., van Dijk, C., Spreeuwenberg, P., et al., 2016. Clinically defined non-specific symptoms in the vicinity of mobile phone base stations: a retrospective before-after study. Sci. Total Environ. 565, 714–720.
Balmori, A., 2005. Possible effects of electromagnetic fields from phone masts on a population of white stork (Ciconia ciconia). Electromagn. Biol. Med. 24 (2), 109–119.
Balmori, A., Hallberg, Ö., 2007. The urban decline of the house sparrow (Passer domesticus): a possible link with electromagnetic radiation. Electromagn. Biol. Med. 26 (2), 141–151.
Balmori, A., 2010. Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory. Electromagn. Biol. Med. 29 (1–12), 31–35.
Bandara, P., Carpenter, D.O., 2018. Planetary electromagnetic pollution: it is time to assess its impact. Lancet Planet. Health 2 (12), e512–e514.
Beekhuizen, J., Vermeulen, R., Kromhout, H., Bürgi, A., Huss, A., 2013. Geospatial modelling of electromagnetic fields from mobile phone base stations. Sci. Total Environ. 445, 202–209.
Belpomme, D., Irigaray, P., 2022. Why Electrohypersensitivity and Related Symptoms Are Caused by Non-ionizing Man-Made Electromagnetic Fields: an Overview and Medical Assessment. Environmental Research, 113374.
Berg-Beckhoff, G., Blettner, M., Kowall, B., Breckenkamp, J., Schlehofer, B., Schmiedel, S., et al., 2009. Mobile phone base stations and adverse health effects:

phase 2 of a cross-sectional study with measured radio frequency electromagnetic fields. Occup. Environ. Med. 66 (2), 124–130.
Bithell, J.F., 2010. Childhood cancer and proximity to mobile phone masts. Bmj 340.
Blank, M., Havas, M., Kelley, E., Lai, H., Moskowitz, J., 2015. International Appeal: scientists call for protection from non-ionizing electromagnetic field exposure. Eur. J. Oncol. 20 (3/4), 180–182.
Blettner, M., Schlehofer, B., Breckenkamp, J., Kowall, B., Schmiedel, S., Reis, U., et al., 2009. Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany. Occup. Environ. Med. 66 (2), 118–123.
Boehmert, C., Freudenstein, F., Wiedemann, P., 2020. A systematic review of health risk communication about EMFs from wireless technologies. J. Risk Res. 23 (5), 571–597.
Bortkiewicz, A., Zmyślony, M., Szyjkowska, A., Gadzicka, E., 2004. Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review. Med. Pr. 55 (4), 345–351.
Boscolo, P., Di Sciascio, M.B., D'ostilio, S., Del Signore, A., Reale, M., Conti, P., et al., 2001. Effects of electromagnetic fields produced by radiotelevision broadcasting stations on the immune system of women. Sci. Total Environ. 273 (1–3), 1–10.
Breckenkamp, J., Blettner, M., Schüz, J., Bornkessel, C., Schmiedel, S., Schlehofer, B., Berg-Beckhoff, G., 2012. Residential characteristics and radiofrequency electromagnetic field exposures from bedroom measurements in Germany. Radiat. Environ. Biophys. 51 (1), 85–92.
Bürgi, A., Theis, G., Siegenthaler, A., Röösli, M., 2008. Exposure modeling of high-frequency electromagnetic fields. J. Expo. Sci. Environ. Epidemiol. 18 (2), 183–191.
Bürgi, A., Scanferla, D., Lehmann, H., 2014. Time averaged transmitter power and exposure to electromagnetic fields from mobile phone base stations. Int. J. Environ. Res. Publ. Health 11 (8), 8025–8037.
Carpenter, D.O., 2019. Extremely low frequency electromagnetic fields and cancer: how source of funding affects results. Environ. Res. 178, 108688.
Chen, H.Y., Chuang, C.Y., 2009. Currents induced in human bodies during radiofrequency exposure near a cellular phone base station. Electromagnetics 29 (1), 13–23.
Coggon, D., 2006. Health risks from mobile phone base stations. Occup. Environ. Med. 63 (5), 298–299.
Cooper, D., Hemmings, K., Saunders, P., 2001. Re: "Cancer incidence near radio and televisión transmitters in Great Britain. I. Sutton Coldfield transmitter"; II. All high power transmitters. Am. J. Epidemiol. 153, 202–204.
Cucurachi, S., Tamis, W.L., Vijver, M.G., Peijnenburg, W.J., Bolte, J.F., de Snoo, G.R., 2013. A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environ. Int. 51, 116–140.
Danker-Hopfe, H., Dorn, H., Bornkessel, C., Sauter, C., 2010. Do mobile phone base stations affect sleep of residents? Results from an experimental double-blind sham-controlled field study. Am. J. Hum. Biol. 22 (5), 613–618.
De Giudici, P., Genier, J.C., Martin, S., Doré, J.F., Ducimetiere, P., Evrard, A.S., et al., 2021. Radiofrequency exposure of people living near mobile-phone base stations in France. Environ. Res. 194, 110500.
Dieudonné, M., 2016. Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study. Bioelectromagnetics 37 (1), 14–24.
Dode, A.C., Leao, M.M., Tjo Fde, A., Gomes, A.C., Dode, D.C., Dode, M.C., 2011. moreira CW, condessa VA, albinatti C, and caiaffa WT. Mortality by neoplasia and cellular telephone base stations in the belo horizonte municipality, minas gerais state, Brazil. Sci. Total Environ. 409, 3649–3665.
Dode, A.C., Leão, M.M., 2012. Comments on" Foster KR, Trottier L, comments on" mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state,. Sci. Total Environ. 442, 553–556 (2012. The Science of the total environment.
Dohle, S., Keller, C., Siegrist, M., 2012. Mobile communication in the public mind: insights from free associations related to mobile phone base stations. Hum. Ecol. Risk Assess. 18 (3), 649–668.
Dolk, H., Shaddick, G., Walls, P., Grundy, C., Thakrar, B., Kleinschmidt, I., Elliott, P., 1997a. Cancer incidence near radio and television transmitters in Great Britain I. Sutton Coldfield transmitter. Am. J. Epidemiol. 145 (1), 1–9.
Dolk, H., Elliot, G., Shaddick, G., Walls, P., Thakrar, B., 1997b. Cancer incidence near radio and television transmitters in great britain, Part 2. All high tower transmitters. Am. J. Epidemiol. 145, 10–17.
Dyer, O., 2018. Microwave weapon caused syndrome in diplomats in Cuba, US medical team believes. BMJ Br. Med. J. (Clin. Res. Ed.) 362.
Eger, H., Hagen, K.U., Lucas, B., Vogel, P., Voit, H., 2004. Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz. Umwelt-Medizin-Gesellschaft 17 (4), 326–335.
Eger, H., Jahn, M., 2010. Specific health symptoms and cell phone radiation in Selbitz (Bavaria, Germany)—evidence of a dose-response relationship. umwelt-medizin-gesellschaft 23, 130–139.
El-Hamd, M.A., Aboeldahab, S., 2018. Cell phone and male infertility: an update. J. Integrat. Nephrol. Androl. 5 (1), 1.
Elliott, P., Toledano, M.B., Bennett, J., Beale, L., De Hoogh, K., Best, N., Briggs, D.J., 2010. Mobile phone base stations and early childhood cancers: case-control study. Bmj 340.
Eltiti, S., Wallace, D., Ridgewell, A., Zougkou, K., Russo, R., Sepulveda, F., et al., 2007. Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomized provocation study. Environ. Health Perspect. 115 (11), 1603–1608.
Elwood, J.M., 2003. Epidemiological studies of radio frequency exposures and human cancer. Bioelectromagnetics 24 (S6), S63–S73.
Eskander, E.F., Estefan, S.F., Abd-Rabou, A.A., 2012. How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin. Biochem. 45 (1–2), 157–161.
Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Belpoggi, F., 2018. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ. Res. 165, 496–503.
Foster, K.R., Trottier, L., 2012. Comments on" Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil" by AC Dode et al, 2011. In: Science of the Total Environment, vol. 409, pp. 3649–3665. The Science of the total environment, 450, 366-368.
Frank, J.W., 2021. Electromagnetic fields, 5G and health: what about the precautionary principle? J. Epidemiol. Community Health 75 (6), 562–566.
Frei, P., Mohler, E., Braun-Fahrländer, C., Fröhlich, J., Neubauer, G., Röösli, M., 2012. Cohort study on the effects of everyday life radio frequency electromagnetic field exposure on non-specific symptoms and tinnitus. Environ. Int. 38 (1), 29–36.
Freudenstein, F., Wiedemann, P.M., Brown, T.W., 2015. Exposure perception as a key indicator of risk perception and acceptance of sources of radio frequency electromagnetic fields. J. Environ. Public Health 2015, 9. https://doi.org/10.1155/2015/198272.
Gandhi, G., Kaur, G., Nisar, U., 2015. A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station. Electromagn. Biol. Med. 34 (4), 344–354.
Goldsmith, J.R., 1997. Epidemiologic evidence relevant to radar (microwave) effects. Environ. Health Perspect. 105 (Suppl. 6), 1579–1587.
Golomb, B.A., 2018. Diplomats' mystery illness and pulsed radiofrequency/microwave radiation. Neural Comput. 30 (11), 2882–2985.
Gómez-Perretta, C., Navarro, E.A., Segura, J., Portolés, M., 2013. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. BMJ Open 3 (12), e003836.
Ha, M., Lim, H.J., Cho, S.H., Choi, H.D., Cho, K.Y., 2003. Incidence of cancer in the vicinity of Korean AM radio transmitters. ArchivE Environ. Health 58 (12), 756–762.
Ha, M., Im, H., Lee, M., Kim, H.J., Kim, B.C., Gimm, Y.M., Pack, J.K., 2007. Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. Am. J. Epidemiol. 166 (3), 270–279.
Hansson, B., Thors, B., Törnevik, C., 2011. Analysis of the effect of mobile phone base station antenna loading on localized SAR and its consequences for measurements. Bioelectromagnetics 32 (8), 664–672.
Hallberg, Ö., Johansson, O., 2002. Melanoma incidence and frequency modulation (FM) broadcasting. ArchivE Environ. Health 57 (1), 32–40.
Hardell, L., Carlberg, M., Söderqvist, F., Mild, K.H., Morgan, L.L., 2007. Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years. Occup. Environ. Med. 64 (9), 626–632 submitted for publication.
Hardell, L., Carlberg, M., Hedendahl, L.K., 2018. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: a case report. Oncol. Lett. 15 (5), 7871–7883.
Hardell, L., Carlberg, M., 2020. [Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. Oncol. Lett. 20 (4), 1, 1.
Hardell, L., Nyberg, R., 2020. [Comment] Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mole. Clinic. Oncol. 12 (3), 247–257.
Hardell, L., Nilsson, M., Koppel, T., Carlberg, M., 2021. Aspects on the international commission on non-ionizing radiation protection (ICNIRP) 2020 guidelines on radiofrequency radiation. J. Cancer Sci. Clinic. Therapeutics 5 (2), 250–285.
Harremoes, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., Vaz, S.G. (Eds.), 2013. The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings. Routledge, London.
Hässig, M., Jud, F., Spiess, B., 2012. Increased occurrence of nuclear cataract in the calf after erection of a mobile phone base station. Schweizer Archiv Fur Tierheilkunde 154 (2), 82–86.
Henderson, S.I., Bangay, M.J., 2006. Survey of RF exposure levels from mobile telephone base stations in Australia. Bioelectromagnetics: J. Bioelectromag. Soc., Soc. Phys. Regul. Biol. Med., European Bioelectromag. Assoc. 27 (1), 73–76.
Hinrichs, H., Heinze, H.J., Rotte, M., 2005. Human sleep under the influence of a GSM 1800 electromagnetic far field. Somnologie-Schlafforschung und Schlafmedizin 9 (4), 185–191.
Hocking, B., Gordon, I.R., Grain, H.L., Hatfield, G.E., 1996. Cancer incidence and mortality and proximity to TV towers. Med. J. Aust. 165 (11–12), 601–605.
Hocking, B., Gordon, I., 2000. Decreased survival for childhood leukemia in proximity to TV towers. In: Poster Presented at the Annual Scientific Meeting of the Royal Australian College of Physicians in Adelaide. SA, Australia.
Hutter, H.P., Moshammer, H., Wallner, P., Kundi, M., 2006. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. Occup. Environ. Med. 63 (5), 307–313.
ICNIRP, 2010. Guidelines for limiting exposure to time-varying electric and magnetic fields (1Hz to 100 kHz). Health Phys. 99 (6), 818–836.
ICNIRP, 2020. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys. 118 (5), 483–524.
Islam, S., Mohammed, S., 2014. Awareness and self-reported health hazards of electromagnetic waves from mobile phone towers in Dhaka, Bangladesh: a pilot study. Adv. Pub. Health 2014, 7. https://doi.org/10.1155/2014/952832, 952832.
Johnson Lyakouris, A.G., 1998. Radiofrequency (RF) sickness in the Lilienfeld study: an effect of modulated microwaves? ArchivE Environ. Health 53, 3, 1998.

Kazaure, J.S., Matthew, U.O., Okafor, N.U., Okey, O.D., 2021. Telecommunication network performances and evaluation of radio frequency electromagnetic radiation: health effects of the RF-EMR GSM base stations. Int. J. Inf. Commun. Technol. Hum. Dev. 13 (3), 16–37.
Keow, M.A., Radiman, S., 2006. Assessment of radiofrequency/microwave radiation emitted by the antennas of rooftop-mounted mobile phone base stations. Radiat. Protect. Dosim. 121 (2), 122–127.
Khurana, V.G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., Ahonen, M., 2010. Epidemiological evidence for a health risk from mobile phone base stations. Int. J. Occup. Environ. Health 16 (3), 263–267.
Kıvrak, E.G., Yurt, K.K., Kaplan, A.A., Alkan, I., Altun, G., 2017. Effects of electromagnetic fields exposure on the antioxidant defense system. J. Micros. Ultrastruct. 5 (4), 167–176.
Klaps, A., Ponocny, I., Winker, R., Kundi, M., Auersperg, F., Barth, A., 2016. Mobile phone base stations and well-being—a meta-analysis. Sci. Total Environ. 544, 24–30.
Koh, T.H., Choi, J.W., Seo, M., Choi, H.D., Kim, K., 2020. Factors affecting risk perception of electromagnetic waves from 5G network base stations. Bioelectromagnetics 41 (7), 491–499.
Kolodynski, A.A., Kolodynska, V.V., 1996. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. Sci. Total Environ. 180 (1), 87–93.
Kostoff, R.N., Heroux, P., Aschner, M., Tsatsakis, A., 2020. Adverse health effects of 5G mobile networking technology under real-life conditions. Toxicol. Lett. 323, 35–40.
Kundi, M., Hutter, H.P., 2009. Mobile phone base stations—effects on wellbeing and health. Pathophysiology 16 (2–3), 123–135.
Kowall, B., Breckenkamp, J., Blettner, M., Schlehofer, B., Schüz, J., Berg-Beckhoff, G., 2012. Determinants and stability over time of perception of health risks related to mobile phone base stations. Int. J. Publ. Health 57 (4), 735–743.
Lamech, F., 2014. Self-reporting of symptom development from exposure to radiofrequency fields of wireless smart meters in Victoria, Australia: a case series. Alternative Ther. Health Med. 20 (6), 28.
Lázaro, A., Chroni, A., Tscheulin, T., Devalez, J., Matsoukas, C., Petanidou, T., 2016. Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. J. Insect Conserv. 20 (2), 315–324.
Lemaire, T., Wiart, J., De Doncker, P., 2016. Variographic analysis of public exposure to electromagnetic radiation due to cellular base stations. Bioelectromagnetics 37 (8), 557–562.
Leitgeb, N., Schröttner, J., Cech, R., Kerbl, R., 2008. EMF-protection sleep study near mobile phone base stations. Somnologie-Schlafforschung und Schlafmedizin 12 (3), 234–243.
Levitt, B.B., Lai, H., 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ. Rev. 18 (NA), 369–395.
Levitt, B.B., Lai, H.C., Manville, A.M., 2021. Effects of Non-ionizing Electromagnetic Fields on Flora and Fauna, Part 2 Impacts: How Species Interact with Natural and Man-Made EMF. Reviews on Environmental Health.
Li, C.Y., Liu, C.C., Chang, Y.H., Chou, L.P., Ko, M.C., 2012. A population-based case–control study of radiofrequency exposure in relation to childhood neoplasm. Sci. Total Environ. 435, 472–478.
Lilienfeld, A.M., Tonascia, J., Tonascia, S., et al., 1978. Foreign Service Health Status Study. Department of State, Washington, DC. Final report contract no. 6025-619037 (NTS publication PB-288163).
López, I., Félix, N., Rivera, M., Alonso, A., Maestú, C., 2021. What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. Environ. Res. 194, 110734.
Lyare, R.N., Volskiy, V., Vandenbosch, G.A., 2019. Study of the correlation between outdoor and indoor electromagnetic exposure near cellular base stations in Leuven, Belgium. Environ. Res. 168, 428–438.
Martens, A.L., Slottje, P., Smid, T., Kromhout, H., Vermeulen, R.C., Timmermans, D.R., 2018. Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms. J. Psychosom. Res. 112, 81–89.
Martens, A.L., Slottje, P., Timmermans, D.R., Kromhout, H., Reedijk, M., Vermeulen, R. C., Smid, T., 2017. Modeled and perceived exposure to radiofrequency electromagnetic fields from mobile-phone base stations and the development of symptoms over time in a general population cohort. Am. J. Epidemiol. 186 (2), 210–219.
Martin, S., De Giudici, P., Genier, J.C., Cassagne, E., Doré, J.F., Ducimetière, P., et al., 2021. Health disturbances and exposure to radiofrequency electromagnetic fields from mobile-phone base stations in French urban areas. Environ. Res. 193, 110583.
Maskarinec, G., Cooper, J., Swygert, L., 1994. Investigation of increased incidence in childhood leukemia near radio towers in Hawaii: preliminary observations. J. Environ. Pathol. Toxicol. Oncol. 13 (1), 33–37.
McKenzie, D.R., Yin, Y., Morrell, S., 1998. Childhood incidence of acute lymphoblastic leukemia and exposure to broadcast radiation in Sydney—a second look. Aust. N. Z. J. Publ. Health 22 (3 Suppl. l), 360–367.
Meo, S.A., Alsubaie, Y., Almubarak, Z., Almutawa, H., AlQasem, Y., Hasanato, R.M., 2015. Association of exposure to radio-frequency electromagnetic field radiation (RF-EMFR) generated by mobile phone base stations with glycated hemoglobin (HbA1c) and risk of type 2 diabetes mellitus. Int. J. Environ. Res. Publ. Health 12 (11), 14519–14528.
Meo, S.A., Almahmoud, M., Alsultan, Q., Alotaibi, N., Alnajashi, I., Hajjar, W.M., 2019. Mobile phone base station tower settings adjacent to school buildings: impact on students' cognitive health. Am. J. Men's Health 13 (1), 1557988318816914.
Michelozzi, P., Ancona, C., Fusco, D., Forastiere, F., Perucci, C.A., 1998. Risk of leukemia and residence near a radio transmitter in Italy. Epidemiology 9 (4), S111.
Michelozzi, P., Capon, A., Kirchmayer, U., Forastiere, F., Biggeri, A., Barca, A., Perucci, C.A., 2002. Adult and childhood leukemia near a high-power radio station in Rome, Italy. Am. J. Epidemiol. 155 (12), 1096–1103.
Milham Jr., S., 1988. Increased mortality in amateur radio operators due to lymphatic and hematopoietic malignancies. Am. J. Epidemiol. 127 (1), 50–54.
Mortazavi, S.M.J., 2014. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. J. Biomed. Phys. Eng. 4 (1).
Mortazavi, S.M.J., 2017. RE:"Modeled and perceived exposure to radiofrequency electromagnetic fields from mobile-phone base stations and the development of symptoms over time in a general population cohort". Am. J. Epidemiol. 186 (10), 1217, 1217.
National Academies of Sciences, 2020. Engineering, and medicine. An assessment of illness in US government employees and their families at overseas embassies. https://doi.org/10.17226/25889.
Navarro, E.A., Segura, J., Portolés, M., Gómez-Perretta de Mateo, C., 2003. The microwave syndrome: a preliminary study in Spain. Electromagn. Biol. Med. 22 (2–3), 161–169.
Neitzke, H.P., Osterhoff, J., Peklo, K., Voigt, H., 2007. Determination of exposure due to mobile phone base stations in an epidemiological study. Radiat. Protect. Dosim. 124 (1), 35–39.
Pachuau, L., Pachuau, Z., 2014. Study of cell tower radiation and its health hazards on human body. IOSR J. Appl. Phys. (IOSR-JAP) 2278–4861.
Pachuau, L., Pachuau, Z., Zothansiama, 2015. Comparisons of non specific health symptoms faced by inhabitants exposed to high and low power density from mobile phone tower radiation. Int. J. Recent Innov. Trends Comput. Commun. 3 (2), 94–98.
Pall, M., 2016. Electromagnetic fields act similarly in plants as in animals: probable activation of calcium channels via their voltage sensor. Curr. Chem. Biol. 10 (1), 74–82.
Panagopoulos, D.J., Karabarbounis, A., Margaritis, L.H., 2002. Mechanism for action of electromagnetic fields on cells. Biochem. Biophys. Res. Commun. 298, 95–102.
Panagopoulos, D.J., Karabarbounis, A., Yakymenko, I., Chrousos, G.P., 2021. Human-made electromagnetic fields: ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage. Int. J. Oncol. 59 (5), 1–16.
Park, S.K., Ha, M., Im, H.J., 2004. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. Int. Arch. Occup. Environ. Health 77 (6), 387–394.
Premlal, P.D., Eldhose, N.V., 2017. Mobile tower radiation-an assessment of radiation level and its health implications in the residential areas of western ghats in idukki, Kerala. Int. J. Appl. Eng. Res. 12 (20), 9548–9554.
Regel, S.J., Negovetic, S., Röösli, M., Berdiñas, V., Schuderer, J., Huss, A., et al., 2006. UMTS base station-like exposure, well-being, and cognitive performance. Environ. Health Perspect. 114 (8), 1270–1275.
Regel, S.J., Tinguely, G., Schuderer, J., Adam, M., Kuster, N., Landolt, H.P., Achermann, P., 2007. Pulsed radio-frequency electromagnetic fields: dose-dependent effects on sleep, the sleep EEG and cognitive performance. J. Sleep Res. 16 (3), 253–258.
Riddervold, I.S., Pedersen, G.F., Andersen, N.T., Pedersen, A.D., Andersen, J.B., Zachariae, R., et al., 2008. Cognitive function and symptoms in adults and adolescents in relation to rf radiation from UMTS base stations. Bioelectromagnetics: J. Bioelectromag. Soc., Soc. Phys. Regul. Biol. Med., European Bioelectromag. Assoc. 29 (4), 257–267.
Rodrigues, N.C.P., Dode, A.C., Andrade, M.K.D.N., O'Dwyer, G., Monteiro, D.L.M., Reis, I.N.C., et al., 2021. The effect of continuous low-intensity exposure to electromagnetic fields from radio base stations to cancer mortality in Brazil. Int. J. Environ. Res. Publ. Health 18 (3), 1229.
Röösli, M., Huss, A., 2008. Mobile phone base station exposure and symptoms. Environ. Health Perspect. 116 (2), A62–A63.
Röösli, M., Frei, P., Mohler, E., Hug, K., 2010. Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations. Bull. World Health Organ. 88, 887–896.
Santini, R., Santini, P., Danze, J.M., Le Ruz, P., Seigne, M., 2002. Enquête sur la santé de riverains de stations relais de téléphonie mobile: I/Incidences de la distance et du sexe. Pathol. Biol. 50 (6), 369–373.
Santini, R., Santini, P., Le Ruz, P., Danze, J.M., Seigne, M., 2003a. Survey study of people living in the vicinity of cellular phone base stations. Electromagn. Biol. Med. 22 (1), 41–49.
Santini, R., Santini, P., Danze, J.M., Le Ruz, P., Seigne, M., 2003b. Symptoms experienced by people in vicinity of base stations: II/Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors. Pathol. Biol. 51 (7), 412–415.
Satta, G., Mascia, N., Serra, T., Salis, A., Saba, L., Sanna, S., et al., 2018. Estimates of environmental exposure to radiofrequency electromagnetic fields and risk of lymphoma subtypes. Radiat. Res. 189 (5), 541–547.
Schmiedel, S., Brüggemeyer, H., Philipp, J., Wendler, J., Merzenich, H., Schüz, J., 2009. An evaluation of exposure metrics in an epidemiologic study on radio and television broadcast transmitters and the risk of childhood leukemia. Bioelectromagnetics 30 (2), 81–91.
Shinjyo, T., Shinjyo, A., 2014. Significant decrease of clinical symptoms after mobile phone base station removal–an intervention study. Umwelt medizin gesellschaft (Environ. Med. Company) 27, 294–301.
Schoeni, A., Roser, K., Bürgi, A., Röösli, M., 2016. Symptoms in Swiss adolescents in relation to exposure from fixed site transmitters: a prospective cohort study. Environ. Health 15 (1), 1–8.
Seitz, H., Stinner, D., Eikmann, T., Herr, C., Röösli, M., 2005. Electromagnetic hypersensitivity (EHS) and subjective health complaints associated with

electromagnetic fields of mobile phone communication—a literature review published between 2000 and 2004. Sci. Total Environ. 349 (1–3), 45–55.
Singh, M.M., Pati, A.K., 2016. Effects of radiation emanating from base transceiver station and mobile phone on sleep, circadian rhythm and cognition in humans–a review. Biol. Rhythm. Res. 47 (3), 353–388.
Singh, K., Nagaraj, A., Yousuf, A., Ganta, S., Pareek, S., Vishnani, P., 2016. Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. J. Int. Soc. Prev. Community Dent. 6 (1), 54.
Smith-Roe, S.L., Wyde, M.E., Stout, M.D., Winters, J.W., Hobbs, C.A., Shepard, K.G., Witt, K.L., 2020. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ. Mol. Mutagen. 61 (2), 276–290.
Starkey, S.J., 2016. Inaccurate official assessment of radiofrequency safety by the advisory group on non-ionising radiation. Rev. Environ. Health 31 (4), 493–503.
Stewart, A., Rao, J.N., Middleton, J.D., Pearmain, P., Evans, T., 2012. Mobile telecommunications and health: report of an investigation into an alleged cancer cluster in Sandwell, West Midlands. Perspect. Public Health 132 (6), 299–304.
Swanson, R.L., Hampton, S., Green-McKenzie, J., Diaz-Arrastia, R., Grady, M.S., Verma, R., et al., 2018. Neurological manifestations among US government personnel reporting directional audible and sensory phenomena in Havana, Cuba. JAMA 319 (11), 1125–1133.
Szmigielski, S., Sobiczewska, E., Kubacki, R., 2001. Carcinogenic potency of microwave radiation: overview of the problem and results of epidemiological studies on Polish military personnel. Eur. J. Oncol. 6, 193–200.
Taheri, M., Roshanaei, G., Ghaffari, J., Rahimnejad, S., Khosroshahi, B.N., Aliabadi, M., Eftekharian, M.M., 2017. The effect of Base Transceiver Station waves on some immunological and hematological factors in exposed persons. Hum. Antibodies 25 (1–2), 31–37.
Urbinello, D., Joseph, W., Huss, A., Verloock, L., Beekhuizen, J., Vermeulen, R., et al., 2014. Radio-frequency electromagnetic field (RF-EMF) exposure levels in different European outdoor urban environments in comparison with regulatory limits. Environ. Int. 68, 49–54.
Viel, J.F., Clerc, S., Barrera, C., Rymzhanova, R., Moissonnier, M., Hours, M., Cardis, E., 2009. Residential exposure to radiofrequency fields from mobile phone base stations, and broadcast transmitters: a population-based survey with personal meter. Occup. Environ. Med. 66 (8), 550–556.
Vijay, S., Choudhary, M.P., 2017. Study on health effects of mobile tower radiation on human beings. Int. Res. J. Eng. Technol 4 (11), 1548–1552.
Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., Balmori, A., 2016. Radiofrequency radiation injures trees around mobile phone base stations. Sci. Total Environ. 572, 554–569.
Wang, J., Su, H., Xie, W., Yu, S., 2017. Mobile phone use and the risk of headache: a systematic review and meta-analysis of cross-sectional studies. Sci. Rep. 7 (1), 1–7.
Wallace, D., Eltiti, S., Ridgewell, A., Garner, K., Russo, R., Sepulveda, F., et al., 2010. Do TETRA (Airwave) base station signals have a short-term impact on health and well-being? A randomized double-blind provocation study. Environ. Health Perspect. 118 (6), 735–741.
World Health Organization (WHO), 2015. International EMF Project – Progress Report. https://cdn.who.int/media/docs/default-source/radiation-international-emf-project-reports/emf-iac-2016-progress-report.pdf?sfvrsn=7b2836c0_2.
Wiedemann, P.M., Thalmann, A.T., Grutsch, M.A., Schütz, H., 2006. The impacts of precautionary measures and the disclosure of scientific uncertainty on EMF risk perception and trust. J. Risk Res. 9 (4), 361–372.
Wolf, R., Wolf, D., 2004. Increased incidence of cancer near a cell-phone transmitter station. Int. J. Cancer Prev. 1 (2), 123–128.
Yakymenko, I., Sidorik, E., Kyrylenko, S., Chekhun, V., 2011. Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems. Exp. Oncol. 33, 62–70.
Yetiş, C., Kayili, M.T., 2021. Determination of EMF pollution in the context of urban health: the case of safranbolu. Comput. Res. Prog. Appl. Sci. Eng.: Transact. Civil Environ. Eng. 7, 1–10, 2021 Article ID: 2418.
Yildirim, M.S., Yildirim, A., Zamani, A.G., Okudan, N., 2010. Effect of mobile phone station on micronucleus frequency and chromosomal aberrations in human blood cells. Genet. Counsel. 21 (2), 243.
Zinelis, S.A., 2010. The precautionary principle: radiofrequency exposures from mobile telephones and base stations. Environ. Health Perspect. 118 (1), A16. A16.
Zothansiama, Zosangzuali, M., Lalramdinpuii, M., Jagetia, G.C., 2017. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn. Biol. Med. 36 (3), 295–305.
Zwamborn, A.P.M., Vossen, S.H.J.A., van Leersum, B.J.A.M., Ouwens, M.A., Mäkel, W. N., 2003. Effects of Global Communication System Radio-Frequency Fields on Well Being and Cognitive Functions of Human Subjects with and without Subjective Complaints.

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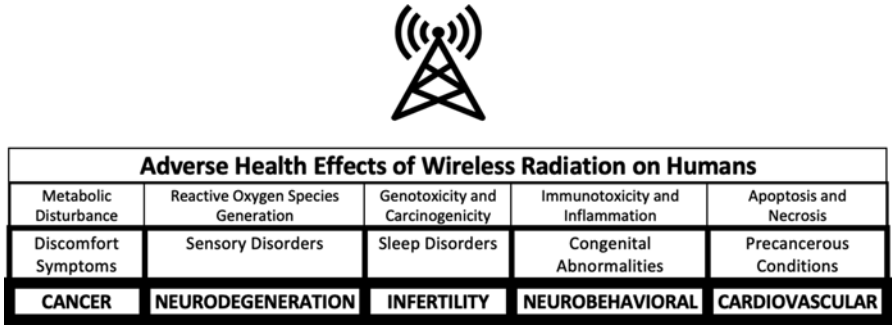
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Adverse health effects of 5G mobile networking technology under real-life conditions

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GRAPHICAL ABSTRACT



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ABSTRACT

This article identifies adverse effects of non-ionizing non-visible radiation (hereafter called wireless radiation) reported in the premier biomedical literature. It emphasizes that most of the laboratory experiments conducted to date are not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate. Many experiments do not include pulsing and modulation of the carrier signal. The vast majority do not account for synergistic adverse effects of other toxic stimuli (such as chemical and biological) acting in concert with the wireless radiation. This article also presents evidence that the nascent 5G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have adverse systemic effects as well.

1. Introduction

Wireless communications have been expanding globally at an exponential rate. The latest imbedded version of mobile networking technology is called 4G (fourth generation), and the next version (called 5G- fifth generation) is in the early implementation stage. Neither 4G

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nor 5G have been tested for safety in credible real-life scenarios. Alarmingly, many of the studies conducted in more benign environments show harmful effects from this radiation. The present article overviews the medical and biological studies that have been performed to date relative to effects from wireless radiation, and shows why these studies are deficient relative to safety. However, even in the absence of the missing real-life components such as toxic chemicals and biotoxins (which tend to exacerbate the adverse effects of the wireless radiation), the literature shows there is much valid reason for concern about potential adverse health effects from both 4G and 5G technology. The studies on wireless radiation health effects reported in the literature should be viewed as extremely conservative, substantially underestimating the adverse impacts of this new technology.

2. Wireless radiation/electromagnetic spectrum

This section overviews the electromagnetic spectrum, and delineates the parts of the spectrum on which this article will focus. The electromagnetic spectrum encompasses the entire span of electromagnetic radiation, including:

- ionizing radiation (gamma rays, x-rays, and the extreme ultraviolet, with wavelengths below $\sim 10^{-7}$ m and frequencies above $\sim 3 \times 10^{15}$ Hz);
- non-ionizing visible radiation (wavelengths from $\sim 4 \times 10^{-7}$ m to $\sim 7 \times 10^{-7}$ m and frequencies between $\sim 4.2 \times 10^{14}$ Hz and $\sim 7.7 \times 10^{14}$ Hz);
- non-ionizing non-visible radiation

short wavelength radio waves and microwaves, with wavelengths between $\sim 10^{-3}$ m and $\sim 10^{5}$ m and frequencies between $\sim 3 \times 10^{11}$ to $\sim 3 \times 10^{3}$ Hz;

long wavelengths, ranging between $\sim 10^{5}$ m and $\sim 10^{8}$ m and frequencies ranging between 3×10^{3} and 3 Hz.

How are these frequencies used in practice?

- The low frequencies (3 Hz – 300 KHz) are used for electrical power line transmission (60 Hz in the U.S.) as well as maritime and submarine navigation and communications.
- Medium frequencies (300 KHz–900 MHz) are used for AM/FM/TV broadcasts in North America.
- Lower microwave frequencies (900 MHz – 5 GHz) are used for telecommunications such as microwave devices/communications, radio astronomy, mobile/cell phones, and wireless LANs.
- Higher microwave frequencies (5 GHz – 300 GHz) are used for radar and proposed for microwave WiFi, and will be used for high-performance 5 G.
- Terahertz frequencies (300 GHz – 3000 GHz) are used increasingly for imaging to supplement X-rays in some medical and security scanning applications (Kostoff and Lau, 2017).

In the present study of wireless radiation health effects, the frequency spectrum ranging from 3 Hz to 300 GHz is covered, with particular emphasis on the high frequency communications component ranging from ~1 GHz to ~300 GHz. Why was this part of the spectrum selected? Previous reviews of wireless radiation health effects found that pulsed electromagnetic fields (PEMF) applied for relatively short periods of time could sometimes be used for therapeutic purposes, whereas chronic exposure to electromagnetic fields (EMF) in the power frequency range (~60 Hz) and microwave frequency range (~1 GHz-tens GHz) tended to result in detrimental health effects (Kostoff and Lau, 2013, 2017). Given present concerns about the rapid expansion of 5G communications systems (which are projected to use mainly the higher microwave frequencies part of the spectrum in the highest performance (aka high-band) mode) in the absence of adequate and rigorous safety testing, more emphasis will be placed on the communications frequencies in this document.

3. Modern wireless radiation exposures

In ancient times, sunlight and its lunar reflections provided the bulk of the visible spectrum for human beings (with fire a distant second and lightning a more distant third). Now, many varieties of artificial light (incandescent, fluorescent, and light emitting diode) have replaced the sun as the main supplier of visible radiation during waking hours. Additionally, EMF radiations from other parts of the non-ionizing non-visible spectrum have become ubiquitous in daily life, such as from wireless computing and telecommunications. In the last two or three decades, the explosive growth in the cellular telephone industry has placed many residences in metropolitan areas within less than a mile of a cell tower. Future implementation of the next generation of mobile networking technology, 5 G, will increase the cell tower densities by an order of magnitude. Health concerns have been raised about wireless radiation from (1) mobile communication devices, (2) occupational exposure, (3) residential exposure, (4) wireless networks in homes, businesses, and schools, (5) automotive radar, and (6) other non-ionizing EMF radiation sources, such as 'smart meters' and 'Internet of Things'.

4. Demonstrated biological and health effects from prior generations of wireless networking technology

There have been two major types of studies performed to ascertain biological and health effects of wireless radiation: laboratory and epidemiology. The laboratory tests performed provided the best scientific understanding of the effects of wireless radiation, but did not reflect the real-life environment in which wireless radiation systems operate (exposure to toxic chemicals, biotoxins, other forms of toxic radiation, etc). There are three main reasons the laboratory tests failed to reflect real-life exposure conditions for human beings.

First, the laboratory tests have been performed mainly on animals, especially rats and mice. Because of physiological differences between small animals and human beings, there have been continual concerns about extrapolating small animal results to human beings. Additionally, while inhaled or ingested substances can be scaled from laboratory experiments on small animals to human beings relatively straight-forwardly, radiation may be more problematic. For non-ionizing radiation, penetration depth is a function of frequency, tissue, and other parameters. Radiation could penetrate much deeper into a small animal's interior than similar wavelength radiation in humans, because of the much smaller animal size. Different organs and tissues would be affected, with different levels of power density.

Second, the typical incoming EMF signal for many/most laboratory tests performed in the past consisted of single carrier wave frequency; the lower frequency superimposed signal containing the information was not always included. This omission may be important. As Panagopoulos states: "It is important to note that except for the RF/microwave carrier frequency, Extremely Low Frequencies - ELFs (0–3000 Hz) are always present in all telecommunication EMFs in the form of pulsing and modulation. There is significant evidence indicating that the effects of telecommunication EMFs on living organisms are mainly due to the included ELFs…. While ~50 % of the studies employing simulated exposures do not find any effects, studies employing real-life exposures from commercially available devices display an almost 100 % consistency in showing adverse effects" (Panagopoulos, 2019). These effects may be exacerbated further with 5 G: "with every new generation of telecommunication devices…..the amount of information transmitted each moment…..is increased, resulting in higher variability and complexity of the signals with the living cells/ organisms even more unable to adapt" (Panogopoulos, 2019).

Third, these laboratory experiments typically involved one stressor

(toxic stimulus) and were performed under pristine conditions. This contradicts real-life exposures, where humans are exposed to multiple toxic stimuli, in parallel or over time (Tsatsakis et al., 2016, 2017; Docea et al., 2019a). In perhaps five percent of the cases reported in the wireless radiation literature, a second stressor (mainly a biological or chemical toxic stimulus) was added to the wireless radiation stressor, to ascertain whether additive, synergistic, potentiative, or antagonistic effects were generated by the combination (Kostoff and Lau, 2013, 2017; Juutilainen, 2008; Juutilainen et al., 2006).

Combination experiments are extremely important because, when other toxic stimuli are considered in combination either with each other or with wireless radiation, the synergies tend to enhance the adverse effects of each stimulus in isolation. This was shown in several studies that evaluated the cumulative effects of chronic exposure to low doses of xenobiotics in combination (Kostoff et al., 2018; Docea et al., 2018; Tsatsakis et al., 2019a; Docea et al., 2019b; Tsatsakis et al., 2019b, c; Fountoucidou et al., 2019). For those combinations that include wireless radiation, combined exposure to toxic stimuli and wireless radiation translates into much lower levels of tolerance for each toxic stimulus in the combination relative to its exposure levels that produce adverse effects in isolation. Accordingly, the exposure limits for wireless radiation when examined in combination with other potentially toxic stimuli would be far lower for safety purposes than those derived from wireless radiation exposures in isolation.

Thus, almost all of the wireless radiation laboratory experiments that have been performed to date are flawed/limited with respect to showing the full adverse impact of the wireless radiation that would be expected under real-life conditions. Either 1) non-inclusion of signal information or 2) using single stressors only tends to underestimate the seriousness of the adverse effects from wireless radiation. Excluding ***both*** of these phenomena from experiments, as was done in the vast majority of the reported wireless radiation health effects studies, tends to amplify this underestimation substantially. Thus, the results reported in the biomedical literature should be viewed as 1) extremely conservative and 2) the very low 'floor' of the seriousness of the adverse effects from wireless radiation, not the 'ceiling'.

In contrast to the controlled pristine environments that characterize the wireless radiation animal laboratory experiments, the wireless radiation epidemiology studies carried out to date typically involved human beings who had been subjected to myriad known and unknown stressors prior to (and during) the study. The real-life human exposure levels from cell tower studies (reported by Kostoff and Lau (2017)) that showed increased cancer incidence were orders of magnitude lower than those exposure levels generated in the recent highly-funded National Toxicology Program animal laboratory studies (Melnick, 2019). We believe the inclusion of real-world effects in the cell tower studies accounted for the orders of magnitude exposure level decreases that were associated with the increased cancer incidence. The laboratory tests were conducted under controlled conditions not reflective of real-life, while the epidemiology studies were performed in the presence of many stressors, known and unknown, reflective of real-life. The myriad toxic stimuli exposure levels of the epidemiology studies were, for the most part, uncontrolled.

A vast literature published over the past sixty years shows adverse effects from wireless radiation applied in isolation or as part of a combination with other toxic stimuli. Extensive reviews of wireless radiation-induced biological and health effects have been published (Kostoff and Lau, 2013, 2017; Belpomme et al., 2018; Desai et al., 2009; Di Ciaula, 2018; Doyon and Johansson, 2017; Havas, 2017; Kaplan et al., 2016; Lerchl et al., 2015; Levitt and Lai, 2010; Miller et al., 2019; Pall, 2016, 2018; Panagopoulos, 2019; Panagopoulos et al., 2015; Russell, 2018; Sage and Burgio, 2018; van Rongen et al., 2009; Yakymenko et al., 2016; Bioinitiative, 2012). In aggregate, for the high frequency (radiofrequency-RF) part of the spectrum, these reviews show that RF radiation ***below the FCC guidelines*** can result in:

- carcinogenicity (brain tumors/glioma, breast cancer, acoustic neuromas, leukemia, parotid gland tumors),
- genotoxicity (DNA damage, DNA repair inhibition, chromatin structure),
- mutagenicity, teratogenicity,
- neurodegenerative diseases (Alzheimer's Disease, Amyotrophic Lateral Sclerosis),
- neurobehavioral problems, autism, reproductive problems, pregnancy outcomes, excessive reactive oxygen species/oxidative stress, inflammation, apoptosis, blood-brain barrier disruption, pineal gland/melatonin production, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, tinnitus, burning and flushed skin, digestive disturbance, tremor, cardiac irregularities,
- adverse impacts on the neural, circulatory, immune, endocrine, and skeletal systems.

From this perspective, RF is a highly pervasive cause of disease!

The response from industry has been that no mechanism could explain the biological action of non-thermal and non-ionizing EM fields. Yet, reports of clear perturbations of biological systems at levels near or even below 1000 μW/m^2 (Bioinitiaive, 2019) were explained by perturbations in electron and proton transfers supporting ATP production in mitochondria (Sanders et al., 1980; 1985) exposed to RF or ELF signals (Li and Heroux, 2014).

To obtain another perspective on the full spectrum of adverse effects from wireless radiation, a query was run on Medline to retrieve representative records associated with adverse EMF effects (mainly, but not solely, RF). Over 5400 records were retrieved, and the leading Medical Subject Headings (MeSH) extracted. The categories of adverse impacts from both approaches match quite well. The adverse health effects range from myriad feelings of discomfort to life-threatening diseases.

The full list of MeSH Headings associated with this retrieval is shown in Appendix 1 of (Kostoff, 2019). The interested reader can ascertain what other diseases/symptoms were included. The 5400+ references retrieved are shown in Appendix 2 of (Kostoff, 2019).

5. What types of biological and health effects can be expected from 5G wireless networking technology?

The potential 5G adverse effects derive from the intrinsic nature of the radiation, and its interaction with tissue and target structures. 4G networking technology was associated mainly with carrier frequencies in the range of ~1-2.5 GHz (cell phones, WiFi). The wavelength of 1 GHz radiation is 30 cm, and the penetration depth in human tissue is a few centimeters. In its highest performance (high-band) mode, 5G networking technology is mainly associated with carrier frequencies at least an order of magnitude greater than the 4G frequencies, although, as stated previously, "ELFs (0–3000 Hz) are always present in all telecommunication EMFs in the form of pulsing and modulation". Penetration depths for the carrier frequency component of high-band 5G wireless radiation will be on the order of a few millimeters (Alekseev et al., 2008a, b). At these wavelengths, one can expect resonance phenomena with small-scale human structures (Betzalel et al., 2018). Additionally, numerical simulations of millimeter-wave radiation resonances with insects showed a general increase in absorbed RF power at and above 6 GHz, in comparison to the absorbed RF power below 6 GHz. A shift of 10 % of the incident power density to frequencies above 6 GHz was predicted to lead to an ***increase in absorbed power between 3–***370 % (Thielens et al., 2018).

The common 'wisdom' presented in the literature and media is that, if there are adverse impacts resulting from high-band 5 G, the main impacts will be focused on near-surface phenomena, such as skin cancer, cataracts, and other skin conditions. However, there is evidence that biological responses to millimeter-wave irradiation can be initiated

within the skin, and the subsequent systemic signaling in the skin can result in physiological effects on the nervous system, heart, and immune system (Russell, 2018).

Additionally, consider the following reference (Zalyubovskaya, 1977). This is one of many translations of articles produced in the Former Soviet Union on wireless radiation (also, see reviews of Soviet research on this topic by McRee (1979, 1980), Kositsky et al. (2001), and Glaser and Dodge (1976)). On p. 57 of the pdf link, the article by Zalyubovskaya addresses biological effects of millimeter radiowaves. Zalyubovskaya ran experiments using power fluxes of 10,000,000 μW/square meter (the FCC (Federal Communications Commission) guideline limit for the general public today in the USA), and frequencies on the order of 60 GHz. Not only was skin impacted adversely, but also heart, liver, kidney, spleen tissue as well, and blood and bone marrow properties. These results reinforce the conclusion of Russel (quoted above) that ***systemic results may occur from millimeter-wave radiation.*** To re-emphasize, for Zalyubovskaya's experiments, the incoming signal was unmodulated carrier frequency only, and the experiment was single stressor only. Thus, the expected real-world results (when human beings are impacted, the signals are pulsed and modulated, and there is exposure to many toxic stimuli) would be far more serious and would be initiated at lower (perhaps much lower) wireless radiation power fluxes.

The Zalyubovskaya paper was published in 1977. The referenced version was classified in 1977 by USA authorities and declassified in 2012. What national security concerns caused it (and the other papers in the linked pdf reference) to be classified for 35 years, until declassification in 2012? Other papers on this topic with similar findings were published in the USSR (and the USA) at that time, or even earlier, but many never saw the light of day, both in the USSR and the USA. It appears that the potentially damaging effects of millimeter-wave radiation on the skin (and other major systems in the body) have been recognized for well over forty years, yet today's discourse only revolves around the possibility of modest potential effects on the skin and perhaps cataracts from millimeter-wave wireless radiation.

6. What is the consensus on adverse effects from wireless radiation?

Not all studies of wireless radiation have shown adverse effects. For example, consider potential genotoxic effects of mobile phone radiation. A study investigating "the effect of mobile phone use on genomic instability of the human oral cavity's mucosa cells" concluded "Mobile phone use did not lead to a significantly increased frequency of micronuclei" (Hintzsche and Stopper, 2010).

Conversely, a 2017 study investigated buccal cell preparations for genomic instability, and found "The frequency of micronuclei (13.66x), nuclear buds (2.57x), basal (1.34x), karyorrhectic (1.26x), karyolytic (2.44x), pyknotic (1.77x) and condensed chromatin (2.08x) cells were highly significantly ($p = 0.000$) increased in mobile phone users" (Gandhi et al., 2017). Also, a 2017 study to ascertain the "effect of cell phone emitted radiations on the orofacial structures" concluded that "Cell phone emitted radiation causes nuclear abnormalities of the oral mucosal cells" (Mishra et al., 2017). Further, a 2016 study to "explore the effects of mobile phone radiation on the MN frequency in oral mucosal cells" concluded "The number of micronucleated cells/1000 exfoliated buccal mucosal cells was found to be significantly increased in high mobile phone users group than the low mobile phone users group" (Banerjee et al., 2016). Finally, a study aimed at investigating the health effects of WiFi exposure concluded "long term exposure to WiFi may lead to adverse effects such as neurodegenerative diseases as observed by a ***significant alteration on AChE gene expression*** and some neurobehavioral parameters associated with brain damage" (Obajuluwa et al., 2017).

There are many possible reasons to explain this lack of consensus.

1) There may be 'windows' in parameter space where adverse effects occur, and operation outside these windows would show a) no effects or b) hormetic effects or c) therapeutic effects. For example, if information content of the signal is a strong contributor to adverse health effects (Panagopoulus, 2019), then experiments that involve only the carrier frequencies may be outside the window where adverse health effects occur. Alternatively, in this specific example, the carrier signal and the information signal could be viewed as a combination of potentially toxic stimuli, where the adverse effects of each component are enabled because of the synergistic effects of the combination.

As another example, an adverse health impact on one strain of rodent was shown for a combination of 50 Hz EMF and DMBA, while no adverse health impact was shown on another rodent strain for the same toxic stimuli combination (Fedrowitz et al., 2004). From a higher-order combination perspective, if genetic abnormalities/differences are viewed conceptually as potentially equivalent to a toxic stimulus for combination purposes, then a synergistic three-constituent combination of 50 Hz EMF, DMBA, and genetics was required to produce adverse health impacts in the above experiment. If these results can be extrapolated across species, then human beings could exhibit different responses to the same electromagnetic stimuli based on their unique genetic predispositions (Caccamo et al., 2013; De Luca et al., 2014).

1) Research quality could be poor, and adverse effects were overlooked.
2) Or, the research team could have had a preconceived agenda, where finding no adverse effects from wireless radiation was **THE** objective of the study. For example, studies have shown that industry-funded research of wireless radiation adverse health effects is far more likely to show no effects than funding from non-industry sources (Huss et al., 2007; Slesin, 2006; Carpenter, 2019). Studies in disciplines other than wireless radiation have shown that, for products of high military, commercial, and political sensitivity, 'researchers'/organizations are hired to publish articles that conflict with the credible science, and therefore create doubt as to whether the product of interest is harmful (Michaels, 2008; Oreskes and Conway, 2011). Unfortunately, given the strong dependence of the civilian and military economies on wireless radiation, incentives for identifying adverse health effects from wireless radiation are minimal and disincentives are many. These perverse incentives apply not only to the sponsors of research and development, but to the performers as well.

Even the Gold Standard for research credibility - **independent replication of research results** - is questionable in politically, commercially, and militarily sensitive areas like wireless radiation safety, where the accelerated implementation goals of most wireless radiation research sponsors (government and industry) are aligned. It is imperative that highly objective evaluators with minimal conflicts of interest play a central role ensuring that rigorous safety standards for wireless radiation systems are met before widescale implementation is allowed.

7. Conclusions

Wireless radiation offers the promise of improved remote sensing, improved communications and data transfer, and improved connectivity. Unfortunately, there is a large body of data from laboratory and epidemiological studies showing that previous and present generations of wireless networking technology have significant adverse health impacts. Much of this data was obtained under conditions not reflective of real-life. When real-life considerations are added, such as 1) including the information content of signals along with 2) the carrier frequencies, and 3) including other toxic stimuli in combination with

the wireless radiation, the adverse effects associated with wireless radiation are increased substantially. Superimposing 5G radiation on an already imbedded toxic wireless radiation environment will exacerbate the adverse health effects shown to exist. Far more research and testing of potential 5G health effects under real-life conditions is required before further rollout can be justified.

Transparency document

The Transparency document associated with this article can be found in the online version.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Alekseev, S.I., Radzievsky, A.A., Logani, M.K., Ziskin, M.C., 2008a. Millimeter wave dosimetry of human skin. Bioelectromagnetics 29 (January (1)), 65–70. https://doi.org/10.1002/bem.20363.

Alekseev, S.I., Gordiienko, O.V., Ziskin, M.C., 2008b. Reflection and penetration depth of millimeter waves in murine skin. Bioelectromagnetics 29 (July (5)), 340–344. https://doi.org/10.1002/bem.20401.

Banerjee, S., Singh, N.N., Sreedhar, G., Mukherjee, S., 2016. Analysis of the genotoxic effects of mobile phone radiation using buccal micronucleus assay: a comparative evaluation. J. Clin. Diagn. Res. 10 (3) ZC82-ZC5.

Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., Carpenter, D.O., 2018. Thermal and non-thermal health effects of low intensity non-ionizing radiation: an international perspective. Environ. Pollut. 242, 643–658.

Betzalel, N., Ben Ishai, P., Feldmann, Y., 2018. The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? Environ. Res. 163, 208–216.

BioInitiative Working Group, Cindy Sage, David O. Carpenter, BioInitiative Report: A Rationale for Biologically-Based Public Exposure Standards for Electromagnetic Radiation at 2012; www.bioinitiative.org December 31, 2012, last updated 2019.

Caccamo, D., Cesareo, E., Mariani, S., Raskovic, D., Lentile, R., Currò, M., Korkina, L., De Luca, C., 2013. Xenobiotic sensor- and metabolism-related gene variants in environmental sensitivity-related illnesses: a survey on the Italian population. Oxid. Med. Cell. Longev. 2013https://doi.org/10.1155/2013/831969. Article ID 831969.

Carpenter, D.O., 2019. Extremely low frequency electromagnetic fields and cancer: how source of funding affects results. Environ. Res. 178, 108688. https://doi.org/10.1016/j.envres.2019.108688.

De Luca, C., Thai, J.C., Raskovic, D., Cesareo, E., Caccamo, D., Trukhanov, A., Korkina, L., 2014. Metabolic and genetic screening of electromagnetic hypersensitive subjects as a feasible tool for diagnostics and intervention. Mediators Inflamm. 2014, 924184. https://doi.org/10.1155/2014/924184. Epub 2014 Apr 9.

Desai, N.R., Kesari, K.K., Agarwal, A., 2009. Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. Reprod. Biol. Endocrinol. 7.

Di Ciaula, A., 2018. Towards 5G communication systems: are there health implications? Int. J. Hyg. Environ. Health 221 (3), 367–375.

Docea, A.O., Gofita, E., Goumenou, M., Calina, D., Rogoveanu, O., Varut, M., Olaru, C., Kerasioti, E., Fountoucidou, P., Taitzoglou, I., Zlatian, O., Rakitskii, V.N., Hernandez, A.F., Kouretas, D., Tsatsakis, A., 2018. Six months exposure to a real life mixture of 13 chemicals' below individual NOAELs induced non monotonic sex-dependent biochemical and redox status changes in rats. Food Chem. Toxicol. 115, 470–481 doi: 10.1016/j.fct.2018.03.052.

Docea, A.O., Calina, D., Goumenou, M., Neagu, M., Gofita, Tsatsakis, A., 2019a. Study design for the determination of toxicity from long-term-low-dose exposure to complex mixtures of pesticides, food additives and lifestyle products. Toxicol. Lett. 258https://doi.org/10.1016/j.toxlet.2016.06.1666. S179-S179.

Docea, A.O., Goumenou, M., Calina, D., Arsene, A.L., Dragoi, C.M., Gofita, E., Pisoschi, C.G., Zlatian, O., Stivaktakis, P.D., Nikolouzakis, T.K., Kalogeraki, A., Izotov, B.N., Galateanu, B., Hudita, A., Calabrese, E.J., Tsatsakis, A., 2019b. Adverse and hormetic effects in rats exposed for 12 months to low dose mixture of 13 chemicals: RLRS part III. Toxicol. Lett. 310, 70–91. https://doi.org/10.1016/j.toxlet.2019b.04.005.

Doyon, P.R., Johansson, O., 2017. Electromagnetic fields may act via calcineurin inhibition to suppress immunity, thereby increasing risk for opportunistic infection: conceivable mechanisms of action. Med. Hypotheses 106, 71–87.

Fedrowitz, M., Kamino, K., Loscher, W., 2004. Significant differences in the effects of magnetic field exposure on 7,12-dimethylbenz(a)anthracene-induced mammary carcinogenesis in two substrains of Sprague-Dawley rats. Cancer Res. 64 (1), 243–251.

Fountoucidou, P., Veskoukis, A.S., Kerasioti, E., Docea, A.O., Taitzoglou, I.A., Liesivuori, J., Tsatsakis, A., 2019. Kouretas DA mixture of routinely encountered xenobiotics induces both redox adaptations and perturbations in blood and tissues of rats after a long-term low-dose exposure regimen: the time and dose issue. Toxicol. Lett. 317, 24–44. https://doi.org/10.1016/j.toxlet.2019.09.015.

Gandhi, G., Singh, P., Kaur, G., 2017. Perspectives revisited - the buccal cytome assay in mobile phone users. Int. J. Hum. Genet. 15 (4), 173–182.

Glaser, R., Dodge, C.H., 1976. Biomedical Aspects of Radiofrequency Radiation: A Review of Selected Soviet, East European, and Western References. Selected Papers of the USNC/ URSI AnnunI Meeting (Boulder, CO. 1975). HEW Publication (FDA) 77-8010/ 8011, pp. 2–34 Dec.

Havas, M., 2017. When theory and observation collide: can non-ionizing radiation cause cancer? Environ. Pollut. 221, 501–505.

Hintzsche, H., Stopper, H., 2010. Micronucleus frequency in buccal mucosa cells of mobile phone users. Toxicol. Lett. 193 (1), 124–130.

Huss, A., Egger, M., Hug, K., Huwiler-Müntener, K., Röösli, M., 2007. Source of funding and results of studies of health effects of mobile phone use: systematic review of experimental studies. Environ. Health Perspect. 115 (1), 1–4.

Juutilainen, J., 2008. Do electromagnetic fields enhance the effects of environmental carcinogens? Radiat. Prot. Dosimetry 132 (2), 228–231.

Juutilainen, J., Kumlin, T., Naarala, J., 2006. Do extremely low frequency magnetic fields enhance the effects of environmental carcinogens? A meta-analysis of experimental studies. Int. J. Radiat. Biol. 82 (1), 1–12.

Kaplan, S., Deniz, O.G., Onger, M.E., Turkmen, A.P., Yurt, K.K., Aydin, I., et al., 2016. Electromagnetic field and brain development. J. Chem. Neuroanat. 75, 52–61.

Kositsky, N.N., Nizhelska, A.I., Ponezh, G.V., 2001. Influence of high-frequency electromagnetic radiation at non-thermal intensities on the human body (a review of work by Russian and Ukrainian researchers). No Place to Hide- Newsletter of the Cellular Phone Taskforce Inc. 3 (Supplement (1)).

Kostoff, R.N., 2019. Adverse Effects of Wireless Radiation. PDF. http://hdl.handle.net/1853/61946.

Kostoff, R.N., Lau, C.G.Y., 2013. Combined biological and health effects of electromagnetic fields and other agents in the published literature. Technol. Forecast. Soc. Change 80 (7), 1331–1349.

Kostoff, R.N., Lau, C.G.Y., 2017. Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature. In: Geddes, C.D. (Ed.), Microwave Effects on DNA and Proteins. Springer International Publishing AG. https://doi.org/10.1007/978-3-319-50289-2_4.

Kostoff, R.N., Goumenou, M., Tsatsakis, A., 2018. The role of toxic stimuli combinations in determining safe exposure limits. Toxicol. Rep. 5, 1169–1172. https://doi.org/10.1016/j.toxrep.2018.10.010. eCollection 2018.

Lerchl, A., Klose, M., Grote, K., Wilhelm, A.F.X., Spathmann, O., Fiedler, T., et al., 2015. Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem. Biophys. Res. Commun. 459 (4), 585–590.

Levitt, B.B., Lai, H., 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ. Rev. 18, 369–395.

Li, Y., Héroux, P., 2014. Extra-Low-Frequency magnetic fields alter cancer cells through metabolic restriction. Electromagn. Biol. Med. 33 (4), 264–275. https://doi.org/10.3109/15368378.2013.817334.

McRee, D.I., 1979. Review of Soviet Eastern-European research on health-aspects of microwave-radiation. Bull. N. Y. Acad. Med. 55 (11), 1133–1151.

McRee, D.I., 1980. Soviet and Eastern-European research on biological effects of microwave-radiation. Proc. IEEE 68 (1), 84–91. https://doi.org/10.1109/PROC.1980.11586. Also. https://www.avaate.org/IMG/pdf/mcree80_rev_soviet.pdf.

Melnick, R.L., 2019. Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ. Res. 168, 1–6. https://doi.org/10.1016/j.envres.2018.09.010.

Michaels, D., 2008. Doubt Is Their Product: How Industry's Assault on Science Threatens Your Health, 1st edition. Oxford University Press, Oxford, United Kingdom.

Miller, A.B., Sears, M.E., Morgan, L.L., Davis, D.L., Hardell, L., Oremus, M., et al., 2019. Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. Front. Public Health 7, 223. https://doi.org/10.3389/fpubh.2019.00223.

Mishra, S.K., Chowdhary, R., Kumari, S., Rao, S.B., 2017. Effect of cell phone radiations on orofacial structures: a systematic review. J. Clin. Diagn. Res. 11 (5), 5.

Obajuluwa, A.O., Akinyemi, A.J., Afolabi, O.B., Adekoya, K., Sanya, J.O., Ishola, A.O., 2017. Exposure to radio-frequency electromagnetic waves alters acetylcholinesterase gene expression, exploratory and motor coordination-linked behaviour in male rats. Toxicol. Rep. 4, 530–534.

Oreskes, N., Conway, E.M., 2011. Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues From Tobacco Smoke to Global Warming. Bloomsbury Press, New York, NY.

Pall, M.L., 2016. Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. J. Chem. Neuroanat. 75, 43–51.

Pall, M.L., 2018. Wi-Fi is an important threat to human health. Environ. Res. 164, 405–416.

Panagopoulos, D.J., 2019. Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. Mutat. Res. Mutat. Res. 781, 53–62.

Panagopoulos, D.J., Johansson, O., Carlo, G.L., 2015. Real versus simulated mobile phone exposures in experimental studies. Biomed Res. Int. 2015, 607053. https://doi.org/10.1155/2015/607053.

Russell, C.L., 2018. 5 G wireless telecommunications expansion: public health and environmental implications. Environ. Res. 165, 484–495.

Sage, C., Burgio, E., 2018. Electromagnetic fields, pulsed radiofrequency radiation, and epigenetics: how wireless technologies may affect childhood development. Child Dev. 89 (1), 129–136.

Sanders, A.P., Schaefer, D.J., Joines, W.T., 1980. Microwave effects on energy metabolism of rat brain. Bioelectromagnetics 1, 171–181.

Sanders, A.P., Joines, W.T., Allis, J.W., 1985. Effects of continuous-wave, pulsed, and

sinusoidal-amplitude-modulated microwaves on brain energy metabolism. Bioelectromagnetics. 6, 89–97.
Slesin, L., 2006. “Radiation Research” and the Cult of Negative Results. Microwave News 31 July. http://microwavenews.com/RR.html.
Thielens, A., Bell, D., Mortimore, D.B., Greco, M.K., Martens, L., Joseph, W., 2018. Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. Sci. Rep. 8, 3924. https://doi.org/10.1038/s41598-018-22271-3.
Tsatsakis, A.M., Docea, A.O., Tsitsimpikou, C., 2016. New challenges in risk assessment of chemicals when simulating real exposure scenarios; simultaneous multi-chemicals' low dose exposure. Food Chem. Toxicol. 96, 174–176. https://doi.org/10.1016/j.fct.2016.08.011.
Tsatsakis, A.M., Kouretas, D., Tzatzarakis, M.N., Stivaktakis, P., Tsarouhas, K., Golokhvast, K.S., Rakitskii, V.N., Tutelyan, V.A., Hernandez, A.F., Rezaee, R., Chung, G., Fenga, C., Engin, A.B., Neagu, M., Arsene, A.L., Docea, A.O., Gofita, E., Calina, D., Taitzoglou, I., Liesivuori, J., Hayes, A.W., Gutnikov, S., Tsitsimpikou, C., 2017. Simulating real-life exposures to uncover possible risks to human health: a proposed consensus for a novel methodological approach. Hum. Exp. Toxicol. 36 (6), 554–564. https://doi.org/10.1177/0960327116681652.
Tsatsakis, A.M., Docea, A.O., Calina, D., Buga, A.M., Zlatian, O., Gutnikov, S., Kostoff, R.N., Aschner, M., 2019a. Hormetic Neurobehavioral effects of low dose toxic chemical mixtures in real-life risk simulation (RLRS) in rats. Food Chem. Toxicol. 125, 141–149. https://doi.org/10.1016/j.fct.2018.12.043.
Tsatsakis, A., Tyshko, N.V., Docea, A.O., Shestakova, S.I., Sidorova, Y.S., Petrov, N.A., Zlatian, O., Mach, M., Hartung, T., Tutelyan, V.A., 2019b. The effect of chronic vitamin deficiency and long term very low dose exposure to 6 pesticides mixture on neurological outcomes - A real-life risk simulation approach. Toxicol. Lett. 315, 96–106. https://doi.org/10.1016/j.toxlet.2019.07.026.
Tsatsakis, A., Docea, A.O., Constantin, C., Calina, D., Zlatian, O., Nikolouzakis, T.K., Stivaktakis, P.D., Kalogeraki, A., Liesivuori, J., Tzanakakis, G., Neagu, M., 2019c. Genotoxic, cytotoxic, and cytopathological effects in rats exposed for 18 months to a mixture of 13 chemicals in doses below NOAEL levels. Toxicol. Lett. 316, 154–170. https://doi.org/10.1016/j.toxlet.2019.09.004.
van Rongen, E., Croft, R., Juutilainen, J., Lagroye, I., Miyakoshi, J., Saunders, R., et al., 2009. Effects of radiofrequency electromagnetic fields on the human nervous system. J. Toxicol. Environ. Health-Part B-Crit. Rev. 12 (8), 572–597.
Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., Kyrylenko, S., 2016. Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn. Biol. Med. 35 (2), 186–202.
Zalyubovskaya, N.P., 1977. Biological Effects of Millimeter Radiowaves. Vrachebnoye Delo. No. 3. P. 57. https://www.cia.gov/library/readingroom/docs/CIA-RDP88B01125R000300120005-6.pdf.

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NEW YORK CITY



THE NEED FOR ACCOUNTABILITY ON WIRELESS SAFETY

EXPERT VOICES





"The National Toxicology Program studies clearly showed that non-ionizing cell phone radiofrequency radiation radiation can cause cancers and other adverse health effects. An important lesson that should be learned is that we cannot assume any current or future wireless technology such as 5G is safe without adequate testing."
— Ronald Melnick PhD 28 year scientist at National Institutes of Health

"I recommend public health organizations raise awareness and educate the public on why and how to reduce our daily exposure to wireless radio frequency radiation. Protective public health policy is needed now. It is time for regulatory bodies to fully evaluate the research and develop science based exposure limits that truly protect the public and the environment."
— Linda S. Birnbaum, PhD, Former Director, National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health.

"Now we have 5G rolling out in massive quantities, without due diligence to determine are these sources of radiation safe not only for humans but for wildlife. And the answer is, no, they are not."
— Albert M. Manville II, Ph.D. Adjunct Professor, Johns Hopkins University, Wildlife Biologist (17 years), retired from Division of Migratory Bird Management, U.S. Fish & Wildlife Service

"Given the human, animal and experimental evidence, I assert that, to a reasonable degree of scientific certainty, the probability that RF exposure causes gliomas and neuromas is high."
— Christopher Portier PhD former Director of the United States National Center for Environmental Health at the CDC, former Director of the U.S. Agency for Toxic Substances and Disease Registry.

"We should not wait to protect children's brains. The science is now clear and compelling indicating that wireless technology is harmful to health, especially to for children. Wireless radiation is repeating the history of lead, tobacco and DDT."
— Devra Davis PhD, MPH, President of Environmental Health Trust, founding director of the Board on Environmental Studies and Toxicology of the U.S. National Research Council, National Academy of Sciences, and a member of the team of the Intergovernmental Panel on Climate Change scientists who were awarded the Nobel Peace Prize in 2007

THE URGENT NEED FOR SAFER TECHNOLOGY

EXPERT VOICES

"I am calling on my industry to bring safer technology to market. The current implementation of technology is not safe. Take a good look at the science. This is about our children's future. Do not be lulled into believing that 25-year-old standards can protect the youngest and most vulnerable. They simply cannot."
— Frank Clegg, Former President of Microsoft Canada, CEO of Canadians for Safe Technology

"A moratorium is urgently needed on the implementation of 5G for wireless communication."
— Lennart Hardell, MD, PhD , advisory to World Health Organization international Agency for Research on Cancer, Department of Oncology, University Hospital, Örebro, Sweden (retired) , leads the Environment and Cancer Research Foundation

"The evidence indicating wireless is carcinogenic has increased and can no longer be ignored. If the World Health Organization International Agency for Research on Cancer were to meet to review all of the evidence, we believe the weight of evidence supports a new determination- that wireless radiofrequency radiation is a human carcinogen."
— Anthony B. Miller MD, Professor Emeritus, Dalla Lana School of Public Health of the University of Toronto. Former Senior Epidemiologist for the International Agency for Research on Cancer and former Director of the Epidemiology Unit of the National Cancer Institute of Canada

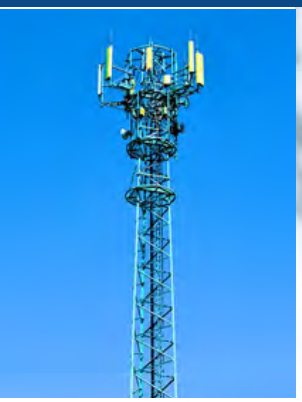
"Most parents believe that cellphones were safety-tested before they came on the market. We assume that our federal health and environmental agencies regularly review the latest research and ensure that these incredible devices are safe. They do not. Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible."
— Jerome Paulson, MD , Professor Emeritus, George Washington University, Milliken School of Public Health, former Chair of American Academy of Pediatrics Committee on Environmental Health

"The exposure levels of the Federal Communications Commission are totally outdated and do not protect the health of the public, especially of children. I urge you to take strong and active steps to reduce exposure of children and staff to excessive levels of radiofrequency EMFS within your schools."
— David O. Carpenter, M.D. Director, Institute for Health and the Environment University at Albany





CHILDREN'S VULNERABILITY TO WIRELESS RADIOFREQUENCY (RF) RADIATION





The American Academy of Pediatrics states:

"In recent years, concern has increased about exposure to radio frequency (RF) electromagnetic radiation emitted from cell phones and phone station antennas. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment."

–American Academy of Pediatrics
HealthyChildren.org

Cell towers and cell phones emit wireless radiofrequency (RF) radiation.

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They have proportionately more exposures to RF compared to adults. More importantly, even very low exposures to children can have serious impacts later in life because their nervous and immune systems are still in development.

Children absorb higher levels of RF radiation deeper into their brains and bodies because they have:

- Thinner skulls allow RF radiation to move easier into the brain.
- Higher water content in brain tissue which is more conductive to electricity.
- Smaller heads result in a shorter distance for the RF to travel from the skull to critical brain regions important for learning and memory.

Children are more sensitive to RF impacts because:

- Their brains are still developing.
- Children have more active stem cells- a type of cell scientifically found to be uniquely impacted by RF.
- Children will have a longer lifetime of higher exposures, starting from before they are born.

CELL TOWER RF RADIATION AND CANCER



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 – The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

The World Health Organization International Agency for Research on Cancer Classified Radiofrequency Radiation as a "Possible" Carcinogen in 2011

In 2011, radiofrequency electromagnetic fields (RF-EMF) were classified as a Group 2B possible carcinogen by the World Health Organization's International Agency for Research on Cancer (WHO/IARC).

The WHO/IARC scientists clarified that this determination was for RF-EMF from any source be it cell phones, wireless devices, cell towers or any other type of wireless equipment.

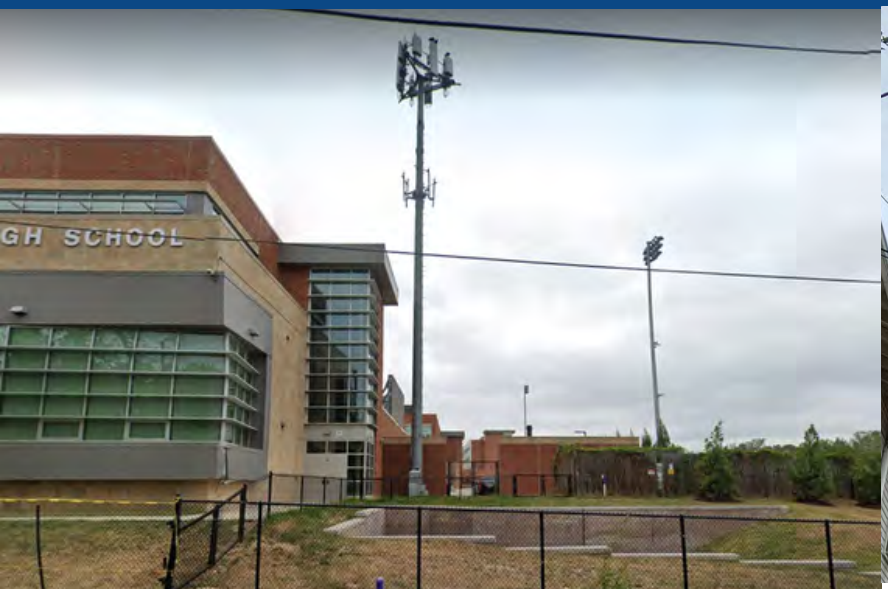
Since 2011, the published peer-reviewed scientific evidence associating RF-EMF (also known as RF-EMR and RFR) to cancer and other adverse effects has significantly increased.

A large-scale animal study published in Environmental Research found rats exposed to RF levels comparable to cell tower emissions had elevated cancers, the very same cancers also found in the US National Toxicology Program animal study of cell phone level RF that found "clear evidence" of cancer in carefully controlled conditions (Falcioni 2018).

In 2019, the WHO/IARC advisory committee recommended that radiofrequency radiation be re-evaluated as a "high" priority in light of the new research. The date of the re-evaluation has not been set.

Currently, several scientists conclude that the weight of currently available, peer-reviewed evidence supports the conclusion that radiofrequency radiation is a proven human carcinogen (Hardell and Carlberg 2017, Peleg et al. 2022, Miller et al. 2018).

PUBLISHED RESEARCH STUDIES





RESEARCHERS RECOMMEND CELL TOWERS BE DISTANCED AWAY FROM HOMES AND SCHOOLS

The review paper entitled "**Limiting liability with positioning to minimize negative health effects of cellular phone towers**" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes, and restricting antennas within 500 meters of schools and hospitals to protect companies from future liability (**Pearce 2020**).

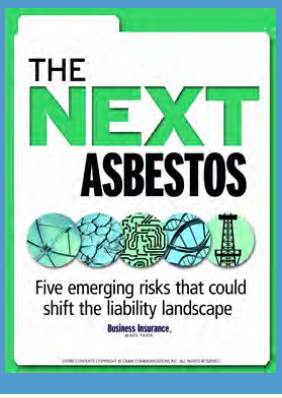
An **analysis** of 100 studies published in *Environmental Reviews* found approximately 80% showed biological effects near towers. "As a general guideline, cell base stations should not be located less than 1500 ft from the population, and at a height of about 150 ft" (**Levitt 2010**).

A **review** published in the *International Journal of Occupational and Environmental Health* found people living less than 500 meters from base station antennas had increased adverse neuro-behavioral symptoms and cancer in eight of the ten epidemiological studies (**Khurana 2010**).

A **paper** by human rights experts published in *Environment Science and Policy* documented the accumulating science indicating safety is not assured, and considered the issue within a human rights framework to protect vulnerable populations from environmental pollution. "We conclude that, because scientific knowledge is incomplete, a precautionary approach is better suited to State obligations under international human rights law" (**Roda and Perry 2014**, **PDF**).

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES SHAREHOLDER WARNINGS



"Some research has shown biological effects from lower -level "non thermal" exposure and people exposed at lower levels have reported headaches, dizziness, nausea, mood disorders, mental slowing and memory loss."
Business Insurance White Paper, The Next Asbestos: Five Emerging Risks That Could Shift the Liability Landscape

Insurance Companies Have Electromagnetic Field Exclusions
Electromagnetic field exclusions" are clear and common in most insurance companies. It is applied as a market standard. This exclusion serves to exclude cover for illnesses caused by long-term EMF (non-ionizing radiation) exposure." — Complete Markets

"Exclusions: This insurance does not apply to: Bodily injury, personal injury, advertising injury, or property damage arising directly or indirectly out of, resulting from, caused or contributed to by electromagnetic radiation, provided that such loss, cost or expense results from or is contributed to by the hazardous properties of electromagnetic radiation.
— Portland Oregon Public School Insurance (page 30)

Insurance Plans Not Only Exclude EMF Damages, But Some Even Exclude Defending Decision Makers From Their Actions in Regards to Their Actions on EMFS

"This policy does not apply to and we will not provide a defense for: a. bodily injury... arising out of ... exposure to or contact with electromagnetic radiation... b. costs of abatement .. of EMF" or c. any supervision, instruction, recommendation, warning or advice given or which should have been given in connection with a or b. above."- City of Ann Arbor Michigan Insurance Policy page 14.

Insurance Authorities Rate 5G as "High Risk."
5G mobile networks are classified as a "high," "off-the-leash" risk. "Existing concerns regarding potential negative health effects from electromagnetic fields (EMF) are only likely to increase. An uptick in liability claims could be a potential long-term consequence" and "[a]s the biological effects of EMF in general and 5G in particular are still being debated, potential claims for health impairments may come with a long latency."
— Swiss Re Institute (2019)

Wireless Companies Rank EMF as a Risk with High Impact
"Electro-magnetic signals emitted by mobile devices and base stations may be found to pose health risks, with potential impacts including: changes to national legislation, a reduction in mobile phone usage or litigation."
— Vodaphone 2017 Report ranks EMF as a "Principal Risk with "High" impact.

Wireless Companies Warn Shareholder About Risk But Not People Living Near Their Wireless Infrastructure

Crown Castle says:
"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

Wireless Companies Define Pollution in Their Own Policies as Including EMFs, Microwaves and Non-ionizing Radiation.

Verizons Total Mobile Protection Plan says: "Pollution" is defined as "any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste."

ENVIRONMENTAL HEALTH TRUST

T-Mobile on 5G: Possible Changes to FCC Human Exposure Limits for RF Could Impact Cash Flow



T-Mobile advertises to the public about going "live" but omits the warnings they give to shareholders regarding 5G, regulatory changes and risk perception.

T-Mobile

T-Mobile 10-K Report 2/2023

"Negative public perception of, and regulations regarding, the perceived health risks relating to 5G networks could undermine market acceptance of our 5G services" (page 13)

"We, along with equipment manufacturers and other carriers, are subject to current and potential future lawsuits **alleging adverse health effects arising from the use of wireless handsets or from wireless transmission equipment such as cell towers."**

"In addition, **the FCC has from time to time gathered data regarding wireless device emissions, and its assessment of the risks associated with using wireless devices may evolve based on its findings.** Any of these allegations or changes in risk assessments could result in customers purchasing fewer devices and wireless services, could result in significant legal and regulatory liability, and could have a material adverse effect on our business, reputation, financial condition, cash flows and operating results." (T- Mobile 10-K Report page 21)


Mobile Telecommunications and Health

Review of the Current Scientific Research in view of Precautionary Health Protection

A 2000 Ecolog Institute Report commissioned by T-Mobile and DeTeMobil Deutsche Telekom MobilNet recommended an exposure limit 1000x lower than the FCC's current power density limit after reviewing the research on biological effects, including impacts to the immune system, central nervous system, hormones, cancer, neurotransmitters and fertility.

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ENVIRONMENTAL HEALTH TRUST

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

Verizon 10-K Report

"Our wireless business also faces personal injury and wrongful death lawsuits relating to alleged health effects of wireless phones or radio frequency transmitters. We may incur significant expenses in defending these lawsuits. In addition, we may be required to pay significant awards or settlements."

Crown Castle 10-K Report

"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

AT&T 10-K Report

"In the wireless area, we also face current and potential litigation relating to alleged adverse health effects on customers or employees who use such technologies including, for example, wireless devices. We may incur significant expenses defending such suits or government charges and may be required to pay amounts or otherwise change our operations in ways that could materially adversely affect our operations or financial results."

T- MOBILE 10-K Report

"Our business could be adversely affected by findings of product liability for health or safety risks from wireless devices and transmission equipment, as well as by changes to regulations or radio frequency emission standards."

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

American Tower 10-K

"If a scientific study or court decision resulted in a finding that radio frequency emissions pose health risks to consumers, it could negatively impact our tenants and the market for wireless services, which could materially and adversely affect our business, results of operations or financial condition. We do not maintain any significant insurance with respect to these matters."

Nokia 10-K

"Although our products are designed to meet all relevant safety standards and other recommendations and regulatory requirements globally, we cannot guarantee we will not become subject to product liability claims or be held liable for such claims, which could have a material adverse effect on us."

Qualcomm 10-K

"If wireless handsets pose health and safety risks, we may be subject to new regulations, and demand for our products and those of our licensees and customers may decrease."

Ericsson Annual Report

"Any perceived risk or new scientific findings of adverse health effects from mobile communication devices and equipment could adversely affect us through a reduction in sales or through liability claims."

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES





When a new cell tower or wireless network is proposed, the first question to ask is: "Do you have insurance for damages from long-term exposure to the radiofrequency radiation (RFR)?" Usually the answer is "No."

An Uninsurable Risk?

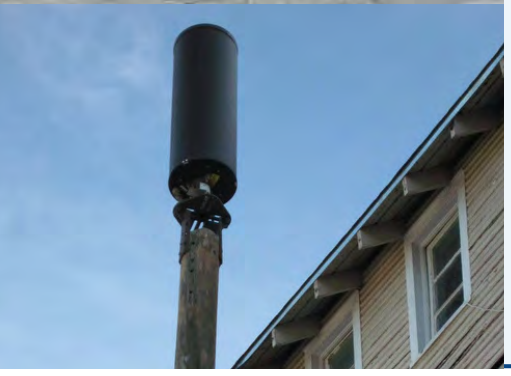
- Insurers rank wireless, cell tower, and 5G RFR non-ionizing electromagnetic field (EMF) radiation as a "high" risk, comparing the issue to lead and asbestos.
- Most insurance plans have "electromagnetic field exclusions" and do not insure for long-term RFR damages.
- Additionally, some insurance plans will not provide a defense for any supervision instruction or recommendation given *"or which should have been given"* in connection to EMFs.
- Wireless RFR and non-ionizing electromagnetic radiation are defined as a type of "pollution" by wireless companies themselves.
- U.S. mobile operators have been unable to get insurance to cover liabilities related to damages from long-term RFR exposure.
- Wireless companies warn their shareholders of RFR risk but do not warn users of their products, nor do the companies warn the people exposed to emissions from their infrastructure.

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ENVIRONMENTAL HEALTH TRUST

APARTMENTS & CONDO BUILDINGS
INCREASED RF RADIATION FROM CELL ANTENNAS





The study "**Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**" published in *Oncology Letters* by **Koppel et al. (2019)** measured 2 apartments and found that the apartment with high RF levels had outdoor areas as close as 6 meters (about 19.6 feet) from transmitting base station cell antennas. In contrast, the apartment with low RF exposure had cell antennas at 40 meters (about 131 feet) away from the balcony.

Furthermore, the researchers also found that both high- and low-RF apartments had good mobile phone reception, and they concluded,"therefore, installation of base stations to risky places cannot be justified using the good reception requirement argument."

A measurement study by **Baltrėnas et al. (2012)** published in *Journal of Environmental Engineering and Landscape Management* investigated RF power density levels from cell phone antennas located 35 meters away from a 10-story apartment building. The transmitting antennas were approximately at the same height as the 6th floor of the building. The researchers found the highest RF levels at floors 5, 6 and 7. The RF at the 6th floor balcony was three times higher than the 3rd floor balcony. The RF power density at the 6th floor was about 15 times the RF measured at the first floor.

A **case report by Hardell et al. (2017)** of RF levels in an apartment in close proximity to rooftop cellular network antennas used an exposimeter to measure levels of different types of RF in the apartment and balconies including TV, FM, TETRA emergency services, 2G GSM, 3G UMTS, 4G LTE, DECT cordless, Wi-Fi 2.4 GHz and 5 GHz and WiMAX. The closest transmitting antennas were 6 meters away from the balcony. The researchers found 97.9% of the mean RF radiation was caused by downlink from the 2G, 3G and 4G base stations. (Downlink means frequencies emitted "down" from the base station cellular antennas.) The researchers found that if the base station RF emissions were excluded, the RF radiation in the children's bedrooms was reduced approximately 99%.

The researchers conclude, "due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults."

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ENVIRONMENTAL HEALTH TRUST

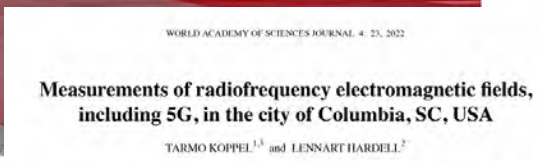
INCREASED EXPOSURE FROM 5G/4G "SMALL" CELL ANTENNAS LOCATED CLOSE TO PEOPLE

A study entitled "**Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**" published in *Environmental Research* by Koppel et al. (2022) created an RF heat map of RF measurements, finding that the highest RF measurements were in areas of close proximity to the base station antennas. The researchers concluded with recommendations to reduce close proximity placements such as positioning antennas "as far as possible from the general public" like in high-elevation locations or more remote areas.

A study entitled "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in the *World Academy of Sciences* Journal found the highest RF levels in areas where the cell phone base station antennas were placed on top of utility poles, street lamps, traffic lights or other posts near to the street. The scientists compared their **2022 findings** to an earlier **2019 published review** on the mean outdoor exposure level of European cities and they found the South Carolina measurements to be higher.

The researchers concluded that the highest exposure areas were due to two reasons: cell phone base antennas on top of high-rise buildings provide "good cell coverage reaching far away, but creating elevated exposure to the radiofrequency electromagnetic fields at the immediate vicinity; and cell phone base station antennas installed on top of utility poles have placed the radiation source closer to humans walking on street level."




WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.

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HEALTH SYMPTOMS REPORTED BY PEOPLE LIVING CLOSE TO CELL ANTENNAS



Image: Figure 1: Top floor apartment adjacent to base stations. Nilsson M, Hardell L. (2023) Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office. Ann Clin Case Rep

RESEARCH ON ANTENNAS CLOSE TO HOMES, SCHOOL AND WORK

Surveys of people living near cell tower antennas in **France**, **Spain**, **Iraq**, **India**, **Germany**, **Egypt**, **Poland** have found significantly higher reports of health issues including sleep issues, fatigue and headaches (See **Santini et al. 2003**, **López 2021**, **Alazawi 2011**, **Pachuau and Pachuaua 2016**, **Eger et al. 2004**, **Abdel-Rassoul et al. 2007**, **Bortkiewicz et al., 2004**).

A **study** published in *American Journal of Men's Health* linked higher cell tower RFR exposures to delayed fine and gross motor skills and to deficits in spatial working memory and attention in school adolescents (**Meo 2018**).

A **study** published in *Environmental Research and Public Health* found higher exposures linked to higher risk of type 2 diabetes (**Meo 2015**).

A study following people for 6 years linked increased cell phone and cell phone tower antenna exposure to altered levels of hormones including cortisol, thyroid, prolactin and testosterone (**Eskander et al. 2021**).

A **study** that followed people in a German town after a cell tower was erected found stress hormones adrenaline and noradrenaline significantly increased over the first 6 months after the antenna activation and decreased dopamine and PEA levels after 18 months (**Buchner 2011**).

Two published case report document illness that developed after 5G antennas were installed. In **Hardell and Nilsson 2023,** a couple developed microwave syndrome symptoms (e.g., neurological symptoms, tinnitus, fatigue, insomnia, emotional distress, skin disorders, and blood pressure variability) after a 5G base station was installed on the roof above their apartment.

Similarly, in **"Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office**" two men developed symptoms after 5G antennas were activated on the roof of their workplace. The symptoms disappeared in both men within a couple of weeks (case 1) or immediately (case 2) after leaving the office.

PUBLISHED RESEARCH ON 5G



New York City Jumbo 5G poles with 5 tiers to house transmitting antennas from numerous carriers.



New York City "small cell" antennas in front of living room window.

Scientists state that 5G's higher frequencies cannot be assumed safe.

5G systems are using low band frequencies well associated with harmful effects **(ICBE-EMF 2022, European Parliament 2021, Panagopoulos et al. 2021)**. However 5G networks are *also using higher frequencies* such as 3.5 GHz and into the mmWave range with 24 GHz and higher.

Contrary to claims that the 5G's higher frequencies simply "bounce" off the skin, researchers have documented that the coiled portion of the skin's sweat duct can be regarded as a helical antenna in the sub-THz band and the skin, our largest organ, can intensely absorb the higher 5G frequencies **(Feldman and Ben Ishai 2017).**

Reviews of 5G health effects caution that the expected real-world impact would be far more serious due to the complex waveforms and other combinations with other toxic stimuli in the environment **(Kostoff et al 2020, Russell, 2018, Belyaev 2019, McCredden et al 2023).**

Researchers will often experiment with zebrafish, rodents and fruit flies to gain data on potential health effects to humans. An Oregon State University study on zebrafish exposed to 3.5 GHz **(Dasgupta et al. 2022)** found "significant abnormal responses in RFR-exposed fish" which "suggest potential long-term behavioral effects. Yang et al 2022 found 3.5 GHZ induced oxidative stress in guinea pigs.

A study on 3.5 GHz exposure to both diabetic and healthy rats (**Bektas et al 2022)** found an increase in degenerated neurons in the hippocampus of the brains, changes in oxidative stress parameters and changes in the energy metabolism and appetite of both healthy and diabetic rats. The researchers conclude that, "5G may not be innocent in terms of its biological effects, especially in the presence of diabetes."

PUBLISHED RESEARCH ON 5G



5G's higher frequencies will be combined with the lower frequencies from current networks already present in the environment.

Studies on rats have found exposure to both 1.5 and 4.3 GHz microwaves induced: cognitive impairment and hippocampal tissue damage **(Zhu et al 2921)**; impairments in spatial learning and memory, *with the combined simultaneous exposures* resulting in the most most severe effects **(Wang et al 2022)**; and immune suppressive responses **(Zhao 2022)**.

Long-term exposure to 2.856 and 9.375 GHz microwaves impaired learning and memory abilities as well as EEG disturbance, structural damage to the hippocampus, and differential expression of hippocampal tissue and serum exosomes **Wang et al. 2023)**.

Studies on fruit flies exposed to 3.5 GHz have found the exposure led to increases in oxidative stress, changes in the microbial community **(Wang et al 2022)** and alterations of the expression of several types of genes (Wang et al 2021).

A review by **Russell 2018** found evidence for millimeter wave effects to the skin, eyes, immune system, gene expression, and bacterial antibiotic resistance.

Recent experimental research on high-band 5G impacts to animal fertility found that 27 GHz damages sperm quality in mussels **(Pecoraro et al 2023).**

Yet the US government is not funding any research on biological effects of frequencies at 3.5 GHz or above 6 GHz to humans.

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NEW HAMPSHIRE STATE COMMISSION

2020 REPORT: 5G HEALTH AND ENVIRONMENT

In 2020, the New Hampshire State Commission issued a Final Report with 15 recommendations to "to protect people, wildlife, and the environment from harmful levels of radiation" after a year-long investigation with numerous meetings and expert testimony.


State of New Hampshire

MEMORANDUM

"A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured."

Recommendations To Update RF Exposure Regulations With New Science

- A resolution to U.S. Congress to require the FCC to commission an independent health study and review of safety limits.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.

Recommendations To Address Impacts to Wildlife And Environment

- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.

Recommendations To Reduce Public Exposure

- Require setbacks of 1,640 feet for new wireless antennas from residences, businesses and schools.
- Cell phones and wireless devices should be equipped with updated software that stops cell phones from radiating when positioned against the body.
- Establish RF radiation-free zones in commercial and public buildings.
- New Hampshire health agencies should educate the public on minimizing RF exposure with public service announcements on radio, television, print.

Recommendations To Utilize Safer Alternatives

- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.

Recommendations To Increase Transparency

- State should measure RFR and post maps with RF measurements..
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer RF measurement education for home inspectors.
- Warning signs posted in commercial and public buildings.

European Parliament

Health impact of 5G

STUDY

Panel for the Future of Science and Technology

EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)

PE 690.012 – July 2021

Health impact of 5G

Current state of knowledge of 5G-related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies

The upcoming deployment of 5G mobile networks will allow for significantly faster mobile broadband speeds and increasingly extensive mobile data usage. Technical innovations include a different transmission system (MIMO: use of multiple-input and multiple-output antennas), directional signal transmission or reception (beamforming), and the use of other frequency ranges. At the same time, a change is expected in the exposure to electromagnetic fields (EMF) of humans and the environment. In addition to those used to date, the 5G pioneer bands identified at EU level have frequencies of 700 MHz, 3.6 GHz (3.4 to 3.8 GHz) and 26 GHz (24.25 to 27.5 GHz). The first two frequencies (FR1) are similar to those used for 2G to 4G technologies and have been investigated in both epidemiological and experimental studies for different end points (including carcinogenicity and reproductive/developmental effects), while 26 GHz (FR2) and higher frequencies have not been adequately studied for the same end points.

The International Agency for Research on Cancer (IARC) classified radiofrequency (RF) EMF as 'possibly carcinogenic to humans' (Group 2B) and recently recommended RF exposure for re-evaluation 'with high priority' (IARC, 2019). Since 2011 a great number of studies have been performed, both epidemiological and experimental. The present review addresses the current knowledge regarding both carcinogenic and reproductive/developmental hazards of RF as exploited by 5G. There are various *in vivo* experimental and epidemiological studies on RF at a lower frequency range (450 to 6000 MHz), which also includes the frequencies used in previous generations' broadband cellular networks, but very few (and inadequate) on the higher frequency range (24 to 100 GHz, centimetre/MMW).

The review shows: 1) 5G lower frequencies (700 and 3 600 MHz): a) limited evidence of carcinogenicity in epidemiological studies; b) sufficient evidence of carcinogenicity in experimental bioassays; c) sufficient evidence of reproductive/developmental adverse effects in humans; d) sufficient evidence of reproductive/developmental adverse effects in experimental animals; 2) 5G higher frequencies (24.25-27.5 GHz): the systematic review found no adequate studies either in humans or in experimental animals.

Conclusions: 1) cancer: FR1 (450 to 6 000 MHz): EMF are probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas; FR2 (24 to 100 GHz): no adequate studies were performed on the higher frequencies; 2) reproductive developmental effects: FR1 (450 to 6 000 MHz): these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, foetuses and newborns; FR2 (24 to 100 GHz): no adequate studies were performed on non-thermal effects of the higher frequencies.

SCIENTIFIC RESEARCH STUDIES





European Parliament requested a research report "**Health Impact of 5G**" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.

A review entitled "**Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**" reviewed the existing scientific literature and found radiofrequency sickness, cancer and changes in biochemical parameters (**Balmori 2022**).

A **study** published in Electromagnetic Biology and Medicine found changes in blood considered biomarkers predictive of cancer in people living closer to cell antenna arrays (**Zothansiama 2017**).

A **study** published in the International Journal of Environmental Research and Public Health found higher exposure to cell network arrays linked to higher mortality from all cancer and specifically lung and breast cancer (**Rodrigues 2021**).

A 10-year **study** published in Science of the Total Environment on cell phone network antennas by the local Municipal Health Department and several universities in Brazil found a clearly elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell phone towers (**Dode 2011**).

A **study** commissioned by the Government of Styria, Austria found a significant cancer incidence in the area around the RF transmitter as well as significant exposure-effect relationships between radiofrequency radiation exposure and the incidence of breast cancers and brain tumors (**Oberfeld 2008**).

A **review** published in Experimental Oncology found "alarming epidemiological and experimental data on possible carcinogenic effects of long term exposure to low intensity microwave (MW) radiation." A year of operation of a powerful base transmitting station for mobile communication reportedly resulted in a dramatic increase of cancer incidence among the population living nearby (**Yakymenko 2011**).

PUBLISHED RESEARCH STUDIES

OUTDOOR LEVELS OF RF ARE INCREASING DUE TO THE DENSIFICATION OF WIRELESS NETWORKS

An **article** published in *The Lancet Planetary Health* documents how RF exposures are increasing and so is the scientific research linking exposure to adverse biological effects. "It is plausibly the most rapidly increasing anthropogenic environmental exposure since the mid-20th century..."

A **2021 report** by the French government on 5G analyzed more than 3,000 measurements and found that while RF levels had *not yet* significantly increased, this was due to the lack of 5G traffic. Additional study specific to 5G in the 3500 MHz band with artificially generated traffic concluded that, "initial results suggest an eventual increase of about 20% in overall exposure."

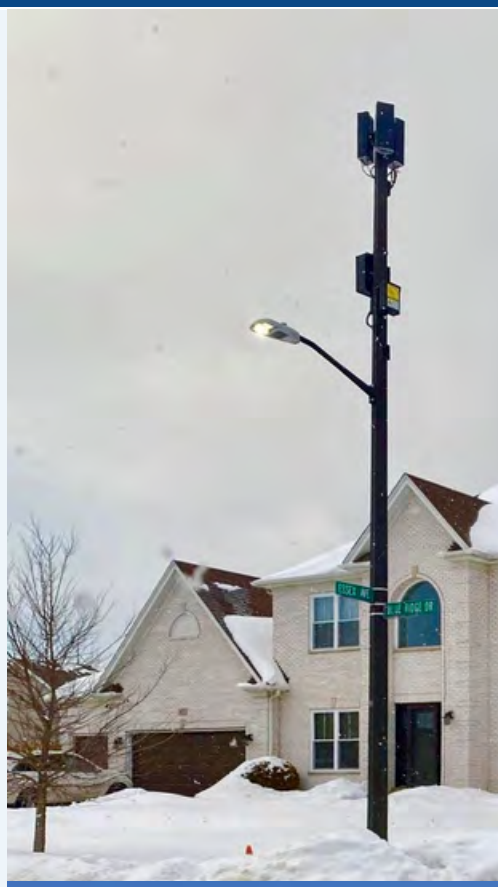
A **2018 multi-country study** published in *Environment International* measured RF in several countries and found cell tower/base station radiation to be the dominant contributor to RF exposure in most outdoor areas. Urban areas had higher RF.

A **study** measuring RF exposure in the European cities of Basel, Ghent and Brussels found the total RF exposure levels in outdoor locations had increased up to 57.1% in one year (April 2011 to March 2012) and most notably due to mobile phone base stations.

A **2018 study** published in *Oncology Letters* documented "unnecessarily high" RF levels in several locations in Sweden and concludes that "using high-power levels causes an excess health risk to many people."

A **2017 Swedish** study of Royal Castle, Supreme Court, three major squares and the Swedish Parliament found that despite the architecturally camouflaged RF-emitting antennas, the passive exposure was higher than RF levels associated with non-thermal biological effects. The researchers noted that the heaviest RF load falls on people working or living near hotspots.

A **2016 study** at Stockholm Central Railway Station in Sweden documented higher RF levels in areas where base station antennas were located closest to people. Importantly, the RF from the downlink of UMTS, LTE, GSM base station antennas contributed to most of the radiation levels.





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CELL TOWERS NEAR SCHOOLS

SCHOOL CELL TOWER SETBACKS

Many communities have policies, ordinances or zoning that ensures cellular antennas are restricted to a specific minimum distance from schools. Hempstead, New York requires a special use permit for cell towers near schools.

Examples of cell tower/4G/5G small cell setbacks/preferred placements for schools:

- Palo Alto, California: 1,500 feet
- Copake, NewYork :1500 feet
- Los Altos , California: 500 feet
- Walnut City, California: 1,500 feet
- Bar Harbor, Maine: 1,500 feet
- Sallisaw, Oklahoma: 1,500 feet
- Shelbourne , Massachusetts: 1,500 feet
- Stockbridge, Massachusetts: 1,500 feet
- San Diego County California 1,000 feet
- Encinitas California:500 feet
- Scarsdale New York: 500 feet
- Ithaca, New York: 250 feet

CELL TOWERS REMOVED FROM SCHOOL GROUNDS

- Milpitas California: School Board asked Crown Castle and T-Mobile to relocate the cell tower to remote location.
- Ripon California: Sprint moved the cell tower at elementary after students and staff developed cancer and parents argued children should not be guinea pigs.
- Alameda California cancelled cell tower contracts.
- Dekalb County Georgia dropped school tower plan.

SCHOOL BOARDS

- Palo Alto Unified School District Cell Tower Resolution supports the City 1,500 setback and opposes cell tower "on or in close proximity to schools to ensure individuals, especially children, are protected from the potential negative effects associated with radiation exposure."
- West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
- Vancouver School Boards Resolution: 1,000 feet
- Greenbelt Maryland Council opposes school towers.

DID YOU KNOW?

- The International Association of Firefighters passed a Resolution opposing cell towers on its stations in 2004 after a study found neurological damage in firefighters with antennas on their fire stations.

LOS ANGELES UNIFIED CA SCHOOL DISTRICT

- 3 resolutions opposing cell towers on school property.
- The District Office of Health and Safety developed a "cautionary level" for radiofrequency radiation 10,000 times lower than FCC regulations because, *"it is believed that a more conservative level is necessary to protect children, who represent a potentially vulnerable and sensitive population."*

SCHOOL BOARDS THAT REVERSED COURSE

- Montgomery County Maryland Schools policy does not allow cell towers on elementary schools.
- Prince George's County Maryland School Board decided not to renew a cell tower construction master leasing agreement that had allowed over 60 schools to be marketed as cell tower sites.
- Portland Oregon Schools ended new leases for cell towers.

EXPERT RECOMMENDATIONS

- The New Hampshire State Commission 5G Health and Environment Report recommends a setback of 1640 feet for schools.
- The Collaborative For High Performance Schools (Green building rating program) has LOW EMF Criteria which includes no cell towers on school property.

THE EPA SCHOOL SITING GUIDELINES

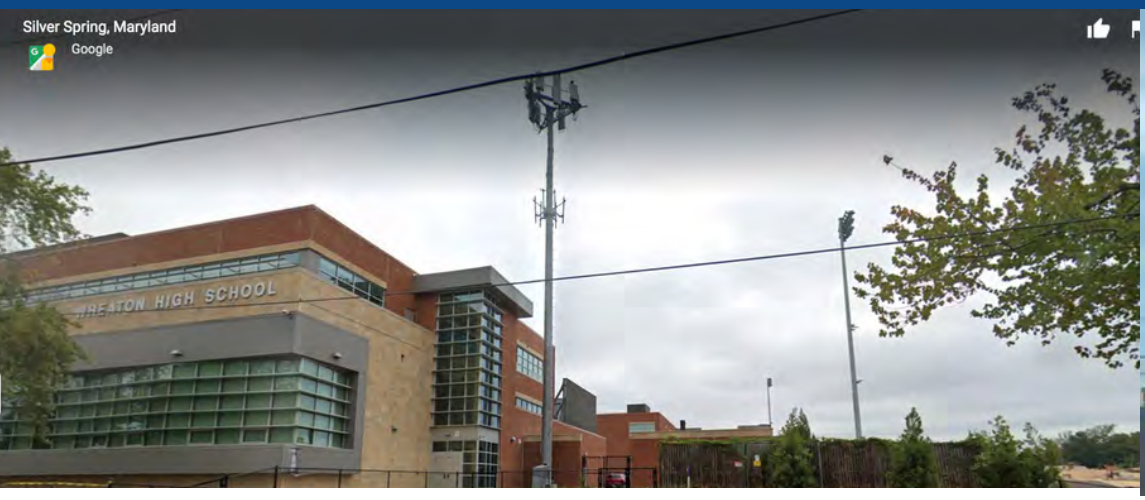
Lists exposure to electromagnetic fields and the fall distance as "potential hazards" from cell towers. The EPA guidelines recommend schools "identify and evaluate cell towers within ~200 feet of prospective school locations."

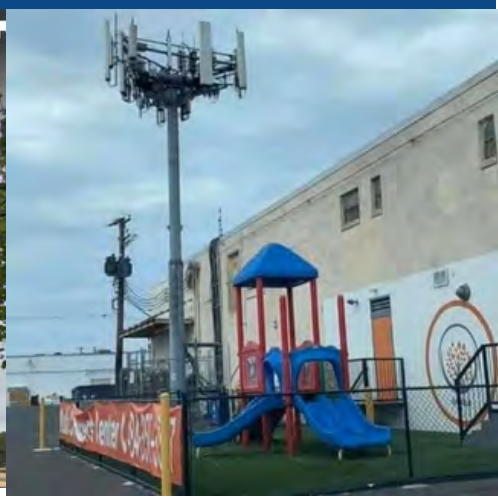
PUBLISHED RESEARCH

- 500 meter buffer recommended for schools to reduce liability and minimize risk (Pearce 2019)
- A moratorium on 5G pending safety research (Frank 2020)
- A precautionary approach is better suited to State obligations under international human rights law (Roda and Perry 2014)
- Increased cancer deaths near cell antennas (Rodrigues 2021)
- Studies find: DNA Damage(Zothansiama 2017), Diabetes (Meo 2015), Cognitive effects (Meo 2018), sleep problems and headaches (Abdel-Rassoul 2007, Levitt & Lai 2010, Shahbazi-Gahrouei 2013)

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS





CONEJO PTA WANTS CELL TOWER MOVED
Op-ed in Thousand Oaks Acorn Journal

The California PTA advocates on behalf of children and families. They advocate against electromagnetic field radiation your schools.

The Conejo PTA urges the use of the precautionary principle in making decisions regarding public health this means if something cannot be proven to be safe it is best to avoid exposure. Most people don't realize that the 1996 FCC state standards for safe levels of omission was actually based on a level set by the American national standards institute in 1982. Well this standard has not been changed in 30 years it has usurped all local authority."

"For this reason, Conejo Council PTA made up of 9000 parents and teachers has decided to take action. We're calling on our local leaders to put in place policies that would ensure parents are notified when cell towers are propose near schools and then encourage a buffer zone around schools."

-Kim Huber, legislative chair of the Conejo Council PTA.

NEW YORK STATE PTA
-Adopted TWO Resolutions 2014

"CELLULAR PHONE TOWERS – 2014 (R-'07, R-'00); Resolved that the New York State Congress of Parents and Teachers, Inc. support legislation that would encourage local communities, including parents and school officials, to regulate the placement of cell towers and cell tower antennas particularly in schools and areas where children congregate,

and be it further Resolved that the New York State PTA support continued research into the long-term effects of radio frequency and microwave frequencies on humans especially as they apply to children, and be it further Resolved that the New York State PTA seek to educate parents and school officials as to the current debate over the placement of cell towers and antennas."

NEELSVILLE MIDDLE SCHOOL PTA (MD)

- Voted to oppose proposed cell tower.
- Hosted parent information session with both the cell tower company and Environmental Health Trust.

HILLSMERE ELEMENTARY SCHOOL PTA (MD)

- Sent letters to the school board in opposition to cell towers near the school.

BRIARLAKE ELEMENTARY (GA)

- Voted to oppose cell tower after board approved towers on schools.

PACIFIC GROVE (CA) PTAs

- Forest Grove Elementary Pacific Grove Middle School and Pacific Grove High School PTAs sent a letter to City Council opposing a high school cell tower.

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS

Exhibit A

August 6, 2018

Pacific Grove City Council
City Hall
300 Forest Ave.
Pacific Grove, CA 93950

Dear members of Pacific Grove City Council,

I am writing you on behalf of Pacific Grove High School PTA in regard to the Pacific Grove Planning Commission's vote on July 26, 2018, which approved a request by Verizon Wireless to install and maintain a cell tower adjacent to Pacific Grove High School (PGHS). For the reasons described below, the Pacific Grove High School PTA **is strongly opposed** to the location of the Verizon cell tower and is requesting that the City Council consider and support the appeal that is being filed by a group of concerned parents who live in Pacific Grove and send their children to PG schools.

The installment of a cell tower adjacent to PGHS poses significant potential health dangers to both students and staff at PGHS. While some argue that radiation emitted from a cell tower is not a health danger, data from many studies indicate the opposite. Research shows that children and pregnant women are the most vulnerable – two demographics most likely to be on PGHS school grounds on a regular basis. The actual placement of the cell tower– near the back of PGHS and very close to Forest Grove Elementary School- only increases the concerns of the frequency in exposure.

Cell towers also pose a risk to students due to fire hazard. Many cell towers throughout the United States have caught fire and collapsed, posing a significant safety concern, especially in an area with young students walking to and from school every day.

The mission of all PTAs nationwide is to make every child's potential a reality by engaging and empowering families and communities to advocate for all children. Our local PTA is very active in expressing our support for or opposition to issues dealing with the health, safety, education, or general well-being of children and youth in our community.

The members of the Pacific Grove High School PTA strongly urge you to please reconsider the Pacific Grove Planning Commission's previous vote and rescind approval for the Verizon cell tower at Pacific Grove High School.

Sincerely,

Julie Kavanaugh
President, Pacific Grove High School PTA

Example of an EMF Exclusion in an Insurance Plan

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ELECTROMAGNETIC RADIATION EXCLUSION

This endorsement modifies insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
PUBLIC RISK GENERAL LIABILITY RETAINED LIMIT COVERAGE FORM
LAW ENFORCEMENT COVERAGE PART
LAW ENFORCEMENT LIABILITY RETAINED LIMIT COVERAGE FORM
PUBLIC OFFICIALS COVERAGE PART
PUBLIC OFFICIALS LIABILITY RETAINED LIMIT COVERAGE FORM
EMPLOYMENT PRACTICES LIABILITY COVERAGE PART
EMPLOYMENT PRACTICES LIABILITY RETAINED LIMIT COVERAGE FORM

The following **Exclusion** is added:

This policy does not apply to and we will not provide a defense for:

a. "Bodily injury," "property damage", "personal and advertising injury", "employee benefits wrongful acts", "personal injury", "law enforcement wrongful acts", "public officiels wrongful acts", "educator's legel wrongful acts", or "employment practices wrongful acts" arising out of, or which result in, the actual, alleged, threatened, perceived, latent, sudden and accidental or incidental exposure to or contact with electromegnetic radiation in any form, from any source.

b. The costs of abatement or mitigation of:

(1) Electromagnetic radiation; or

(2) Exposure to electromagnetic rediation.

c. Any supervision, instruction, recommendation, waming or advice given or which should have been given in connection with **a.** or **b.** above.

Electromagnetic radiation includes but is not limited to, magnetic energy, waves, fields or forces generated, produced, transmitted or maintained by the charges, currents, frequencies, energy or forces of electricity that is generated, flowing or otherwise transmitted through or via the medium, methods and equipment designed to generate, produce, distribute, trensport or transmit the electrical charges, currents, frequencies, energy or forces.



Verizon Total Mobile Protection Plan

16. Pollution

The discharge, dispersal, seepage, migration or escape of pollutants. Pollutants means any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste. Waste includes materials to be recycled, reconditioned or reclaimed.

CITIES AND TOWNS WITH STRONG ORDINANCES

SETBACKS FOR CELL ANTENNAS





Many communities have setbacks for cell towers and small cells.

Shelburne, MA: 3,000 feet for schools and 1,500 feet for homes; no new wireless antennas in residential zones
Copake, NY: 1,500 feet from homes, schools, churches or other buildings containing dwelling units
Sallisaw, OK: No commercial wireless telecommunications towers within 1,500 of homes.
Calabasas, CA: No "Tier 2" wireless telecommunications facilities within 1,000 feet of homes and schools
Bedford, NH: 750 feet from residentially-zoned property
Scarsdale, NY: No wireless facilities within 500 feet from homes, schools, parks, and houses of worship
Walnut City, California: 1,500 feet
Stockbridge, Massachusetts: 1,000 feet
San Diego County California: 1,000 feet (small cells)
Bar Harbor Maine: 1500 setback for schools

School Boards
Palo Alto, California: School Board supports the City of Palo Alto immediately establishing local municipal zoning setback rules of 1,500 feet or more from an operating wireless transmitter and a school site.
West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
Los Angeles California School District: Resolutions opposing cell towers on school property and a cautionary level for radiofrequency radiation 10,000 times lower than FCC limits.

Bold blue on this PDF are hyperlinked. For more setbacks go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

The 2022 study "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in World Academy of Sciences Journal authored by Tarmo Koppel and Lennart Hardell, MD of the Environment and Cancer Research Foundation found the highest RF exposure readings were registered close to cell phone base station antennas mounted on top of utility poles, street lamps or traffic lights.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.



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Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 8. Gervais Street: Another cell phone base station antenna close to street level and causing high exposure to pedestrians (exposure scenario illustration). Note the antenna appears undistinguishable from the utility pole an unnoticeable between the trees.

5G, Small Cells & Cell Towers Can Drop Property Values

Would you buy a home with cell antennas outside the bedroom window?



Legal filings by cities and municipalities to the FCC highlight how small cell deployment could impact aesthetics and property values.

"many deployments of small cells could affect property values, with significant potential effect…"

— Reply Comments of Smart Communities Siting Coalition (local governments and associations representing 1,854 communities) 4/7/2017,Docket No. 16-421, April 7, 2017

"Considering that the Smart Communities' prior filings show that the addition of facilities of this size diminish property values, it is strange for the Commission to assume that approval can be granted in the regulatory blink of an eye…."

"…allowing poles to go up in areas where poles have been taken down has significant impacts on aesthetics (not to mention property values)."

— *Ex Parte* Submission of Smart Communities Letter to Ms. Marlene H. Dortch, Secretary, Federal Communications Commission, September 19, 2018

ENVIRONMENTAL HEALTH TRUST

5G, CELL TOWERS AND WIRELESS

DECREASED PROPERTY VALUE



"An overwhelming 94 percent of home buyers and renters surveyed by the National Institute for Science, Law & Public Policy (NISLAPP) say they are less interested and would pay less for a property located near a cell tower or antenna."

"of the 1,000 survey respondents, 79 % said that under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas, and almost 90% said they were concerned about the increasing number of cell towers and antennas in their residential neighborhood."

"Cell Towers, Antennas Problematic for Buyers" — Realtor Magazine

"...cell towers are concerning to many people and drop property values."

"While most states do not require disclosure of neighborhood nuisances, such as cell towers or noisy neighbors, a few states do, and more are likely to in the future."
— Real Estate Attorney, South Florida Sun Sentinel, 2021

The California Association of Realtors' Property Sellers Questionnaire specifically lists "cell towers" on the disclosure form for sellers of real estate.
— Click to go to the California Association of Realtors' Property Sellers Questionnaire
(p. 3-4 under K. Neighborhood)

"While the magnitude of the impact varies, the studies uniformly indicate that there is a significant impact on residential property values from installation of cell phone towers..."
— David E. Burgoyne, ASA, SR/WA Certified General Real Estate Appraiser

"In some areas with new towers, property values have decreased by up to 20%."

"Your new neighbor, a cell tower, may impact the value of your home" National Business Post, 2022.

PDF is hyperlinked. More on property values at ehtrust.org

ENVIRONMENTAL HEALTH TRUST

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION



FCC human exposure limits were adopted in 1996 after the EPA was defunded from creating safety limits. They have not properly reviewed these limits since 1996.

FCC's human exposure limits for the RF microwaves emitted by 5G, 4G, cell towers, cell phones, Wi-Fi, Bluetooth, smart devices and wireless networks are based on outdated science and faulty assumptions.

The limits are irrelevant to modern-day technologies and do not reflect the way people are exposed to RF and actually use technology in the 21st century.

Reasons Why FCC's 1996 Limits Do Not Protect:

Heating-Based Only

FCC limits are heat-based "thermal" limits. This means they primarily protect against the overheating of tissue from RF. FCC's limits are not based on protecting against non-heating biological effects such as cancer, oxidative stress, headaches, behavioral problems, memory damage, disrupting bee behavior, tree damage etc.

Short-Term Impacts Only

FCC limits are based on protecting against acute effects. No federal report or research review exists regarding safety from chronic, long-term RF exposures from cell towers, Wi-Fi and wireless networks in the home, school and workplace. The FDA nominated the National Toxicology Program (NTP) to perform animal studies designed to mimic a lifetime of human cell phone exposure. Cancer and DNA damage was found. Another large-scale animal study used cell tower level exposures and found the same tumors as the NTP. However, the FDA rejected these findings.

Children Are Not Protected

FCC limits are misleadingly presented as being "designed to protect children. When safety thresholds were developed decades ago, the science investigating RF impacts to children's developing brains did not exist. Current research concludes the limits should be hundreds of times more protective for children because they are more vulnerable.

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION

No Risk Analysis or Review of Totality of Science
No agency has reviewed all of the latest science. Usually the EPA and FDA use risk assessment to characterize the nature and magnitude of risks to human health for various populations such as children and pregnant women. The EPA also estimates ecological risks, including plants, birds, other wildlife and aquatic life. When groundbreaking studies are published, a quantitative risk analysis of the data is performed. This has never been done for RF.

"The FCC and FDA have failed in their obligation to prescribe safe RFR guidelines produced from wireless communication devices to protect the public health and safety. Devices are becoming more sophisticated, and their usage is as common to daily life as brushing your teeth."
— Pittsburgh Law Review "The FCC Keeps Letting Me Be: Why Radiofrequency Radiation Standards Have Failed to Keep Up With Technology" by Hala Mouzaffar

"The wireless industry reaction features stonewalling public relations and hyper aggressive legal action. It can also involve undermining the credibility and cutting off the funding for researchers who do not endorse cellular safety. It is these hardball tactics that look a lot like 20th century Big Tobacco tactics. It is these hardball tactics—along with consistently supportive FCC policies—that heighten suspicion the wireless industry does indeed have something to hide."

— Norm Alster in the Harvard Press Book "Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates"





ENVIRONMENTAL HEALTH TRUST

A REGULATORY GAP
No Federal Agency Ensuring Cell Tower Wireless Safety

There is no U.S. government agency with oversight for cell tower radiation health effects: no research reviews, no reports, no environmental monitoring, no risk mitigation and no post market health surveillance for the daily, full body radio-frequency (RF) radiation exposure from cell towers.

"The FDA does not regulate cell towers or cell tower radiation. Therefore, the FDA has no studies or information on cell towers to provide in response to your questions."
— Ellen Flannery, Director, FDA Policy Center for Devices and Radiological Health to a California mother with a cell tower on her street who asked the FDA about safety, July 11, 2022

"As a Federal research agency, the NCI is not involved in the regulation of radio frequency telecommunications infrastructure and devices, nor do we make recommendations for policies related to this technology"
— National Cancer Institute letter to Denise Ricciardi, member of the New Hampshire State Commission on 5G, July 30, 2020

The ACS does "not have any official position or statement on whether or not radiofrequency radiation from cell phones, cell phones towers, or other sources is a cause of cancer."
— American Cancer Society Website

"EPA's last review was in the 1984 document Biological Effects of Radiofrequency Radiation. The EPA does not currently have a funded mandate for radiofrequency matters."
— Lee Ann B. Veal Director, EPA Radiation Protection Division Office of Radiation and Indoor Air, July 8, 2020 Letter to Theodora Scarato

Fact: There are no scientific reports by the CDC on cell tower radiation safety, nor does the agency have staff with expertise monitoring the science and evaluating risk. Public information requests found that **several CDC website pages on radio frequency were found to be drafted with a wireless industry consultant.**

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today." **— U.S. Department of Interior Letter to FCC, 2014**

Fact: The World Health Organization (WHO) EMF Project has not reviewed the science since 1993. The WHO webpages on cell phones and cell towers are not based on a published scientific review. The WHO EMF Project webpages were written by a scientist who **used wireless industry money** to start the WHO EMF Project and who is now a consultant to industry. **In contrast, the WHO International Agency for Research on Cancer (a separate WHO entity vetted for conflicts of interest) determined RF radiation to be a Class 2 B "possible" carcinogen in 2011.** Many scientists now state **the evidence showing cancer has increased.**

Blue text *is hyperlinked to source.*

FACTSHEET: ENVIRONMENTAL HEALTH TRUST ET AL. V. FCC

COURT RULING ON FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS EXPOSURE LIMITS

LANDMARK FEDERAL COURT RULING AGAINST THE FCC

On August 13, 2021 the U.S. Court of Appeals for the D.C. Circuit ruled the Federal Communications Commission (FCC) ignored scientific evidence and failed to provide a reasoned explanation for its determination that its 1996 regulations adequately protect the public against all the harmful effects of wireless radiation.

FCC'S REFUSAL TO UPDATE 1996 LIMITS

The legal case challenged the FCC's 2019 decision not to update its 1996 regulations regarding allowable radiofrequency radiation (RF) exposures from wireless technologies - including 5G, cell phones, cell towers, Wi-Fi, and wireless networks.

EVIDENCE OF HARMFUL EFFECTS BELOW FCC LIMITS

FCC limits are based on the belief that heating is the only proven harm from RF. Over 11,000 pages of evidence - 447 exhibits in 27 Volumes - was submitted to the Court documenting biological effects and illness from wireless radiation exposure below heating levels. Research has found brain damage, headaches, memory problems, reproduction damage, synergistic effects, nervous system impacts, brain cancer, genetic damage, as well as harm to trees, birds, bees, and wildlife.

THE COURT FINDINGS

The ruling stated that the FCC's "arbitrary and capricious" decision to maintain their 25 year old exposure limits did not address evidence indicating "non-cancer" harm such as:

- impacts to children
- testimony of persons injured by wireless radiation
- impacts to the developing brain
- impacts to the reproductive system
- impacts to wildlife and the environment

THE COURT ORDER

The Court ordered the FCC to provide a reasoned determination as to whether the evidence warrants a change to 1996 RF limits especially in regards to:

- children's vulnerability
- long-term exposure
- environmental impacts
- new technological developments and the ubiquity of wireless
- how FCC's cell phone tests only measure heat and allow a space between the phone and body

TIMELINE

1980s: EPA had robust research program and was tasked to develop RF safety limits by U.S. Science Advisory Board.

1995: EPA presents to FCC on the EPA timeline for its development of human exposure RF limits which would include both thermal effects and non thermal effects.

1996: EPA is fully defunded by Congress amid heavy lobbying for Telecom Act and halts all research on RF.

1996: The FCC adopts RF limits developed by industry-tied groups - based on short term heating - thermal- effects from high power exposures (based on studies of small animals exposed to high RF levels for under an hour).

1999: FDA requests the National Toxicology Program (NTP) study RF because of the lack of safety data on long-term exposure.

2008/2009 Congressional Hearings

2011: Wireless RF classified as a "possible" Class 2B Carcinogen by International Agency for Research on Cancer.

2012: GAO Report recommends rules be reassessed to reflect current use patterns and recent science.

2013-2019: FCC opens record on RF limits - gets over 1000 submissions.

2018: NTP/NIH releases $30M animal study concluding "clear evidence" of cancer. FDA rejects the findings.

2019: FCC closes record, decides not to update its 1996 wireless RF limits.

2020: Cases filed against FCC.

2021: U.S. Court of Appeals, D.C Circuit ruled that the FCC decision not to change human exposure limits and regulations was "arbitrary and capricious." FCC ordered to respond.

2021: No FCC response to Court, so EHT and others filed request to refresh record.

Timeline is hyperlinked to sources.

FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS RADIATION EXPOSURE LIMITS

FCC Compliance Does Not Ensure Safety

Most of the public assumes that current FCC safety limits for cell phones, cell towers, Wi-Fi, 5G, and wireless networks are based upon an up to date robust review of all relevant research. This assumption of safety is now clearly documented to be erroneous.

Lack of Oversight by Health and Environmental Agencies

The ruling reveals a lack of accountability with our federal health agencies regarding wireless radiation. The EPA, CDC, NIOSH, and NCI did not submit any reports to the Court, revealing that none of these agencies has reviewed the science on health effects to ensure safety for the public. The U.S. has no pre- market safety testing for health effects, no post-market surveillance, no environmental monitoring, and no meaningful interagency coordination.

FDA's Dismissal of Harm Deemed Insufficient

The Court states the FCC improperly relied on the FDA's conclusions that RF limits did not need an update. The FDA's submissions were described by the Court as "cursory" and "insufficient." Although the FDA later released a literature review, it was only focused on cell phones, not cell towers, Wi-Fi nor 5G technology. It also was only focused on cancer, further confirming the fact that U.S. agencies have failed to evaluate the myriad of effects documented in scientific studies, such as brain, immune, fertility and endocrine impacts. A U.S. government review of *the full body of recent science* has simply never been done.

"the Commission's failure to provide a reasoned or even relevant explanation of its position that RF radiation below the current limits does not cause health problems unrelated to cancer renders its explanation as to the effect of RF radiation on children arbitrary and capricious. "

— 2021 EHT et al. v. FCC

The Court Did Not Agree That "Cell Phones Do Not Cause Cancer"

Contrary to the wireless industry's recent claims, the Court *did not make a scientific determination regarding cancer*. The ruling simply stated that in regards to cancer- the FCC passed the minimum legal requirement for adequate review because it (at least) referenced why the FCC dismissed cancer evidence. The FCC cited the rejections of NIH studies by the FDA and of ICNIRP (a small group with no oversight and whose members have a long history of industry ties).

Children's Vulnerability and Effects of Long Term Exposure Ignored by the FCC

The Court states the FCC "dismissed" the American Academy of Pediatrics recommendations to strengthen regs and ensure children and pregnant women are protected. The Court found the FCC failed to explain why it ignored research indicating children's developing brains are more sensitive. Children will have a lifetime of exposure, yet the FCC was found to ignore the issue of impacts *from long term exposure*.

Wildlife Remains Unprotected

FCC's limits were designed in 1996 to protect only humans, not flora or fauna. The Court found that the FCC had "completely failed" to address the "substantive evidence of potential environmental harms" on the record, which included science showing serious impacts to birds, bees, trees, and plants.

PETITIONERS: Environmental Health Trust, Consumers for Safe Cell Phones, Elizabeth Barris, Theodora Scarato, Children's Health Defense, Michelle Hertz, Petra Brokken, Dr. David Carpenter, Dr. Toril Jelter, Dr. Paul Dart, Dr. Ann Lee, Virginia Farver, Jennifer Baran, Paul Stanley M.Ed.

KEY RESOURCES: Court Ruling 8/13/2021, Evidence (11,000 pages), EHT Press Conference

Amicus Briefs

- Amicus of NRDC: Natural Resources Defense Council
- Amicus of Attorney Joe Sandri including declaration of Dr. Linda Birnbaum, former Director of the National Institute of Environmental Health Sciences
- Amicus of Catherine Kleiber
- Amicus of the Building Biology Institute

EHTrust.org for more.

REFERENCES/CITATIONS

Abdel-Rassoul, G., et al (2007). **Neurobehavioral effects among inhabitants around mobile phone base stations**. *NeuroToxicology*

Balmori A. (2002) **Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**. *Environmental Research*

Dode, A. C et al (2011). **Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil**. *Science of The Total Environment*

Hardell, L., & Carlberg, M. (2019). **Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz**. *International Journal of Oncology*

Hardell, L., & Koppel, T. (2022). **Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden**. *Reviews on Environmental Health*.

Khurana et al. (2010). **Epidemiological evidence for a health risk from mobile phone base stations**. *International Journal of Occupational and Environmental Health*

Koppel et al (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Levitt & Lai, H. (2011). **Corrigendum: Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays**. *Environmental Reviews*

López et al (2021). **What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid**. *Environmental Research*

Meo et al (2019). **Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health**. *American Journal of Men's Health*

Meo et al (2015a). **Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus**. *International Journal of Environmental Research and Public Health*

Pearce, J. M. (2020). **Limiting liability with positioning to minimize negative health effects of cellular phone towers**. *Environmental Research*

Roda, C., & Perry, S. (2014). **Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection**. *Environmental Science & Policy*

Rodrigues et al (2021). **The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil**. *International Journal of Environmental Research and Public Health*

Santini et al. (2003). **Survey Study of People Living in the Vicinity of Cellular Phone Base Stations**. *Electromagnetic Biology and Medicine*

Thamilselvan et al (2021) **Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study**. *Journal of International Oral Health*

Yakymenko et al (2011). **Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems**. *Experimental Oncology*

Zothansiama et al (2017). **Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations**. *Electromagnetic Biology and Medicine*

Belyaev et al (2022) **Possible health risks from exposure to microwaves from base stations**, Conference Paper Department of Radiobiology, Cancer Research Institute, Biomedical Research Center *Conference paper

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

5G

Betzalel et al. (2018). **The human skin as a sub-THz receiver—Does 5G pose a danger to it or not?** *Environmental Research*

Betzalel et al. 2017). **The Modeling of the Absorbance of Sub-THz Radiation by Human Skin**. *IEEE Transactions on Terahertz Science and Technology*

Dasgupta et al. (2022). **Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish**. *Environmental Science & Technology Letters*

Di Ciaula, A. (2018). **Towards 5G communication systems: Are there health implications?** *International Journal of Hygiene and Environmental Health*

Frank, J. W. (2021). **Electromagnetic fields, 5G and health: What about the precautionary principle?** *Journal of Epidemiology and Community Health*

Hardell, L., & Carlberg, M. (2020). **[Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest**. *Oncology Letters*

Hardell, L., & Nilsson, M. (2023). **Case Report: The Microwave Syndrome after Installation of 5G Emphasizes the Need for Protection from Radiofrequency Radiation.** Annals of Case Reports.

Nilsson M, Hardell L. (2023) **Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office.** Ann Clin Case Rep. 8: 2378.

Hinrikus et al. (2022). **Possible health effects on the human brain by various generations of mobile telecommunication: A review based estimation of 5G impact**. *International Journal of Radiation Biology*

Kostoff et al. (2020). **Adverse health effects of 5G mobile networking technology under real-life conditions**. *Toxicology Letters*

Nasim, I., & Kim, S. (2019). **Adverse Impacts of 5G Downlinks on Human Body**. *2019 SoutheastCon IEEE*

Russell, C. L. (2018). **5G wireless telecommunications expansion: Public health and environmental implications**. *Environmental Research*

Yang et al. (2022). **Effects of Acute Exposure to 3500 MHz (5G) Radiofrequency Electromagnetic Radiation on Anxiety-Like Behavior and the Auditory Cortex in Guinea Pigs**. *Bioelectromagnetics*

Increasing Exposures From Expanding 5G Networks and Close Proximity "Small Cell" Antennas

Baltrėnas et al.(2012). **Research and evaluation of the intensity parameters of electromagnetic fields produced by mobile communication antennas**. *Journal of Environmental Engineering and Landscape Management*

Bhatt et al. (2017). **Radiofrequency-electromagnetic field exposures in kindergarten children**. *Journal of Exposure Science & Environmental Epidemiology*

Bonato et al. (2022). **Computational Assessment of RF Exposure Levels due to 5G Mobile Phones**. *2022 Microwave Mediterranean Symposium*

Carlberg et al. (2019). **High ambient radiofrequency radiation in Stockholm city, Sweden.** *Oncology Letters*

El-Hajj et al. (2020). **Radiation Analysis in a Gradual 5G Network Deployment Strategy**. *2020 IEEE 3rd 5G World Forum (5GWF)*

Hardell et al. (2018). **Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report**. *Oncology Letters*

Hardell et al. (2017). **High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament**. *Molecular and Clinical Oncology*

Hardell, L., Koppel, T., Carlberg, M., Ahonen, M., & Hedendahl, L. (2016). **Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields**. *International Journal of Oncology*

Koppel et al. (2022). **Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**. *Environmental Research*

Koppel et al. (2019). **Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**. *Oncology Letters*

Bold blue on this PDF are hyperlinked.

REFERENCES/CITATIONS

Koppel, T., & Hardell, L. (2022). **Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA**. *World Academy of Sciences Journal*

Mazloum et al. (2019). **RF-EMF exposure induced by mobile phones operating in LTE small cells in two different urban cities**. *Annals of Telecommunications*

Urbinello et al. (2014). **Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities**. *Environmental Research*, 134, 134–142.

4G LTE

Broom et al. (2019). **Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6J Mice**. *Bioelectromagnetics*

Choi et al. (2020). **Continuous Exposure to 1.7 GHz LTE Electromagnetic Fields Increases Intracellular Reactive Oxygen Species to Decrease Human Cell Proliferation and Induce Senescence**. *Scientific Reports*

Lv et al. (2014). **The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure**. *Clinical Neurophysiology*

Malik et al. (2021). **Short- and long-duration exposures to cell-phone radiofrequency waves produce dichotomous effects on phototactic response and circadian characteristics of locomotor activity rhythm in zebrafish, Danio rerio**. *Biological Rhythm Research*

Oh, J. J., Byun, S.-S., Lee, S. E., Choe, G., & Hong, S. K. (2018). **Effect of Electromagnetic Waves from Mobile Phones on Spermatogenesis in the Era of 4G-LTE**. *BioMed Research International*, 2018, 1801798.

Özdemir et al. (2021). **The effect of 4.5 G (LTE Advanced-Pro network) mobile phone radiation on the optic nerve**. *Cutaneous and Ocular Toxicology*

Souffi et al. (2022). **Exposure to 1800 MHz LTE electromagnetic fields under proinflammatory conditions decreases the response strength and increases the acoustic threshold of auditory cortical neurons**. *Scientific Reports*

Wei et al. (2019). **Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study**. *Bioelectromagnetics*

Yang et al. (2021). **Functional and network analyses of human exposure to long-term evolution signal**. *Environmental Science and Pollution Research International*

Yang et al. (2017). **Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands**. *Clinical EEG and Neuroscience*

Yu et al. (2020). **Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3–MMP2-BTB axis in the testes of adult rats**. *Science of The Total Environment*

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American Academy of Pediatrics Webpage Excerpts

Electromagnetic Fields: A Hazard to Your Health?

In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.

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Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective☆

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ABSTRACT

Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the World Health Organization. There is strong evidence that excessive exposure to mobile phone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. *In vivo* and *in vitro* studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. There is increasing evidence the exposures can result in neurobehavioral decrements and that some individuals develop a syndrome of "electro-hypersensitivity" or "microwave illness", which is one of several syndromes commonly categorized as "idiopathic environmental intolerance". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that excludes the symptoms as being only psychosomatic. Unfortunately standards set by most national and international bodies are not protective of human health. This is a particular concern in children, given the rapid expansion of use of wireless technologies, the greater susceptibility of the developing nervous system, the hyperconductivity of their brain tissue, the greater penetration of radiofrequency radiation relative to head size and their potential for a longer lifetime exposure.

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Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.



Clinical Biochemistry
Volume 45, Issues 1–2, January 2012, Pages 157-161



Case Report

How does long term exposure to base stations and mobile phones affect human hormone profiles?

Emad F. Eskander ✉, Selim F. Estefan, Ahmed A. Abd-Rabou

Objectives

This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations v human's hormone profiles.

Results

This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels.

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Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads

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Fig. 3. Street view on the Skeppsbron street with some of the mobile phone base station antennas pointed out with a circle; note the low placement of the antennas, where microwaves irradiate the pedestrian at close range.

A B S T R A C T

In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter. The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading from the entire area was 31.6 V m^{-1} (2648 mW m^{-2}). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.

Studies from recent decades have shown elevated health risk under long term exposure to such highly elevated radiofrequency fields.

A review by Khurana et al. (2010) found in 80% of the available studies neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations (Khurana et al., 2010). In another review exposure from base stations and other antenna arrays showed changes in immunological and reproductive systems as well as DNA double strand breaks, influence on calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells (Levitt and Lai, 2010).

When a GSM 900 MHz base station was installed in the village Rimbach in Germany it had an influence on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (Buchner and Eger, 2011). Influence on cortisol and thyroid hormones in people living near base stations was shown in other studies (Augner et al., 2010; Eskander et al., 2012).

Dode et al. (2011 compared base station (BS) clusters and cases of deaths by neoplasia in the Belo Horizonte municipality, Minas Gerais state, Brazil, from 1996 to 2006. In their study largest electric field was 12.4 V m^{-1} and the smallest was 0.4 V m^{-1}. They found cancer-related death rates be higher close to base stations. This finding confirmed earlier findings by Eger (Eger et al., 2004).

In a study from India, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. Genetic damage parameters of DNA migration length, damage frequency, and damage index were significantly ($p < 0.001$) elevated in the sample group compared to respective values in healthy controls (Gandhi et al., 2014).

The effect of RF radiation among 20 subjects living close to mobile phone base station compared with 20 subjects living with a distance of about 1 km was studied (Singh et al., 2016). The authors concluded that: "*It was unveiled that a majority of the subjects who were residing near the mobile base station complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties, and hypertension. A majority of the study subjects had significantly lesser stimulated salivary secretion ($p < 0.01$) as compared to the control subjects.*"

Zothansiama et al. (2017) in India inspected DNA damage a antioxidant status in cultured human peripheral blood lymphocy (HPBLs) of individuals residing in the vicinity of mobile phone b stations and compared it with healthy controls living further away. analyses of data from the exposed group (n = 40), residing withi perimeter of 80 m of mobile base stations, showed statistically sign cantly ($p < 0.0001$) higher frequency of micronuclei when compare the control group, residing 300 m away from the mobile base statio

The Ramazzini Institute findings (Falcioni et al., 2018) are suppor by the results in the USNTP study on rats and mice exposed to RF diation (National Toxicology Program, 2018a, 2018b). A clear evide of increased incidence of heart Schwannoma and some evidence glioma and tumours in the adreanal medulla in male rats was fo according to the expert panel, for further discussion see Hardell Carlberg (2019).

The study concluded that Skeppsbron street mobile phone base station antennas are examples of a poor radiofrequency infrastructure design with mobile phone base station antennas positioned into close range to the general public which brings upon high exposure levels. Given the low placement of the antennas (height from the street floor), the highest exposure was often registered at pedestrian head level. Given that head is one of most vulnerable parts of the body, these placements by mobile telephony service providers put pedestrians into unnecessary risk. Position of these antennas, can pose a health risk to people at close range. This is especially critical for people at particular risk, including persons with medical implants, pregnant women or chronically ill persons.

Based on the latest scientific literature regarding RF exposure and adverse health effects, this study recommends repositioning such base station antennas to areas away from the nearby inhabitants, workers and the general public. Alternatively, very low power antennas may also be considered to reduce the exposure. Occupational exposure of people

Current Alzheimer Research, 2022, *19*, 119-132

MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



Martin L. Pall[1,*]

[1]*Professor Emeritus of Biochemistry & Basic Medical Sciences, Washington State University, Current Address: 638 NE 41st Ave., Portland, OR 97232, USA*

Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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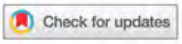
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The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines

Henry Lai[a] and B. Blake Levitt[b]

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ABSTRACT

In this paper, we review the literature on three important exposure metrics that are inadequately represented in most major radiofrequency radiation (RFR) exposure guidelines today: intensity, exposure duration, and signal modulation. Exposure intensity produces unpredictable effects as demonstrated by nonlinear effects. This is most likely caused by the biological system's ability to adjust and compensate but could lead to eventual biomic breakdown after prolonged exposure. A review of 112 low-intensity studies reveals that biological effects of RFR could occur at a median specific absorption rate of 0.0165 W/kg. Intensity and exposure duration interact since the dose of energy absorbed is the product of intensity and time. The result is that RFR behaves like a biological "stressor" capable of affecting numerous living systems. In addition to intensity and duration, man-made RFR is generally modulated to allow information to be encrypted. The effects of modulation on biological functions are not well understood. Four types of modulation outcomes are discussed. In addition, it is invalid to make direct comparisons between thermal energy and radiofrequency electromagnetic energy. Research data indicate that electromagnetic energy is more biologically potent in causing effects than thermal changes. The two likely functionthrough different mechanisms. As such, any current RFR exposure guidelines based on acute continuous-wave exposure are inadequate for health protection.

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Radiofrequency radiation (RFR); intensity; duration of exposure; modulation; specific absorption rate (SAR); biological effects

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MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



Martin L. Pall[1,*]

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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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REVIEW

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Genetic effects of non-ionizing electromagnetic fields

Henry Lai

Department of Bioengineering, University of Washington, Seattle, WA, USA

ABSTRACT

This is a review of the research on the genetic effects of non-ionizing electromagnetic field (EMF), mainly on radiofrequency radiation (RFR) and static and extremely low frequency EMF (ELF-EMF). The majority of the studies are on genotoxicity (e.g., DNA damage, chromatin conformation changes, etc.) and gene expression. Genetic effects of EMF depend on various factors, including field parameters and characteristics (frequency, intensity, wave-shape), cell type, and exposure duration. The types of gene expression affected (e.g., genes involved in cell cycle arrest, apoptosis and stress responses, heat-shock proteins) are consistent with the findings that EMF causes genetic damages. Many studies reported effects in cells and animals after exposure to EMF at intensities similar to those in the public and occupational environments. The mechanisms by which effects are induced by EMF are basically unknown. Involvement of free radicals is a likely possibility. EMF also interacts synergistically with different entities on genetic functions. Interactions, particularly with chemotherapeutic compounds, raise the possibility of using EMF as an adjuvant for cancer treatment to increase the efficacy and decrease side effects of traditional chemotherapeutic drugs. Other data, such as adaptive effects and mitotic spindle aberrations after EMF exposure, further support the notion that EMF causes genetic effects in living organisms.

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Radiofrequency radiation; static/extremely low frequency EMF; genetic effects; genotoxicity; gene expression

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Article

The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil

Nádia Cristina Pinheiro Rodrigues [1,2,*], Adilza Condessa Dode [3], Mônica Kramer de Noronha Andrade [1], Gisele O'Dwyer [1], Denise Leite Maia Monteiro [4], Inês Nascimento Carvalho Reis [1], Roberto Pinheiro Rodrigues [5,6], Vera Cecília Frossard [1] and Valéria Teresa Saraiva Lino [1]

Abstract: Background: this study aims to estimate the rate of death by cancer as a result of Radio Base Station (RBS) radiofrequency exposure, especially for breast, cervix, lung, and esophagus cancers. Methods: we collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime. We investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers). Results: in capitals where RBS radiofrequency exposure was higher than 2000/antennas-year, the average mortality rate was 112/100,000 for all cancers. The adjusted analysis showed that, the higher the exposure to RBS radiofrequency, the higher cancer mortality was. The highest adjusted risk was observed for cervix cancer (rate ratio = 2.18). The spatial analysis showed that the highest RBS radiofrequency exposure was observed in a city in southern Brazil that also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancer. Conclusion: the balance of our results indicates that exposure to radiofrequency electromagnetic fields from RBS increases the rate of death for all types of cancer.

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Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission

A B S T R A C T

Background: In 2011, IARC classified radiofrequency radiation (RFR) as possible human carcinogen (Group 2B). According to IARC, animals studies, as well as epidemiological ones, showed limited evidence of carcinogenicity. In 2016, the NTP published the first results of its long-term bioassays on near field RFR, reporting increased incidence of malignant glial tumors of the brain and heart Schwannoma in rats exposed to GSM – and CDMA – modulated cell phone RFR. The tumors observed in the NTP study are of the type similar to the ones observed in some epidemiological studies of cell phone users.

Objectives: The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2448 animals. In this article, we reported the final results regarding brain and heart tumors.

Methods: Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day.

Results: A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of heart Schwann cells hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), although this was not statistically significant. An increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant.

Conclusions: The RI findings on far field exposure to RFR are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the re-evaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.

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December 12, 2012

The Honorable Dennis Kucinich
2445 Rayburn House Office Building
Washington, DC 20515

Dear Representative Kucinich:

On behalf of the American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults, I would like to share our support of H.R. 6358, the *Cell Phone Right to Know Act*.

The AAP strongly supports H.R. 6358's emphasis on examining the effects of radiofrequency (RF) energy on vulnerable populations, including children and pregnant women. In addition, we are pleased that the bill would require the consideration of those effects when developing maximum exposure standards. Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes.

In addition, the AAP supports the product labeling requirements in H.R. 6358. These standards will ensure consumers can make informed choices in selecting mobile phone purchases. They will also enable parents to better understand the potential dangers of RF energy exposure and protect their children.

On July 24, the U.S. Government Accountability Office (GAO) published a report on federal cell phone radiation exposure limits and testing requirements. The GAO noted that the Federal Communications Commission's (FCC) most recent data indicates that the number of estimated mobile phone subscribers has grown from approximately 3.5 million in 1989 to approximately 289 million at the end of 2009. Cell phone use behaviors have also changed during that time. The quantity and duration of cell phone calls has increased, as has the amount of time people use mobile phones, while cell phone and wireless technology has undergone substantial changes. Many more people, especially adolescents and young adults, now use cell phones as their only phone line, and they begin using wireless phones at much younger ages.

Despite these dramatic changes in mobile phone technology and behavior, the FCC has not revisited the standard for cell phone radiation exposure since 1996. The current FCC standard for maximum radiation exposure levels is based on the heat emitted by mobile phones. These guidelines specify exposure limits for hand-held wireless devices in terms of the Specific Absorption Rate (SAR), which measures the rate the body absorbs radiofrequency (RF). The current allowable SAR limit is 1.6 watts per kilogram (W/kg), as averaged over one gram of tissue. Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF energy exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma.

In May 2011, the International Agency for Research on Cancer (IARC), the United Nations' World Health Organization's (WHO) agency promoting international cancer research collaboration, classified RF energy as "possibly carcinogenic to humans." In addition, the National Cancer Institute has stated that although studies have not definitively linked RF energy exposure from cell phones to cancer, more research is required to address rapidly changing cell phone technology and use patterns.

This and other research identified by the GAO demonstrates the need for further research on this issue, and makes clear that exposure standards should be reexamined.

The GAO concluded that the current exposure limits may not reflect the latest research on RF energy, and that current mobile phone testing requirements may not identify maximum RF energy exposure. The GAO proposed that the FCC formally reassess its limit and testing requirements to determine whether they are effective. The AAP commends the activities proposed under H.R. 6358, as they would address this research gap and improve consumer knowledge and safety. Establishing an expanded federal research program as the basis for exposure standards will ensure that consumer protections incorporate the latest research. Currently, the National Institute of Health (NIH), the only federal agency the GAO identified as directly funding research on this topic, provided approximately $35 million from 2001 to 2011. Given this previous funding level, the AAP supports the $50 million per fiscal year for seven years that H.R. 6358 would authorize.

The AAP appreciates your recognition of the need for new research and standards for mobile phone radiation, and is pleased to support H.R. 6358. For further assistance, please do not hesitate to contact Sonya Clay, Assistant Director, Department of Federal Affairs, at 202-347-8600 or sclay@aap.org.

Sincerely,



Thomas K. McInerny, MD, FAAP
President

Electromagnetic Fields: A Hazard to Your Health?

In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.

Content on this page excerpted from the American Academy of Pediatrics website Healthy Children.org at https://www.healthychildren.org/English/safety-prevention/all-around/Pages/Electromagnetic-Fields-A-Hazard-to-Your-Health.aspx

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August 29, 2013

The Honorable Mignon L. Clyburn
Acting Commissioner
Federal Communications Commission
445 12th Street SW
Washington, DC 20054

The Honorable Dr. Margaret A. Hamburg
Commissioner
U.S. Food and Drug Administration
10903 New Hampshire Avenue
Silver Spring, MD 20993

Dear Acting Chairwoman Clyburn and Commissioner Hamburg:

The American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults appreciates this opportunity to comment on the Proposed Rule "Reassessment of Exposure to Radiofrequency Electromagnetic Fields Limits and Policies" published in the Federal Register on June 4, 2013.

In the past few years, a number of American and international health and scientific bodies have contributed to the debate over cell phone radiation and its possible link to cancer. The International Agency for Research on Cancer (IARC), part of the United Nations' World Health Organization, said in June 2011 that a family of frequencies that includes mobile-phone emissions is "possibly carcinogenic to humans." The National Cancer Institute has stated that although studies have not demonstrated that RF energy from cell phones definitively causes cancer, more research is needed because cell phone technology and cell phone use are changing rapidly. These studies and others clearly demonstrate the need for further research into this area and highlight the importance of reassessing current policy to determine if it is adequately protective of human health.

As radiation standards are reassessed, the AAP urges the FCC to adopt radiation standards that:

- **Protect children's health and well-being**. Children are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standard for cell phones or other wireless devices be based on

protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes.

- **Reflect current use patterns**. The FCC has not assessed the standard for cell phone radiation since 1996. Approximately 44 million people had mobile phones when the standard was set; today, there are more than 300 million mobile phones in use in the United States. While the prevalence of wireless phones and other devices has skyrocketed, the behaviors around cell phone uses have changed as well. The number of mobile phone calls per day, the length of each call, and the amount of time people use mobile phones has increased, while cell phone and wireless technology has undergone substantial changes. Many children, adolescents and young adults, now use cell phones as their only phone line and they begin using wireless phones at much younger ages. Pregnant women may carry their phones for many hours per day in a pocket that keeps the phone close to their uterus. Children born today will experience a longer period of exposure to radio-frequency fields from cellular phone use than will adults, because they start using cellular phones at earlier ages and will have longer lifetime exposures. FCC regulations should reflect how people are using their phones today.

- **Provide meaningful consumer disclosure**. The FCC has noted that it does not provide consumers with sufficient information about the RF exposure profile of individual phones to allow consumers to make informed purchasing decisions. The current metric of RF exposure available to consumers, the Specific Absorption Rate, is not an accurate predictor of actual exposure. AAP is supportive of FCC developing standards that provide consumers with the information they need to make informed choices in selecting mobile phone purchases, and to help parents to better understand any potential risks for their children. To that end, we support the use of metrics that are specific to the exposure children will experience.

The AAP supports the reassessment of radiation standards for cell phones and other wireless products and the adoption of standards that are protective of children and reflect current use patterns. If you have questions, please contact Clara Filice in the AAP's Washington Office at 202/347-8600.

Sincerely,



Thomas K. McInerny, MD FAAP
President

TKM/cf

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July 12, 2012

The Honorable Julius Genachowski
Commissioner
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Chairman Genachowski:

The American Academy of Pediatrics (AAP), a non-profit professional organization of 60,000 primary care pediatricians, pediatric medical sub-specialists, and pediatric surgical specialists dedicated to the health, safety and well-being of infants, children, adolescents, and young adults strongly supports the proposal for a formal inquiry into radiation standards for cell phones and other wireless products. The Academy encourages the Federal Communications Commission (FCC) to vote to move forward with this inquiry in an expeditious manner.

The FCC has not assessed the standard for cell phone radiation since 1996. According to industry groups, approximately 44 million people had mobile phones when the standard was set; today, there are more than 300 million mobile phones in use in the United States. While the prevalence of wireless phones and other devices has sky-rocketed, the behaviors around cell phone uses have changed as well. The number of mobile phone calls per day, the length of each cell phone call, and the amount of time people use mobile phones has increased, while cell phone and wireless technology has undergone substantial changes. Many more people, especially adolescents and young adults, now use cell phones as their only phone line and they begin using wireless phones at much younger ages.

The FCC standard for maximum radiation-exposure levels are based on the heat emitted by mobile phones. These guidelines specify exposure limits for hand-held wireless devices in terms of the Specific Absorption Rate (SAR), which measures the rate the body absorbs radiofrequency (RF). The current allowable SAR limit is 1.6 watts per kilogram (W/kg), as averaged over one gram of tissue. Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma.

In the past few years, a number of American and international health and scientific bodies have contributed to the debate over cell phone radiation and its possible link to cancer. The International Agency for Research on Cancer (IARC), part of the

United Nations' World Health Organization, said in June 2011 that a family of frequencies that includes mobile-phone emissions is "possibly carcinogenic to humans." The National Cancer Institute has stated that although studies have not demonstrated that RF energy from cell phones definitively causes cancer, more research is needed because cell phone technology and cell phone use are changing rapidly. While a definitive link between cell phone radiation and brain cancer has not been established, these studies and others clearly demonstrate the need for further research into this area and highlight the importance of reassessing the current SAR to determine if it is protective of human health.

The AAP believes the inquiry to reassess the radiation standard presents an opportunity to review its impacts on children's health and well-being. In the past, such standards have generally been based on the impact of exposure on an adult male. Children, however, are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. In fact, according to IARC, when used by children, the average RF energy deposition is two times higher in the brain and 10 times higher in the bone marrow of the skull, compared with mobile phone use by adults. While the Academy appreciates that the FCC is considering investigating whether the emission standards should be different for devices primarily used by children, it is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes.

Finally, in reviewing the SAR standard, the FCC has the opportunity to highlight the importance of limiting media use among children. The Academy has found potentially negative effects and no known positive effects of media use by children under the age of two, including television, computers, cell phones, and other handheld wireless devices. In addition, studies consistently show that older children and adolescents utilize media at incredibly high rates, which potentially contributes to obesity and other health and developmental risks. In reviewing the SAR limit, the FCC has the opportunity to improve the health of our nation by highlighting the importance of limiting screen time and media use for children and adolescents.

The AAP supports the proposal for a formal inquiry into radiation standards for cell phones and other wireless products and the Academy encourages the FCC to vote in favor of moving forward with this investigation. If you have questions or concerns, please contact Kristen Mizzi in the AAP's Washington Office at 202/347-8600.

Sincerely,



Robert W. Block, MD FAAP
President

RWB/km

To Whom It May Concern:

Dear Sirs/Madams:

I am Scientist Emeritus and Former Director of the National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health. I am currently a Scholar in Residence at the Nicholas School of the Environment at Duke University.

Wireless networks, cell towers and cell phones create radiofrequency radiation emissions. U.S. FCC limits for human exposure to radiofrequency were last reviewed in 1996 and based on the assumption that heating is the only harmful effect. Aware that the FCC's 1996 limits lacked the underpinning of solid scientific data regarding long term health effects, the FDA requested large-scale studies by the National Toxicology Program (NTP) and in 2018 the NTP studies found clear evidence of an association with cancer in male rats. Additionally, the NTP found heart damage and DNA damage, despite the fact that the animals were carefully exposed to non-heating RFR levels long assumed to be safe. The Ramazzini Institute animal studies used even lower RFR lower exposures to approximate cell tower emissions and also found increases of the same tumor type. The NTP studies were carefully controlled to ensure exposures did not significantly heat the animals. The animal study findings in combination with human studies indicate adverse effects from non heating levels of radiofrequency.

I document the importance of the NTP findings of effects from non thermal exposures in my declaration in an Amicus Brief for the case Environmental Health Trust et al v. the FCC. The August 13, 2021 judgment ordered the FCC to address several issues including the health implications of long term exposures.

A mounting body of published studies associates radiofrequency radiation with adverse negative health effects. FCC limits need to be strengthened to protect the public, especially children and vulnerable populations, from long term exposures.

Linda S. Birnbaum, PhD
Scientist Emeritus and Former Director
National Institute of Environmental Health Sciences and National Toxicology Program
Scholar in Residence, Duke University, Former President, Society of Toxicology
Adjunct Professor, Yale University and UNC, Chapel Hill, Visiting Professor, Queensland University (Australia)

National Toxicology Program Radiofrequency Radiation
https://ntp.niehs.nih.gov/whatwestudy/topics/cellphones/index.html

Amicus Brief of Joe Sandri, August 5, 2020
https://ehtrust.org/wp-content/uploads/20-1025-Amicus-Brief-Joe-Sandri.pdf

Falcioni et al., Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission, Environmental Research, Volume 165, 2018,
Pages 496-503 DOI: 10.1016/j.envres.2018.01.037

Priyanka Bandara, David O Carpenter, Planetary electromagnetic pollution: it is time to assess its impact, The Lancet Planetary Health, Volume 2, Issue 12, 2018, Pages e512-e514,ISSN 2542-5196, https://doi.org/10.1016/S2542-5196(18)30221-3.

Schuermann D, Mevissen M. Manmade Electromagnetic Fields and Oxidative Stress—Biological Effects and Consequences for Health.International Journal of Molecular Sciences. 2021; 22(7):3772. https://doi.org/10.3390/ijms22073772

Smith-Roe SL., et al., Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure, Environ Mol Mutagen 2020; 61 (2): 276-290

MARYLAND MATTERS

Opinion: Children Deserve Safety Assurances When It Comes to Cellphone Radiation

July 23, 2021 Online Link

If new zoning proposals before Montgomery County Council pass, our children and the rest of us may be exposed to levels of radiation that remain untested for their impact on our health and that of the environment.

For 5G and small cell towers, many localities have large setbacks for the new networks. Petaluma, California, has a 500-foot setback. Los Altos, Calif., requires a 500-foot setback from schools.

While the National Toxicology Program shows clear evidence that this radiation can cause cancer and DNA damage, Montgomery County stands poised to allow cell towers closer to homes and schools with minimal restrictions.

Cellphones have become a rite of passage for our children. Most parents believe that cellphones were safety-tested before they came on the market.

We assume that our federal health and environmental agencies regularly review the latest research and ensure that these incredible devices are safe. They do not.

The reality is that U.S. safety regulations for cellphone radiation were last set 25 years ago based on science that is now outdated. Federal agencies such as the Environmental Protection Agency, the National Cancer Institute, and the Food and Drug Administration have not carried out up-to-date full scientific review of this growing technology.

Just like the thousands of chemicals in our environment today, wireless radiation has not had appropriate oversight. It has slipped through the cracks.

Cell tower radiation levels are generally tested by companies hired by the cell tower companies, and municipalities do not require ongoing monitoring. In apartment buildings where cell towers may be erected in front of bedroom windows, or on school grounds,

children may be exposed to much higher levels than those on the ground. There are no laws requiring spot-checking to ensure radiation levels are compliant with the outdated limits we have in place.

Pediatricians have long called for an update to this outdated cellphone radiation test method because research finds children can absorb up to 10 or more times higher radiation than adults into their brain, eyes and bone marrow.

Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible.

Unlike my generation, today's youth will be exposed for years and years.

The U.S. does not have federally developed safety limits for cellphone radiation. No federal health agency has investigated if U.S. cellphone radiation and cell tower safety limits and testing procedures ensure adequate protection for children or for pregnant women.

The FDA and Centers for Disease Control have not reviewed the growing body of current research on how cellphone radiation might impact brain development. No U.S. agency ever has.

It is therefore inappropriate and unsafe for Montgomery County to allow the installation of a 5G and new wireless networks so close to homes throughout the county.

—DR. JEROME A. PAULSON

The writer is professor emeritus of pediatrics, and environmental and occupational health at George Washington University School of Medicine and Health Sciences and George Washington University Milken Institute School of Public Health.

Dr. Jerome Paulson has served as chair of the Environmental Health Council of the American Academy of Pediatrics and served on the Children's Health Protection Advisory Committee for the US EPA.

Massachusetts Joint Committee on Consumer Protection
Massachusetts Joint Committee on Advanced Information Technology, the Internet and Cybersecurity Committee
24 Beacon St. Room 506
Boston, MA 02133

Subject: In Support of Technology Safety Bills S. 186, S. 187, H. 115, H. 105-114

Dear Esteemed Legislators,

I am writing in support of legislation that which reduces RFR exposure, especially for children who are more vulnerable.

I am Professor Emeritus of Pediatrics and of Environmental & Occupational Health George Washington University School of Medicine and Health Sciences and George Washington University Milken Institute School of Public Health. I am also past chair of the Council on Environmental Health of the American Academy of Pediatrics, and also served on the Children's Health Protection Advisory Committee for the US EPA.

We assume that our federal health and environmental agencies regularly review the latest research and ensure that cell phones and wireless devices are safe. However, U.S. agencies which regulate cell phone radiation have not shown they have evaluated the research on children's unique vulnerability to ensure long term safety.

The reality is that US safety regulations for cell phone radiation were last set twenty-five years ago based on science that is now outdated. The Federal Communications Commission (FCC) is the primary agency responsible for regulating wireless radiation. The FCC has no expertise related to human health topics. Moreover, federal agencies like the Environmental Protection Agency or the National Cancer Institute or the Food and Drug Administration have not carried out up-to-date full scientific review of this growing technology. Just like the thousands of chemicals in our environment today, wireless radiation has not had appropriate oversight. It has slipped through the cracks.

The one agency which has carried out studies on the impact of long term exposure to electromagnetic fields and human health is the National Toxicology Program (NTP), a component of the National Institute of Environmental Health Sciences. The NTP found:

- **Clear evidence of an association with tumors in the hearts of male rats.** The tumors were malignant schwannomas.
- **Some evidence of an association with tumors in the brains of male rats.** The tumors were malignant gliomas.
- **Some evidence of an association with tumors in the adrenal glands of male rats.** The tumors were benign, malignant, or complex combined pheochromocytoma.

Pediatricians have long called for an update to this outdated cell phone radiation test method because research finds children can absorb up to 10 or more times higher wireless radiation than adults into their brain, eyes and bone marrow. Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible. Unlike my generation, today's youth will be exposed for years and years.

Please support legislation that reduces children's radiofrequency radiation exposure and call on the federal government to strengthen human exposure limits to protect children. I am glad to answer any questions that you have.

Sincerely,



Jerome Paulson MD FAAP

OXFORD

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Correspondence

RE: Cellular Telephone Use and the Risk of Brain Tumors: Update of the UK Million Women Study

Linda S. Birnbaum, PhD [1], Hugh S. Taylor, MD,[2] Hillel Baldwin, MD,[3] Paul Ben-Ishai, PhD [4,5] Devra Davis, PhD, MPH [6,*]

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The Million Women Study has yielded a number of life-saving findings linking menopausal hormone therapy with breast cancer. However, a recent analysis of self-reported cell phone use of this original cohort by Shuz et al. (1) contains a number of serious errors and flaws of exposure measurement that undermine the validity of their widely publicized finding purporting that there is no risk of brain cancer from cell phone radiofrequency radiation (RFR).

Unsurprisingly for women now in their 70s and 80s, only 18% of cell phone users reported 30 minutes or more weekly use when asked in median years 2001 and 2011. Systematic reviews find increased tumor risk tied to cumulative call time of no less than 1000 hours (2). Yet, this study combined slight and regular mobile phone users.

Most are unaware that cell phones and cordless phones continuously emit RFR, which is absorbed into the brain and body. As more than 80% of UK households had landlines during the study period, it is likely many of the older women in this cohort used cordless phones, a significant source of RF unevaluated by this study.

Further, the National Toxicology Program (NTP) and Ramazzini Institute (RI) experimental animal studies are inaccurately criticized as based on small numbers, inconsistency across species, and excessively high exposures (3,4). The several thousand animals studied by the NTP and RI approximated in rodents a lifetime of human RFR exposures, and both found an increase in the same types of tumors, corroborating accumulated evidence of adverse effects at low levels.

Current outdated regulatory limits for phone RFR rest on the incorrect long-held assumption that nonthermal levels are safe. The NTP's highest RFR exposures were below thermal thresholds and below US FCC occupational guidelines of 8 W/kg specific absorption rate. In addition to "clear evidence" of carcinogenicity in male rats, the NTP found DNA damage in organs of rats and mice as well as induction of right ventricle cardiomyopathy in both male and female rats. The findings of these studies indicate that the long-held assumption that heating is the only harm from wireless RFR is no longer valid.

Shuz et al. (1) mischaracterized the RI study as using excessively high exposures. However, the RI study was designed to mimic low-level cell tower RFR exposures. In 2011, the International Agency for Research on Cancer classified RFR as a "possible human carcinogen" (5) based largely on increased tumors among long-term cell phone users. Concordance of tumor cell types with these experimental animal studies strengthens the association.

The majority of animal and cell studies have found nonionizing RFR can induce oxidative stress—a key characteristic of human carcinogens and a way that RFR can initiate or promote tumor development as well as play a role in the development of other diseases (6).

Recent experimental and epidemiological studies indicate that RFR also induces cancers of the thyroid and breast (7,8). DNA damage and cancer in these state-of-the-art studies signal the need for the public to reduce exposures to RFR now.

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Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer

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ABSTRACT

The objective of this work was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base station antennas on humans. Studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Overall results of this review show three types of effects by base station antennas on the health of people: radiofrequency sickness (RS), cancer (C) and changes in biochemical parameters (CBP). Considering all the studies reviewed globally (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters. Furthermore, studies that did not meet the strict conditions to be included in this review provided important supplementary evidence. The existence of similar effects from studies by different sources (but with RF of similar characteristics), such as radar, radio and television antennas, wireless smart meters and laboratory studies, reinforce the conclusions of this review. Of special importance are the studies performed on animals or trees near base station antennas that cannot be aware of their proximity and to which psychosomatic effects can never be attributed.

1. Introduction

During the last few decades, hundreds of thousands of mobile phone base stations and other types of wireless communications antennas have been installed around the world, in cities and in nature, including protected natural areas, in addition to pre-existing antennas (television, radio broadcasting, radar, etc.). Only the aesthetic aspects or urban regulations have been generally considered in this deployment, while the biological, environmental and health impacts of the associated non-ionizing electromagnetic radiation emissions have not been assessed so far. Therefore, the effects on humans living around these anthropogenic electromagnetic field sources (antennas) have not been considered.

In France, there is a significant contribution of mobile phone base stations in the exposure to radiofrequency electromagnetic fields (RF-EMF) of urban citizens living nearby (De Giudici et al., 2021). Some studies from India indicate that more than 15% of people have levels of EMF strength above 12 V/m due to their proximity to antennas (Premlal and Eldhose, 2017). Exposure estimates have shown that RF-EMF from mobile telephone systems is stronger in urban than in rural areas. For instance, in Sweden the levels of RF radiation have increased considerably in recent years, both outdoor and indoor, due to new telecommunication technologies, and the median power density measured for RF fields between 30 MHz and 3 GHz was 16 $\mu W/m^2$ in rural areas, 270 $\mu W/m^2$ in urban areas and 2400 $\mu W/m^2$ in city areas (Hardell et al., 2018). Total exposure varies not only between urban and rural areas but also, depending on residential characteristics, between different floors of a building, with a tendency for building exposure to increase at higher floors (Breckenkamp et al., 2012).

Over the past five decades, and more intensively since the beginning of this century, many studies and several reviews have been published on the effects of anthropogenic electromagnetic radiation on humans living around the antennas. The first studies were carried out with radio and television antennas, investigating increases in cancer and leukaemia (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; Michelozzi et al., 1998; Altpeter et al., 2000), as well as around radars (Kolodynski and Kolodynska, 1996; Goldsmith, 1997).

Regarding base station antennas, there are scientific discrepancies in their effects: some studies concluded that there are no health-related effects (e.g. Augner and Hacker, 2009; Blettner et al., 2009; Röösli et al., 2010; Baliatsas et al., 2016) whereas others found increases in cancer and other health problems in humans living around antennas (e.g. Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004;

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Eger et al., 2004; Wolf and Wolf, 2004; Abdel-Rassoul et al., 2007; Khurana et al., 2010; Dode et al., 2011; Shinjyo and Shinjyo, 2014; Gandhi et al., 2015; López et al., 2021; Rodrigues et al., 2021). There is a specific symptomatology linked to radar and RF exposure at low levels, characterized by functional disturbances of the central nervous system (headache, sleep disturbance, discomfort, irritability, depression, memory loss, dizziness, fatigue, nausea, appetite loss, difficulty in concentration, dizziness, etc.), that has been termed 'RF sickness' (Lilienfeld et al., 1978; Johnson Lyakouris, 1998; Navarro et al., 2003).

The objective of this study was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base stations on humans living around the antennas.

2. Methods

A search was performed in the EMF portal, Google Scholar and PubMed databases with the words: "mobile phone base station and health" or "cell tower and health".

Only studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Studies conducted in larger regions with numerous antennas, based on surveys and geographic data, were also included.

On the contrary, studies were excluded that considered different sources of electromagnetic radiation, such as mobile phone base stations together with broadcast transmitters (TV and radio), radar, mobile phones, cordless phones, Wi-Fi or wireless smart meters. Also excluded were those that included antennas and powerlines jointly. Studies that only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with health effects, were excluded, as were surveys on risk perception and the nocebo effect, modelled radiofrequency electromagnetic field exposure from mobile-phone base stations or perceived exposure. All experimental laboratory studies, experiments in an exposure chamber or adapted room were also excluded. Finally, the comments or criticism of previously published studies were also excluded. However, due to their importance the conclusions of some of the excluded studies will be discussed in the corresponding section.

3. Results

The studies that met the selected criteria are presented in chronological order in Table 1, catalogued as Y/N depending on whether or not they found effects. The selected studies cover three types of effects: radiofrequency sickness (RS) (according to Lilienfeld et al., 1978; Johnson Lyakouris, 1998), cancer (C) and changes in biochemical parameters (CBP). Table 1 also includes the authors, year and country, antenna type, study design, diseases and symptoms found/not found and the main conclusions of each study.

Considering all the selected studies (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters (Fig. 1). Therefore, most of the studies carried by research groups from twenty different countries reach the same conclusions.

For the reasons previously explained, the following studies (n = 85) were not considered in this review, even though the conclusions of some of these studies will be discussed later due to their importance regarding the similarities of the electromagnetic radiation types involved and the health effects found in many cases. Several studies only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with the effects on health (e.g. Aniołczyk, 1999; Henderson and Bangay, 2006; Keow and Radiman, 2006; Neitzke et al., 2007; Bürgi et al., 2008; Augner et al., 2009; Chen and Chuang, 2009; Schmiedel et al., 2009; Viel et al., 2009; Hansson et al., 2011; Alhekail et al., 2012; Breckenkamp et al., 2012; Beekhuizen et al., 2013; Bürgi et al., 2014; Lyare et al., 2019; Urbinello et al., 2014; Lemaire et al., 2016; Admawi, 2021; De Giudici et al., 2021; Kazaure et al., 2021; Yetiş and Kayili, 2021). Some were surveys on risk perception and the nocebo effect, modelled RF-EMF exposure from mobile-phone base stations or perceived exposure (Wiedemann et al., 2006; Dohle et al., 2012; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Martens et al., 2017; Koh et al., 2020). Others jointly considered various sources of electromagnetic fields such as telephone antennas, mobile phones, cordless phones, Wi-Fi, powerlines or wireless smart meters (Seitz et al., 2005; Baliatsas et al., 2011; Atzmon et al., 2012; Eskander et al., 2012; Frei et al., 2012; Lamech, 2014; Singh and Pati, 2016; Boehmert et al., 2020; Akkam et al., 2020). Some studied the effects of radio or television antennas (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; McKenzie et al., 1998; Michelozzi et al., 1998; Altpeter et al., 2000; Hocking and Gordon, 2000; Boscolo et al., 2001; Cooper et al., 2001; Michelozzi et al., 2002; Hallberg and Johansson, 2002; Elwood, 2003; Ha et al., 2003; Park et al., 2004; Abelin et al., 2005; Altpeter et al., 2006; Ha et al., 2007; Satta et al., 2018). Others were radar studies (Kolodynski and Kolodynska, 1996; Goldsmith, 1997; Szmigielski et al., 2001; Yakymenko et al., 2011; Schoeni et al., 2016; Martens et al., 2018). Some studies performed experiments in a laboratory, exposure chamber or adapted room, with simulated or real electromagnetic radiation from base station antennas (e.g. Zwamborn et al., 2003; Hinrichs et al., 2005; Regel et al., 2006, 2007; Eltiti et al., 2007; Leitgeb et al., 2008; Riddervold et al., 2008; Augner et al., 2009; Augner et al., 2010; Wallace et al., 2010; Danker-Hopfe et al., 2010; Falcioni et al., 2018; Azimzadeh and Jelodar, 2019; Smith-Roe et al., 2020). Some reports were comments or criticisms of previously published studies (e.g. Coggon, 2006; Röösli and Huss, 2008; Bithell, 2010; Dode and Leão, 2012; Foster and Trottier, 2012; Mortazavi, 2014, 2017).

4. Discussion

The results of this review show three types of effects by base station antennas on the health of humans: radiofrequency sickness, cancer and changes in biochemical parameters (Fig. 1). From among all these studies, most of them found effects (73.6%). Thus, despite some limitations and differences in study design, statistical measures, risk estimates and exposure categories (Khurana et al., 2010), together they provide a consistent view of the effects on the health of people living in the vicinity of base station antennas.

Studies conducted in large regions with numerous antennas, based on surveys and geographic data (e.g. Augner and Hacker, 2009; Dode et al., 2011; Baliatsas et al., 2016; Martens et al., 2017; Dode et al. al., 2021), have the limitation that there may be many factors other than the base station antennas affecting the health of the population (environmental and occupational determinants of diseases and symptoms, individual characteristics such as food and life habits, activity level, smoking, self-medication, individual pathologies or genetic factors) that can act as confounding factors. It is important to mention here that the meters used for power density measurements in research papers should have more high quality equipment and better measurement methods.

On the other hand, some studies did not meet the strict conditions to be considered in this review, but due to their importance regarding the similarities of the electromagnetic radiation types involved and the effects found in many cases, they provide important supplementary evidence, as we will see in the next paragraphs.

For example, mobile phone users had an increased risk of headache (one of the typical symptoms for RF sickness near base station antennas) compared with non-users, and the risk of headache was also increased in those who had a longer daily call duration and higher daily call frequency (Wang et al., 2017). The same was also seen with cancer (Hardell et al., 2007). On the other hand, the symptoms caused by wireless smart meters were similar to those reported by people exposed to RF fields emitted by mobile phones (Lamech, 2014).

Table 1
Studies that met the selected criteria.

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
1 Y RS	Santini et al. (2002), 2003a and 2003b France	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 530 people	Effects found on: -tiredness -headache -sleep disturbance -discomfort -irritability -depression -memory loss -dizziness -libido decrease -visual perturbations	Effects occur up to a distance of 300 m from the antenna. Older subjects are more sensitive. Also, hat the facing location is the worst position for some symptoms s tudied, especially for distances till 100 m from base stations. The frequency of reported complaints is significantly higher for women in comparison with men
2 Y RS	Gómez-Perretta et al., 2013 Spain	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 101 people and electric field measurements	Effects found on: -fatigue -irritability -headache -nausea -appetite loss -discomfort -sleep disturbance -depression -difficulty in concentration -dizziness	Significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure. The incidence of most of the symptoms was related to exposure levels, independently of the demographic variables and some possible risk factors. Health changes related with GSM exposure seem to occur in a manner unrelated with those fears
3 Y RS	Bortkiewicz et al. (2004) Poland	Base station antennas	Review of previous publications	Effects found on: -circulatory system -sleep disturbances -irritability depression -blurred vision -concentration -difficulties nausea -lack of appetite -headache -vertigo	Relationship between the incidence of individual symptoms, the level of exposure, and the distance. This association was observed in both groups of persons, those who linked their complaints with the presence of the base station and those who did not notice such a relation.
4 Y C	Eger et al. (2004) Germany	2 Base station antennas	Number of cancer cases in the selected population (1045 resident) in Naila to compare results an inner area (within a distance of 400 m from the base station antennas) and outer area (beyond 400 m).	The number of newly developed cancer cases in the inner area is more than the expected number taken from the cáncer register, which represents the total population being irradiated. The group who had lived during the past five years within a distance of 400 m from the Base station antennas have a two times higher risk of developing cancer than that of the average population. The relative risk of getting cancer in the inner área compared with the Saarland cancer register is 1.7.	The risk of newly developing cancer was three times higher among those patients who had lived during past ten years (1994–2004), within a distance of 400 m From the cellular transmitter, in comparison to those who had lived further away.
5 Y C	Wolf and Wolf (2004) Israel	1 Base station antenna	A cancer incidence study to investigate the incidence of cancer cases of individuals (the cohort included 622 people) exposed to a Base station antenna, in comparison to those of a nearby clinic out of that area, to the national incidence rates of the whole country and to the incidence rates in the whole town of Netanya	There were 4.15 times more cases of cáncer in area A (breast carcinoma, ovary carcinoma, lung carcinoma, Hodgkin's disease, osteoid osteoma, and hypernephroma) than in the entire population.	The study indicates an association between an increased incidence of cancer and living in proximity to a Base station antenna.
6 Y RS	Hutter et al. (2006) Austria	10 Base station antennas in the 900 MHz band	Questionnaire survey in 365 subjects and exposure measurements	Effects found on: -headache -difficulties to concéntrate -Cold hands or feet No effects found on: -vertigo -palpitations -tremor -hot flushes -sweating -loss of apetite -loss of energy, -exhaustion -tiredness	Self-reported symptoms like headache and difficulties in concentrating show an association with microwave exposure from base stations, not attributable to subjects' fear of health effects from these sources. Other symptoms, like sleeping problems, seem to be more due to fear of adverse health effects than actual exposure.

(*continued on next page*)

Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-feeling strained -sleep	
7 Y RS	Abdel-Rassoul et al. (2007) Egypt	Base station antennas (GSM)	Questionnaire survey on 85 exposed persons and 80 controls	Effects found on: -headache -memory changes -dizziness -tremors -depressive symptoms -sleep disturbance No effects found on: -Blurred visión -Irritability -Lack of concentration	The prevalence of neuropsychiatric complaints were significantly higher among exposed inhabitants than controls. Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition.
8 N CBP	Augner and Hacker (2009) Austria	Base station antennas	Questionnaire survey on fifty-seven participants and saliva samples	Self-declared base station neighbors (≤100 m) had significantly higher concentrations of alpha-amylase in their saliva, higher rates in symptoms, somatization, obsessive-compulsive, anxiety, phobic anxiety. There were no differences in EMF-related health concern scales.	Self-declared base station neighbors are more strained than others. EMF-related health concerns cannot explain these findings.
9 N RS	Blettner et al. (2009) Berg-Beckhoff et al. (2009) Germany	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Questionnaire survey on 30,047 participants and geo-coding information on the residence distance (less or more than 500 m) to the nearest mobile phone base station. In a second phase RF measurements were conducted for a sub-sample in the households of 1500 persons	The mailed questionnaire included a list of 38 symptoms that have been reported in previous studies to be possibly associated with RF-EMF exposure	Participants who were concerned about or attributed adverse health effects to mobile phone base stations and those living in the vicinity of a mobile phone base station (500 m), reported slightly more health complaints tan others. The observed slightly higher prevalence of health complaints near base stations cannot be explained by attributions or concerns alone. The worries and health complaints of people living close to mobile phone base stations need to be taken seriously. Measured RF-EMFs emitted from mobile phone base stations were not associated with health disturbances. However, the study shows that sleep disturbances and health complaints are related to the attribution of adverse health effects to mobile phone base stations.
10 Y RS C	Kundi and Hutter (2009) Austria	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	There are indications from epidemiology that such exposures affect wellbeing and health weakly supported by human provocation studies and an inconclusive body of evidence from animal and in vitro studies. Cross-sectional investigations of subjective health as a function of distance or measured field strength, despite differences in methods and robustness of study design, found indications for an effect of exposure that is likely independent of concerns and attributions. Two ecological studies of cancer in the vicinity of base stations report both a strong increase of incidence within a radius of 350 and 400 m respectively. Due to the limitations inherent in this design no firm conclusions can be drawn, but the results underline the urgent need for a comprehensive investigation of this issue
11 Y C	Eger and Jahn (2010) Germany	Base station antennas	Questionnaire survey on 255 persons	Effects found on: -sleep problems -depression -headaches -cerebral affections -concentration difficulties -joint problems -infections -skin problems	A significant relationship between mean exposure levels of the study participants and reported health symptoms. Within the 400-m radius around the transmitter, a higher symptom rate could be documented for 14 out of 19 symptom groups in the highest exposure groups compared to groups

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-dizziness -cardiovascular problems -disturbance of equilibrium -visual problems -nosebleed -gastrointestinal problems No effects found on: -toothaches -hormonal imbalances -weight gain -weight loss	further away from the transmitter and the difference is statistically significant. Decreasing symptom scores in relation to decreasing mean exposure levels caused by cell phone transmitter emissions
12 N C	Elliott et al. (2010) Great Britain	Base station antennas	Data on all registered cases of cancer in children aged 0–4 in Great Britain and data on mobile phone base stations to investigate the risk of early childhood cancer associated with the mother's exposure to radiofrequency from and proximity to mobile phone base stations during pregnancy.	Of the 1397 cases, there were 251 brain and central nervous system cancers and 527 cases of leukaemia and non-Hodgkin's lymphoma. The study found no association between mobile phone base stations and risk of cáncer.	In this systematic national investigation the authors found no association between risk of cancer in young children and estimated exposures to radiofrequency from mobile phone base stations during pregnancy. However there is a research paper limitation on page 5: "our models did not include information on other sources of radiofrequency exposure, such as from microcells or picocells" and the city centers (especially) are full of these kind of antennas.
13 Y RS C	Khurana et al. (2010) international	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	The authors identified a total of 10 epidemiological studies that assessed for putative health effects of mobile pone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. The authors found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations.
14 N RS	Röösli et al. (2010) Switzerland	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Systematic review	There are no adverse effects	Not indication of an association between any health outcome and RF-EMF exposure from mobile phone base stations at levels typically found in our everyday environment. There is also no evidence that EHS individuals are more susceptible to base station radiation than the rest of the population. The evidence for the absence of long-term effects is limited.
15 N CBP C	Yildirim et al. (2010) Turkey	Base station antennas	Blood samples to analise the micronucleus (MN) frequency and chromosomal aberrations on blood in people living around mobile phone base stations and healthy controls.	There was not a significant difference of MN frequency and chromosomal aberrations between the two study groups.	Mobile phones and their base stations do not produce important carcinogenic changes.
16 Y RS	Alazawi, 2011 Iran	8 Base station antennas	Questionnaire survey on 375 subjects. Not measurements	Effects found on: -headaches -sleep disturbances -irritability -depressive -tendencies -feeling of discomfort, -difficulties in concentration -memory loss -lowering of libido	This study shows that inhabitants living nearby mobile phone base stations are at risk for developing non specific health symptoms, the facing position appears to be the worst one for distances from cellular phone base stations <100 m. It is advisable that cellular phone base stations should not be sited closer than 300 m to populations, as a precautionary measure, sitting of base stations should be such as to minimize exposure of neighbors.
17 Y C	Dode et al. (2011) Brazil	Base station antennas	This research was conducted in a broad environmental context, aiming to verify if there is a spatial correlation between the Base station antennas and the cases of death by neoplasia during the period between 1996 and 2006 in Belo Horizonte municipality (Brazil).	The mortality rates and the relative risk were higher for the residents inside a radius of 500 m from the Base station antennas, compared to the average mortality rate of the entire city, and a decreased dose– response gradient was observed for residents who lived farther away from these base stations.	The research showed the existence of a spatial correlation between cases of death by neoplasia and the locations of the Base station antennas, in the Belo Horizonte municipality from 1996 to 2006.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
18 Y C	Li et al. (2012) Taiwan	Base station antennas	Population-based case–control study in Taiwan considerering incident cases aged 15 years or less and admitted in 2003–2007 for all neoplasm (n = 3481 children). Exposure of each study subject to radio frequency (RF) was indicated by the averaged annual power density within 5 years prior to the neoplasm diagnosis. Controls were randomly selected.	Taiwanese children with higher-than median exposure of RF potentially emitted from Base station antennas were at significantly increased risk of all neoplasms combined. Although there were also positive associations between RF power density and risks of brain neoplasm and leukaemia in children, such associations did not reach statistical significance.	This study noted a significantly increased risk of all neoplasms in children with higher-than-median RF exposure to Base station antennas. The slightly elevated risk was seen for leukaemia and brain neoplasm, but was not statistically significant.
19 N C	Stewart et al. (2012) Great Britain	1 Base station antennas (GMS 1800)	Data on cancer incidence and mortality accessing the medical information of near residents	The study cannot conclude that the base station is responsible for the incidence of cancer in the local residents	Although the age range for local residents with cancer in the suspected cluster was younger than might be generally expected, there was no evidence that their cancer incidence is associated with the mobile phone base station. 10 cancers were registered after installation of the base station. However, the collection of cancers does not fulfil the criteria for a cancer cluster; the cases are a mixed variety of relatively common cancers. No single type of cancer was dominant, all but one were common types of cancer and none were seen in a group not usually affected by that cancer. Data from primary and secondary care also provide evidence that lifestyle and family history factors could have contributed to some individual cases.
20 N RS	Islam and Mohammed (2014) Bangladesh	Base station antennas	Questionnaire survey on 220 adults living near a Base station antenna for at least one year in two selected areas	Half of the respondents experienced problems in sleeping patterns, recent episodes of headache or dizziness and mood change, anxiety, or depression. 11 respondents experienced some generalized burning sensation and 4 reported episodes of shaking or fits. 48 respondents mentioned one or more other health effects, such as mood changes/problem, buzzing in the head, hopelessness, palpitation, tachycardia, heaviness of chest, anorexia, diarrhoea, and skin diseases.	From the results of the study cannot conclude that the health effects are direct results of the base station antennas. However, the complaints were similar to those of other studies, which shows the importance of conducting further research to determine the effects of electromagnetic radiarion from base station antennas on human health and should be considered as a public health concern.
21 Y RS	Pachuau and Pachuau (2014) India	Base station antennas (GSM 900)	Questionnaire survey conducted on 64 adults (31 female, 33 male) and electric field measurements. Health symptoms of RF exposure faced by the inhabitants within 50 m and outside 50 m from the tower were analysed and compared.	Effects found on: -Muscle pain -Fatigue -Sleep disorder -Nausea -Skin problema -Dizziness -Feeling of discomfort -Difficulty in concentration -Memory loss -Visual disruption	Inhabitants living within 50 m had more health complaints than those living outside 50 m. It was also found that females had more complaints than males
22 Y RS	Shinjyo and Shinjyo (2014) Japan	2 base station antennas (CDMA 800 MHz and 2 GHz)	Medical examinations and health questionnaires comparing the health of 107 residents during the base station's operation and after its removal. Measurement of the power density	Effects found on: -fatigue -eye problems -sleep disturbances -dizziness -headache -tinnitus -nasal bleeding No effects found on: -tachycardia -tumours -skin problems -rhinitis -angina pectoris -hearing loss	A total of 34 residents suffered from health problems after installation of the 800 MHz antennas. Three months after their removal this number decreased to 13. There were 41 residents who had health problems after installation of the 2 GHz antennas, and this number decreased to 15 after removal of the 2 GHz antennas. In total 49 residents suffered from health problems during operation of both the 800 MHz and the 2 GHz antennas. However, this number decreased to 25 after removal of both sets of antennas.The residents had no prior knowledge about possible adverse health effects of RF-EMFs. Health problems of the residents were associated with the operation of the

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
					mobile phone base station and these problems improved after its removal.
23 Y CBP	Gandhi et al. (2015) India	Base station antennas	Questionnaire survey and blood simples from 91 individuals, with 70% (63) residing in a populated area with a mobile phone base station (the sample group) and 30% (28) in a sparsely-populated zone without any nearby base stations (the control group). Radiofrequency field measurements	Effects found on: Genetic damage parameters of DNA migration length, damage frequency (DF) and damage index	Genetic damage was significantly increased in the sample group compared to that in the controls. The 2.5–4.5-fold increase in DNA damage in peripheral blood lymphocytes of persons staying near a mobile phone base station is of acute concern given that all neoplasia initiate via unrepaired DNA damage. In the light of the above observations and the statistically significant genetic damage observed in those residing within 300 m of a mobile phone base station in this study, it implies that the effects of radiations from mobile phone base stations cannot be overlooked, as unrepaired DNA damage can lead to cancer, precocious ageing and age-related effects.
24 Y CBP	Meo et al. (2015) Saudi Arabia	2 Base station antennas (925 MHz) near two schools	RF-EMF measurements and blood sample collection	Effects found on: -chronic hyperglycemia -increased HbA1c -diabetes mellitus	Students who were exposed to high EMFR generated by MPBS had significantly higher HbA1c and prevalence of pre diabetes mellitus compared to the students who exposed to low EMFR. EMFR appears to be another risk factor contributing to high levels of HbA1c and risk of type 2 diabetes mellitus.
25 Y RS	Pachuau et al. (2015) India	Base station antennas (GSM 900)	Questionnaire survey from 50 exposed and 50 control individuals. Power density measurements	Effects found on: -fatigue -sleep disruption -headache -dizziness -muscle pain -cramp No effects found on: -nausea -discomfort -difficulty in concentration -memory los -skin problems -visual disruption -hearing problem	Inhabitants living near mobile tower are having more health complaints than those inhabitants living in the area where there is no mobile tower
26 Y CBP	Al-Quzwini et al. (2016) Iraq	Base station antennas	Questionnaire survey. Two hundred couples (one hundred subfertile couples as a study group, and one hundred fertile couples as a control group. Semen analysis	Twenty-nine percentage of subfertile couples had exposure to environmental hazards (communication's tower beside their house-within 50 m), and 71% non-hazard. The duration of the exposure to the environmental factor ranged from 2 to 7 years.	The exposure to environmental hazards shows significant difference between the subfertile and the fertile men; as higher percentage of exposure to mobile phone tower among subfertile group, 29% versus 12% for the fertile group,
27 N RS	Baliatsas et al. (2016) The Netherlands	Base station antennas (GSM and UMTS)	Health records from 1069 adult participants, All participants were living within 500 m from the nearest bases station. A propagation model combined with a questionnaire was used to assess indoor exposure to RF-EMF from MPBS at T1. Estimation of exposure at T0 was based on number of antennas at T0 relative to T1.	Compared to the baseline period, there was a higher prevalence of symptoms theoretically relevant to EMF at T1. A significant increase was observed in the prevalence of ear symptoms and a two-fold (but not significant) increase in the prevalence of skin symptoms. Overall, the total prevalence was slightly lower at T1. A consistent association between UMTS exposure and different clusters of GP-registered symptoms, for the self-declared mobile phone base stations-sensitive group.	This before-after study found no evidence that RF-EMF exposure from mobile phone base stations is associated with the development of non-specific symptoms in the general population, corroborating recent observational studies. Subgroup analyses among people with self-reported sensitivity to base stations showed a higher prevalence for most symptoms at T1 compared to baseline and there was some indication for a higher risk of non-specific symptoms for the mobile phone base stations-sensitive group, in relation to exposure.
28 N RS	Klaps et al. (2016) Austria	Base station antennas	Meta-analysis based on the results of 17 studies	The effects of mobile phone base stations seem to be rather unlikely. However, nocebo effects occur.	It is unclear whether electromagnetic fields emitted by mobile phone base stations affect well-being in adults. The existing studies on this topic are highly inconsistent.
29 Y	Singh et al. (2016) India	4 Base station antennas		Effects found: -sleep disturbances	A majority of the subjects who were residing near the mobile base station

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
RS CBP			Questionnaire survey and salivary analysis in 20 individuals (case group) and 20 (control group)	-headache -dizziness -irritability -concentration difficulties -hypertension	had various complaints. A majority of the study subjects had significantly lesser stimulated salivary secretion as compared to the control subjects. The effects of prolonged exposure to EMRs from mobile phone base stations on the health and well-being of the general population cannot be ruled out.
30 Y RS	Premlal and Eldhose, 2017 India	14 Base station antennas	Questionnaire survey (229 persons) and power density measurements	Joint pain, sleep disorders, migraine related headaches and digestive problems	For 32 different diseases, only 4 were found to have obvious relation to the cell tower radiation. Females are more prone to the bad effects of cell tower radiation. The current Indian standard for cell tower exposure is inadequate for the safe living.
31 Y CBP	Taheri et al. (2017) Iran	Base station antennas	45 healthy individuals with their home near BTS antenna (exposed group) and 45 healthy subjects who were away from the antenna	In the exposed group, the whole number of white blood cells, the level of hematocrit, percent of monocytes, eosinophils and basophils were significantly lower than the control group. The number of red blood cells, their average volume and the mean concentration of hemoglobin were notably higher than the controls. There was not observed a significant difference between the two groups in hemoglobin, its mean concentration, platelet count, percent of lymphocytes and neutrophils as well as serum levels of cytokines IL-4, IL-10 and interferon γ.	The radiation of base station antennas influenced the blood and immune systems.
32 Y RS C	Vijay and Choudhary (2017) India	40 Base station antennas (900–1800 MHz)	Questionnaire survey	Effects found: - headache - depression - sleep disturbance - nausea - fatigue - asthma - cancer - Alzheimer's disease - multiple sclerosis - brain tumor.	The questionnaires show that people have some kind of physical or mental illness after the installation of mobile towers.
33 Y CBP	Zothansiama et al. (2017) India	6 Base station antennas (900–1800 MHz)	Questionnaire survey. Blood sample collection and lymphocyte culture. Power density measurement. Exposed group (n = 40) Control group (n = 40) The study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.	Effects found: -higher frequency of micronuclei -decreased antioxidants	The analyses of data from the exposed group residing within a perimeter of 80 m of mobile base stations, showed significantly higher frequency of micronuclei when compared to the control group, residing 300 m away from themobile base station. The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione concentration, activities of catalase and superoxide dismutase and rise in lipid peroxidation when compared to controls. Multiple linear regression analyses revealed a significant association among decreased antioxidants and elevated miconuclei frequency with increasing RF power density. The persistence of DNA unrepaired damage leads to genomic instability which may lead to several health disorders including the induction of cancer.
34 Y RS	Meo et al. (2019) Saudi Arabia	Two different schools both situated nearby base station antennas (925 MHz)	Cognitive function, motor screening task and spatial working memory were tested, and also RF measurements were made.	There was a statistically significant impairment in the motor screening task and spatial working memory among students who were exposed to high RF generated by base station antennas (School 2: 10.021 μW/cm^2) compared to students who were exposed to lower levels of RF (School 1: 2.010 μW/cm^2).	High exposure to RF-EMF produced by base station antennas is associated with a decrease in fine and gross motor skills and spatial working memory and attention in school adolescents compared to students who had been exposed to low RF-EMF.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
35 Y RS	Ali et al. (2021) Iraq	Base station antennas (900–1800 MHz)	Questionnaire survey comparing two groups. The first group (n = 79) was located in a town with three cell phone towers with less than a hundred meters apart. The second study group (n = 79) was limited to the area almost empty from cell phone towers. Electric field measurements were made.	There was a significant association between health problems (skin problem, hair loss issues, sleeping difficulties, and fertility issues) and distance to towers (less distance, more problems: P-value < 0.05). In regards to health problems (abnormalities, blood pressure issues, tumours cases, and memory and concentration difficulties), the obtained results were not statistically significant.	The results showed an increase in both short- and long-term health problems near base stations antennas in general.
36 Y RS C	López et al., 2021 Spain	9 Base station antennas	Questionnaire survey on 268 persons, 174 in exposed área and 94 in control área, and EMF measurements	Effects found on -headache -dizziness -instability -tachycardias -nightmares No effects found on: -fainting	People who are exposed to higher radiation values present more severe headaches, dizziness and nightmares. 5.6% cancer cases in the study population, a percentage 10 times higher tan that of the total Spanish population.
37 N RS	Martin et al. (2021) France	Base station antennas	Questionnaire survey in 354 residents from buildings located at a distance of 250 m or less from the base station antennas in the main transmit beam of the antennas and home exposure measurements	No significant association between RF-EMF exposure and the overall symptoms score, nor between RF-EMF exposure from MPBSs and insomnia-like symptoms. There was a significant association between RF-EMF exposure and insomnia-like symptoms only for participants who attributed their symptoms to radiofrequencies.	The findings of the study do not support the hypothesis of an association between RF-EMF exposure and health outcomes, such as self-reported non-specific or insomnia-like symptoms in the general population. However, they may suggest a possible association between such exposure and insomnia-like symptoms among people reporting environmental concerns.
38 Y C	Rodrigues et al. (2021) Brazil	Base station antennas	This is an ecological study using capitals as the unit of analysis. The authors collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime and investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers).	For all cancers and for the specific types investigated (breast, cervix, lung, and esophagus cancers), the higher the exposure to RBS radiofrequency, the higher the median of mortality rate.	The results indicates that the exposure to radiofrequency electromagnetic fields from an RBS increases the rate of mortality by all cancers and specifically by breast, cervix, lung, and esophageal cancers. These conclusions are based on the fact that the findings of the study indicate that, the higher the RBS radiofrequency exposure, the higher the cancer mortality rate, especially for cervix cancer. The spatial analysis showed that the highest radiofrequency exposure was observed in a city located in the southern region of Brazil, which also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancers.

4.1. Investigations with radar and radio/television antennas

In studies carried out in the last century, occupational exposure of people to microwave radiation (RF) related to military, industrial and radio uses, as well as radio waves, showed several types of effects: an increase in spontaneous abortions, changes in red and white blood cell counts and an increase in childhood, testicular and other cancers. These findings suggest that RF exposures are potentially carcinogenic and have other health effects; the author recommends precautionary measures to avoid unnecessary exposure (Goldsmith, 1997). An analysis of particular locations of diagnosed neoplasms indicates significantly higher morbidity rates in the military exposed to RF for alimentary tract cancers, skin tumours, neoplasms and cerebral and haematological/lymphatic malignancies. For haematological/lymphatic malignancies, the difference in morbidity between exposed and unexposed military was the largest. This may suggest that spontaneous neoplasms develop faster in the exposed group, with a shorter latency period than in those not exposed. In fact, in exposed subjects, the disease occurs 5–10 years earlier (Szmigielski et al., 2001). On the other hand, children exposed to radar electromagnetic radiation had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased (Kolodynski and Kolodynska, 1996).

In several studies performed around radio and television antennas, there was a significant decrease in the risk of cancer and leukaemia with increasing distance to the antennas (Maskarinec et al., 1994; Dolk et al., 1997a, 1997b; Hocking and Gordon, 2000; Michelozzi et al., 2002; Park et al., 2004). People exposed to a radio antenna shortwave broadcasting station in Schwarzenburg (Switzerland) had sleep disturbances, which were more frequent in exposed than in unexposed subjects (Altpeter et al., 2000).

Thus, the coincidences of similar effects from studies with different sources of electromagnetic radiation (but with similar pulsed, polarized and modulated radiation), such as radar or radio/television antennas, reinforce the conclusions of this review. Non-ionizing EMF are among the fastest growing forms of environmental pollution, its increase around the world in recent years has been exponential (Bandara and Carpenter, 2018) and symptoms reported today may be classic microwave/RF sickness (Levitt and Lai, 2010).

4.2. RF exposure incidents among diplomats (Havanna syndrome)

From late 2016 through August 2017, US government personnel on a diplomatic mission in Havana, Cuba, reported neurological symptoms, including cognitive, balance, visual and hearing disturbances, sleep

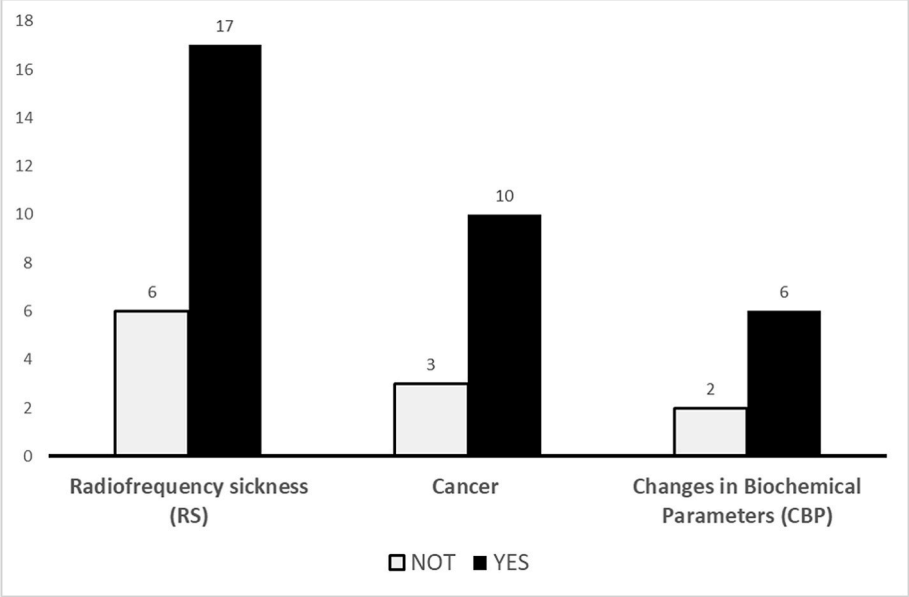


Fig. 1. Results on effects according to the study type considered.

disturbances and headaches. These individuals appeared to have sustained injuries to generalized brain networks with no associated history of head trauma (Swanson et al., 2018). They complained of cognitive decline, fatigue and headache, especially after cognitive exertion, and in some cases tinnitus, nausea and balance problems (Dyer, 2018). This mysterious disease that affected US and Canadian diplomats in Cuba (and later also in China) has confused the FBI, the State Department and US intelligence agencies.

The reported facts seem consistent with pulsed RF/microwave as the source of injuries to the affected diplomats (Golomb, 2018). The same conclusion was later reached by the National Academy of National Academies of Sciences (2020), who reported that many of the chronic or non-specific symptoms were consistent with known effects of RF, such as dizziness, headache, fatigue, nausea, anxiety, cognitive deficits and memory loss. In general, directed pulsed RF energy appears to be the most plausible mechanism to explain these cases. Such symptoms had already been described much earlier at the Moscow embassy (Lilienfeld et al., 1978; Johnson Lyakouris, 1998).

There are objective pathophysiological changes and health effects induced by EMF exposure that can biologically damage the organism and are noxious agents in healthy people (Belpomme and Irigaray, 2022).

4.3. Important laboratory studies

The United States National Toxicology Program (NTP) tested the two main modulation types used for mobile phones worldwide for GSM (2G) and UMTS (3G/4G), in a two-year rodent cancer bioassay under near-field exposure conditions; the experiments included additional assays for genotoxicity endpoints (Smith-Roe et al., 2020). They found clear evidence of carcinogenic activity, and more specifically malignant schwannomas of the heart, malignant gliomas of the brain and benign, malignant or complex pheochromocytomas (combined) of the adrenal medulla. They also found increased DNA damage (measured by the comet assay) in the frontal cortex of male mice, in the leukocytes of female mice and in the hippocampus of male rats, indicating that mobile phone EMF could cause DNA damage and consequent carcinogenesis. In a similar large carcinogenicity study by the Ramazzini Institute, Falcioni et al. (2018) examined far-field exposure to GSM 1800 MHz EMF and reported very similar results to the NTP study. Specifically, they also found increased incidence of tumours of the brain and heart in the mobile phone EMF-exposed Sprague-Dawley rats. Furthermore, these tumours are of the same histotype as those observed in some epidemiological studies on mobile phone users (Hardell et al., 2007).

Kostoff et al. (2020) emphasizes that most of the laboratory experiments conducted to date were not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate, as many experiments do not include pulsing and modulation of the carrier signal and the majority do not account for synergistic adverse effects of other toxic stimuli.

4.4. Importance of studies with biological parameters and those performed on animals and plants

Despite the scientific evidence shown in the studies carried out in many countries by different teams of researchers that we have reviewed, several studies conclude that no effects are found and blame it on risk perception and the nocebo effect (Wiedemann et al., 2006; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Koh et al., 2020). However, the nocebo effect is not supported by objective data (Belpomme and Irigaray, 2022), by the results of cancer studies (Eger et al., 2004; Wolf and Wolf, 2004; Dode et al., 2011; Li et al., 2012; Rodrigues et al., 2021), by studies on changes in haematological parameters (Gandhi et al., 2015; Meo et al., 2015; Taheri et al., 2017; Zothansiama et al., 2017), by hormonal changes after long-term exposure (Eskander et al., 2012), by salivary secretion (Singh et al., 2016) and by effects on fertility (Al-Quzwini et al., 2016). Many reviews on the health effects of mobile phones have reached the same conclusions regarding their effects on male infertility (El-Hamd and Aboeldahab, 2018). Unfortunately, the studies that allude to the nocebo effect seem to be the ones taken into account by the World Health Organization (World Health Organization, 2015).

On the other hand, studies performed on animals or trees near base station antennas are especially important, because animals and plants cannot be aware of their proximity and therefore nocebo or psychosomatic effects cannot be attributed (Balmori, 2005, 2010; Balmori and Hallberg, 2007; Hässig et al., 2012; Lázaro et al., 2016; Waldmann-Selsam et al., 2016; Levitt et al., 2021). In fact, a similar result of this study for humans was found in a review on the significant ecological effects of RF EMF in 65% of the studies on vertebrates, birds and plants (Cucurachi et al., 2013).

Moreover, for these effects, perfectly plausible mechanisms of action

have already been proposed. Plasma membrane calcium channels and other voltage-gated ion channels are irregularly activated/inactivated by man-made EMF in both animals and plants, increasing intracellular [Ca^{2+}] and altering intracellular ion concentrations (Panagopoulos et al., 2002, 2021; Pall, 2016).

Under the influence of non-thermal intensities of microwave radiation, often there are important signals of some hazardous changes in cell metabolism. A significant increase of reactive oxygen species and nitrogen oxide generation in cells under non-thermal intensities has been detected both in vivo and in vitro (Yakymenko et al., 2011; Belpomme and Irigaray, 2022). Thus, the different findings clearly argue for a causal role of EMF in inducing free radical species, including overproduction of reactive oxygen and nitrogen species or suppression of antioxidant defence in cells (Belpomme and Irigaray, 2022). Furthermore, this exposure can result in DNA damage through oxidative stress with reactive oxygen species/free radical overproduction (Yakymenko et al., 2011; Kıvrak et al., 2017; Panagopoulos et al., 2021).

5. The Precautionary Principle

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a private organization that issues exposure guidelines that are then adopted by governments, but it has been accused of having conflicts of interest (Hardell and Carlberg, 2020; Hardell et al., 2021). The ICNIRP (2010, 2020) limits are thousands of times above the levels where effects are recorded for both extremely low frequency and RF man-made EMF and account only for thermal effects, whereas the vast majority of recorded effects are non-thermal. These existing guidelines for public health protection only consider the effects of acute intense (thermal) exposures and do not protect from lower level long-term exposures (Israel et al., 2011; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016; Belpomme and Irigaray, 2022). The exposure duration is crucial to assess the induced effects.

The Precautionary Principle is one of the fundamental principles of the European Union, governing policies related to the environment, health and food safety (Harremoes et al., 2013). This principle enables decision-makers to adopt precautionary measures when the scientific evidence regarding an environmental or human health factor is not certain regarding its safety. Therefore, despite the existing ample and rapidly increasing scientific evidence, no significant progress has been made over all these years, at least at the level of guidelines issued by the responsible authorities and official regulatory bodies. Some authors have pointed out that the source of funding correlates with study findings, and many systematic reviews and meta-analyses in this field have failed to correct for this source of funding bias, which has likely underestimated the evidence for causation (Carpenter, 2019). A growing number of scientists have been calling internationally on governments to raise their safety standards for RF-EMF (Blank et al., 2015; Hardell and Nyberg, 2020; Frank, 2021). Thus, there is an urgent need to adopt the Precautionary Principle and impose more restrictive levels (Zinelis, 2010; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016).

6. Conclusion

In the current circumstances, it seems that the scientific experts in the field are very clear about the serious problems we are facing and have expressed this through important appeals (Blank et al., 2015; Hardell and Nyberg, 2020). However, the media, the responsible organizations (World Health Organization, 2015) and the governments are not transmitting this crucial information to the population, who remain uninformed. For these reasons, the current situation will probably end in a crisis not only for health but also for this technology itself, as it is unsustainable and harmful to the environment and the people.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abelin, T., Altpeter, E., Röösli, M., 2005. Sleep disturbances in the vicinity of the short-wave broadcast transmitter Schwarzenburg. Somnologie-Schlafforschung und Schlafmedizin 9 (4), 203–209.
Akkam, Y., A Al-Taani, A., Ayasreh, S., Almutairi, A., Akkam, N., 2020. Correlation of blood oxidative stress parameters to indoor radiofrequency radiation: a cross sectional study in Jordan. Int. J. Environ. Res. Publ. Health 17 (13), 4673.
Alazawi, S.A., 2011. Mobile phone base stations health effects. Diyala J. Med. 1 (1), 44–52.
Alhekail, Z.O., Hadi, M.A., Alkanhal, M.A., 2012. Public safety assessment of electromagnetic radiation exposure from mobile base stations. J. Radiol. Prot. 32 (3), 325.
Altpeter, E., Battaglia, M., Bader, A., Pfluger, D., Minder, C.E., Abelin, T., 2000, June. Ten years experience with epidemiological research in the vicinity of the short-wave broadcasting area Schwarzenburg: what does the story tell us. In: Proceedings of the International Conference on Cell Tower Siting. Salzburg, Austria, pp. 7–8.
Altpeter, E.S., Röösli, M., Battaglia, M., Pfluger, D., Minder, C.E., Abelin, T., 2006. Effect of short-wave (6–22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study. Bioelectromagnetics 27 (2), 142–150.
Abdel-Rassoul, G., Abou El-Fateh, O., Abou Salem, M., Michael, A., Farahat, F., El-Batanouny, M., Salem, E., 2007. Neurobehavioral effects among inhabitants around mobile phone base stations. Neurotoxicology 28 (2), 434–440.
Admawi, H.K., 2021. Assessment of electromagnetic pollution in some hospitals and schools in Al-najaf city. J. Eng. 27 (3), 1–14.
Ali, M.T., Muhsen, Y.R., Chisab, R.F., Abed, S.N., 2021. Evaluation study of radio frequency radiation effects from cell phone towers on human health. Radioelectron. Commun. Syst. 64 (3), 155–164.
Al-Quzwini, O.F., Al-Taee, H.A., Al-Shaikh, S.F., 2016. Male fertility and its association with occupational and mobile phone towers hazards: an analytic study. Middle East Fertil. Soc. J. 21 (4), 236–240.
Altpeter, E., Battaglia, M., Bader, A., Pfluger, D., Minder, C.E., Abelin, T., 2000. Ten years experience with epidemiological research in the vicinity of the short-wave broadcasting area Schwarzenburg: what does the story tell us. In: Proceedings of the International Conference on Cell Tower Siting, vol. 78. Salzburg, Austria, pp. 127–132.
Aniołczyk, H., 1999. Electromagnetic field pattern in the environment of GSM base stations. Int. J. Occup. Med. Environ. Health 12 (1), 47–58.
Atzmon, I., Linn, S., Richter, E., Portnov, B.A., 2012. Cancer risks in the druze isifya village: reasons and RF/MW antennas. Pathophysiology 19 (1), 21–28.
Augner, C., Hacker, G.W., 2009. Are people living next to mobile phone base stations more strained? Relationship of health concerns, self-estimated distance to base station, and psychological parameters. Indian J. Occup. Environ. Med. 13 (3), 141.
Augner, C., Florian, M., Pauser, G., Oberfeld, G., Hacker, G.W., 2009. GSM base stations: short-term effects on well-being. Bioelectromagnetics 30 (1), 73–80.
Augner, C., Hacker, G.W., Oberfeld, G., Florian, M., Hitzl, W., Hutter, J., Pauser, G., 2010. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed. Environ. Sci. 23 (3), 199–207.
Azimzadeh, M., Jelodar, G., 2019. Alteration of testicular regulatory and functional molecules following long-time exposure to 900 MHz RFW emitted from BTS. Andrologia 51 (9), e13372.
Baliatsas, C., van Kamp, I., Kelfkens, G., Schipper, M., Bolte, J., Yzermans, J., Lebret, E., 2011. Non-specific physical symptoms in relation to actual and perceived proximity to mobile phone base stations and powerlines. BMC Publ. Health 11 (1), 1–12.
Baliatsas, C., van Kamp, I., Bolte, J., Kelfkens, G., van Dijk, C., Spreeuwenberg, P., et al., 2016. Clinically defined non-specific symptoms in the vicinity of mobile phone base stations: a retrospective before-after study. Sci. Total Environ. 565, 714–720.
Balmori, A., 2005. Possible effects of electromagnetic fields from phone masts on a population of white stork (Ciconia ciconia). Electromagn. Biol. Med. 24 (2), 109–119.
Balmori, A., Hallberg, Ö., 2007. The urban decline of the house sparrow (Passer domesticus): a possible link with electromagnetic radiation. Electromagn. Biol. Med. 26 (2), 141–151.
Balmori, A., 2010. Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory. Electromagn. Biol. Med. 29 (1–12), 31–35.
Bandara, P., Carpenter, D.O., 2018. Planetary electromagnetic pollution: it is time to assess its impact. Lancet Planet. Health 2 (12), e512–e514.
Beekhuizen, J., Vermeulen, R., Kromhout, H., Bürgi, A., Huss, A., 2013. Geospatial modelling of electromagnetic fields from mobile phone base stations. Sci. Total Environ. 445, 202–209.
Belpomme, D., Irigaray, P., 2022. Why Electrohypersensitivity and Related Symptoms Are Caused by Non-ionizing Man-Made Electromagnetic Fields: an Overview and Medical Assessment. Environmental Research, 113374.
Berg-Beckhoff, G., Blettner, M., Kowall, B., Breckenkamp, J., Schlehofer, B., Schmiedel, S., et al., 2009. Mobile phone base stations and adverse health effects:

phase 2 of a cross-sectional study with measured radio frequency electromagnetic fields. Occup. Environ. Med. 66 (2), 124–130.
Bithell, J.F., 2010. Childhood cancer and proximity to mobile phone masts. Bmj 340.
Blank, M., Havas, M., Kelley, E., Lai, H., Moskowitz, J., 2015. International Appeal: scientists call for protection from non-ionizing electromagnetic field exposure. Eur. J. Oncol. 20 (3/4), 180–182.
Blettner, M., Schlehofer, B., Breckenkamp, J., Kowall, B., Schmiedel, S., Reis, U., et al., 2009. Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany. Occup. Environ. Med. 66 (2), 118–123.
Boehmert, C., Freudenstein, F., Wiedemann, P., 2020. A systematic review of health risk communication about EMFs from wireless technologies. J. Risk Res. 23 (5), 571–597.
Bortkiewicz, A., Zmyślony, M., Szyjkowska, A., Gadzicka, E., 2004. Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review. Med. Pr. 55 (4), 345–351.
Boscolo, P., Di Sciascio, M.B., D'ostilio, S., Del Signore, A., Reale, M., Conti, P., et al., 2001. Effects of electromagnetic fields produced by radiotelevision broadcasting stations on the immune system of women. Sci. Total Environ. 273 (1–3), 1–10.
Breckenkamp, J., Blettner, M., Schüz, J., Bornkessel, C., Schmiedel, S., Schlehofer, B., Berg-Beckhoff, G., 2012. Residential characteristics and radiofrequency electromagnetic field exposures from bedroom measurements in Germany. Radiat. Environ. Biophys. 51 (1), 85–92.
Bürgi, A., Theis, G., Siegenthaler, A., Röösli, M., 2008. Exposure modeling of high-frequency electromagnetic fields. J. Expo. Sci. Environ. Epidemiol. 18 (2), 183–191.
Bürgi, A., Scanferla, D., Lehmann, H., 2014. Time averaged transmitter power and exposure to electromagnetic fields from mobile phone base stations. Int. J. Environ. Res. Publ. Health 11 (8), 8025–8037.
Carpenter, D.O., 2019. Extremely low frequency electromagnetic fields and cancer: how source of funding affects results. Environ. Res. 178, 108688.
Chen, H.Y., Chuang, C.Y., 2009. Currents induced in human bodies during radiofrequency exposure near a cellular phone base station. Electromagnetics 29 (1), 13–23.
Coggon, D., 2006. Health risks from mobile phone base stations. Occup. Environ. Med. 63 (5), 298–299.
Cooper, D., Hemmings, K., Saunders, P., 2001. Re: "Cancer incidence near radio and televisión transmitters in Great Britain. I. Sutton Coldfield transmitter"; II. All high power transmitters. Am. J. Epidemiol. 153, 202–204.
Cucurachi, S., Tamis, W.L., Vijver, M.G., Peijnenburg, W.J., Bolte, J.F., de Snoo, G.R., 2013. A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environ. Int. 51, 116–140.
Danker-Hopfe, H., Dorn, H., Bornkessel, C., Sauter, C., 2010. Do mobile phone base stations affect sleep of residents? Results from an experimental double-blind sham-controlled field study. Am. J. Hum. Biol. 22 (5), 613–618.
De Giudici, P., Genier, J.C., Martin, S., Doré, J.F., Ducimetiere, P., Evrard, A.S., et al., 2021. Radiofrequency exposure of people living near mobile-phone base stations in France. Environ. Res. 194, 110500.
Dieudonné, M., 2016. Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study. Bioelectromagnetics 37 (1), 14–24.
Dode, A.C., Leao, M.M., Tjo Fde, A., Gomes, A.C., Dode, D.C., Dode, M.C., 2011. moreira CW, condessa VA, albinatti C, and caiaffa WT. Mortality by neoplasia and cellular telephone base stations in the belo horizonte municipality, minas gerais state, Brazil. Sci. Total Environ. 409, 3649–3665.
Dode, A.C., Leão, M.M., 2012. Comments on" Foster KR, Trottier L, comments on" mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state,. Sci. Total Environ. 442, 553–556 (2012. The Science of the total environment.
Dohle, S., Keller, C., Siegrist, M., 2012. Mobile communication in the public mind: insights from free associations related to mobile phone base stations. Hum. Ecol. Risk Assess. 18 (3), 649–668.
Dolk, H., Shaddick, G., Walls, P., Grundy, C., Thakrar, B., Kleinschmidt, I., Elliott, P., 1997a. Cancer incidence near radio and television transmitters in Great Britain I. Sutton Coldfield transmitter. Am. J. Epidemiol. 145 (1), 1–9.
Dolk, H., Elliot, G., Shaddick, G., Walls, P., Thakrar, B., 1997b. Cancer incidence near radio and television transmitters in great britain, Part 2. All high tower transmitters. Am. J. Epidemiol. 145, 10–17.
Dyer, O., 2018. Microwave weapon caused syndrome in diplomats in Cuba, US medical team believes. BMJ Br. Med. J. (Clin. Res. Ed.) 362.
Eger, H., Hagen, K.U., Lucas, B., Vogel, P., Voit, H., 2004. Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz. Umwelt-Medizin-Gesellschaft 17 (4), 326–335.
Eger, H., Jahn, M., 2010. Specific health symptoms and cell phone radiation in Selbitz (Bavaria, Germany)—evidence of a dose-response relationship. umwelt-medizin-gesellschaft 23, 130–139.
El-Hamd, M.A., Aboeldahab, S., 2018. Cell phone and male infertility: an update. J. Integrat. Nephrol. Androl. 5 (1), 1.
Elliott, P., Toledano, M.B., Bennett, J., Beale, L., De Hoogh, K., Best, N., Briggs, D.J., 2010. Mobile phone base stations and early childhood cancers: case-control study. Bmj 340.
Eltiti, S., Wallace, D., Ridgewell, A., Zougkou, K., Russo, R., Sepulveda, F., et al., 2007. Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomized provocation study. Environ. Health Perspect. 115 (11), 1603–1608.
Elwood, J.M., 2003. Epidemiological studies of radio frequency exposures and human cancer. Bioelectromagnetics 24 (S6), S63–S73.
Eskander, E.F., Estefan, S.F., Abd-Rabou, A.A., 2012. How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin. Biochem. 45 (1–2), 157–161.
Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Belpoggi, F., 2018. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ. Res. 165, 496–503.
Foster, K.R., Trottier, L., 2012. Comments on" Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil" by AC Dode et al, 2011. In: Science of the Total Environment, vol. 409, pp. 3649–3665. The Science of the total environment, 450, 366-368.
Frank, J.W., 2021. Electromagnetic fields, 5G and health: what about the precautionary principle? J. Epidemiol. Community Health 75 (6), 562–566.
Frei, P., Mohler, E., Braun-Fahrländer, C., Fröhlich, J., Neubauer, G., Röösli, M., 2012. Cohort study on the effects of everyday life radio frequency electromagnetic field exposure on non-specific symptoms and tinnitus. Environ. Int. 38 (1), 29–36.
Freudenstein, F., Wiedemann, P.M., Brown, T.W., 2015. Exposure perception as a key indicator of risk perception and acceptance of sources of radio frequency electromagnetic fields. J. Environ. Public Health 2015, 9. https://doi.org/10.1155/2015/198272.
Gandhi, G., Kaur, G., Nisar, U., 2015. A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station. Electromagn. Biol. Med. 34 (4), 344–354.
Goldsmith, J.R., 1997. Epidemiologic evidence relevant to radar (microwave) effects. Environ. Health Perspect. 105 (Suppl. 6), 1579–1587.
Golomb, B.A., 2018. Diplomats' mystery illness and pulsed radiofrequency/microwave radiation. Neural Comput. 30 (11), 2882–2985.
Gómez-Perretta, C., Navarro, E.A., Segura, J., Portolés, M., 2013. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. BMJ Open 3 (12), e003836.
Ha, M., Lim, H.J., Cho, S.H., Choi, H.D., Cho, K.Y., 2003. Incidence of cancer in the vicinity of Korean AM radio transmitters. ArchivE Environ. Health 58 (12), 756–762.
Ha, M., Im, H., Lee, M., Kim, H.J., Kim, B.C., Gimm, Y.M., Pack, J.K., 2007. Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. Am. J. Epidemiol. 166 (3), 270–279.
Hansson, B., Thors, B., Törnevik, C., 2011. Analysis of the effect of mobile phone base station antenna loading on localized SAR and its consequences for measurements. Bioelectromagnetics 32 (8), 664–672.
Hallberg, Ö., Johansson, O., 2002. Melanoma incidence and frequency modulation (FM) broadcasting. ArchivE Environ. Health 57 (1), 32–40.
Hardell, L., Carlberg, M., Söderqvist, F., Mild, K.H., Morgan, L.L., 2007. Long-term use of cellular phones and brain tumours: increased risk associated with use for > or =10 years. Occup. Environ. Med. 64 (9), 626–632 submitted for publication.
Hardell, L., Carlberg, M., Hedendahl, L.K., 2018. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: a case report. Oncol. Lett. 15 (5), 7871–7883.
Hardell, L., Carlberg, M., 2020. [Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. Oncol. Lett. 20 (4), 1, 1.
Hardell, L., Nyberg, R., 2020. [Comment] Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mole. Clinic. Oncol. 12 (3), 247–257.
Hardell, L., Nilsson, M., Koppel, T., Carlberg, M., 2021. Aspects on the international commission on non-ionizing radiation protection (ICNIRP) 2020 guidelines on radiofrequency radiation. J. Cancer Sci. Clinic. Therapeutics 5 (2), 250–285.
Harremoes, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., Vaz, S.G. (Eds.), 2013. The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings. Routledge, London.
Hässig, M., Jud, F., Spiess, B., 2012. Increased occurrence of nuclear cataract in the calf after erection of a mobile phone base station. Schweizer Archiv Fur Tierheilkunde 154 (2), 82–86.
Henderson, S.I., Bangay, M.J., 2006. Survey of RF exposure levels from mobile telephone base stations in Australia. Bioelectromagnetics: J. Bioelectromag. Soc., Soc. Phys. Regul. Biol. Med., European Bioelectromag. Assoc. 27 (1), 73–76.
Hinrichs, H., Heinze, H.J., Rotte, M., 2005. Human sleep under the influence of a GSM 1800 electromagnetic far field. Somnologie-Schlafforschung und Schlafmedizin 9 (4), 185–191.
Hocking, B., Gordon, I.R., Grain, H.L., Hatfield, G.E., 1996. Cancer incidence and mortality and proximity to TV towers. Med. J. Aust. 165 (11–12), 601–605.
Hocking, B., Gordon, I., 2000. Decreased survival for childhood leukemia in proximity to TV towers. In: Poster Presented at the Annual Scientific Meeting of the Royal Australian College of Physicians in Adelaide. SA, Australia.
Hutter, H.P., Moshammer, H., Wallner, P., Kundi, M., 2006. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. Occup. Environ. Med. 63 (5), 307–313.
ICNIRP, 2010. Guidelines for limiting exposure to time-varying electric and magnetic fields (1Hz to 100 kHz). Health Phys. 99 (6), 818–836.
ICNIRP, 2020. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys. 118 (5), 483–524.
Islam, S., Mohammed, S., 2014. Awareness and self-reported health hazards of electromagnetic waves from mobile phone towers in Dhaka, Bangladesh: a pilot study. Adv. Pub. Health 2014, 7. https://doi.org/10.1155/2014/952832, 952832.
Johnson Lyakouris, A.G., 1998. Radiofrequency (RF) sickness in the Lilienfeld study: an effect of modulated microwaves? ArchivE Environ. Health 53, 3, 1998.

Kazaure, J.S., Matthew, U.O., Okafor, N.U., Okey, O.D., 2021. Telecommunication network performances and evaluation of radio frequency electromagnetic radiation: health effects of the RF-EMR GSM base stations. Int. J. Inf. Commun. Technol. Hum. Dev. 13 (3), 16–37.
Keow, M.A., Radiman, S., 2006. Assessment of radiofrequency/microwave radiation emitted by the antennas of rooftop-mounted mobile phone base stations. Radiat. Protect. Dosim. 121 (2), 122–127.
Khurana, V.G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., Ahonen, M., 2010. Epidemiological evidence for a health risk from mobile phone base stations. Int. J. Occup. Environ. Health 16 (3), 263–267.
Kıvrak, E.G., Yurt, K.K., Kaplan, A.A., Alkan, I., Altun, G., 2017. Effects of electromagnetic fields exposure on the antioxidant defense system. J. Micros. Ultrastruct. 5 (4), 167–176.
Klaps, A., Ponocny, I., Winker, R., Kundi, M., Auersperg, F., Barth, A., 2016. Mobile phone base stations and well-being—a meta-analysis. Sci. Total Environ. 544, 24–30.
Koh, T.H., Choi, J.W., Seo, M., Choi, H.D., Kim, K., 2020. Factors affecting risk perception of electromagnetic waves from 5G network base stations. Bioelectromagnetics 41 (7), 491–499.
Kolodynski, A.A., Kolodynska, V.V., 1996. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. Sci. Total Environ. 180 (1), 87–93.
Kostoff, R.N., Heroux, P., Aschner, M., Tsatsakis, A., 2020. Adverse health effects of 5G mobile networking technology under real-life conditions. Toxicol. Lett. 323, 35–40.
Kundi, M., Hutter, H.P., 2009. Mobile phone base stations—effects on wellbeing and health. Pathophysiology 16 (2–3), 123–135.
Kowall, B., Breckenkamp, J., Blettner, M., Schlehofer, B., Schüz, J., Berg-Beckhoff, G., 2012. Determinants and stability over time of perception of health risks related to mobile phone base stations. Int. J. Publ. Health 57 (4), 735–743.
Lamech, F., 2014. Self-reporting of symptom development from exposure to radiofrequency fields of wireless smart meters in Victoria, Australia: a case series. Alternative Ther. Health Med. 20 (6), 28.
Lázaro, A., Chroni, A., Tscheulin, T., Devalez, J., Matsoukas, C., Petanidou, T., 2016. Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. J. Insect Conserv. 20 (2), 315–324.
Lemaire, T., Wiart, J., De Doncker, P., 2016. Variographic analysis of public exposure to electromagnetic radiation due to cellular base stations. Bioelectromagnetics 37 (8), 557–562.
Leitgeb, N., Schröttner, J., Cech, R., Kerbl, R., 2008. EMF-protection sleep study near mobile phone base stations. Somnologie-Schlafforschung und Schlafmedizin 12 (3), 234–243.
Levitt, B.B., Lai, H., 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ. Rev. 18 (NA), 369–395.
Levitt, B.B., Lai, H.C., Manville, A.M., 2021. Effects of Non-ionizing Electromagnetic Fields on Flora and Fauna, Part 2 Impacts: How Species Interact with Natural and Man-Made EMF. Reviews on Environmental Health.
Li, C.Y., Liu, C.C., Chang, Y.H., Chou, L.P., Ko, M.C., 2012. A population-based case–control study of radiofrequency exposure in relation to childhood neoplasm. Sci. Total Environ. 435, 472–478.
Lilienfeld, A.M., Tonascia, J., Tonascia, S., et al., 1978. Foreign Service Health Status Study. Department of State, Washington, DC. Final report contract no. 6025-619037 (NTS publication PB-288163).
López, I., Félix, N., Rivera, M., Alonso, A., Maestú, C., 2021. What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. Environ. Res. 194, 110734.
Lyare, R.N., Volskiy, V., Vandenbosch, G.A., 2019. Study of the correlation between outdoor and indoor electromagnetic exposure near cellular base stations in Leuven, Belgium. Environ. Res. 168, 428–438.
Martens, A.L., Slottje, P., Smid, T., Kromhout, H., Vermeulen, R.C., Timmermans, D.R., 2018. Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms. J. Psychosom. Res. 112, 81–89.
Martens, A.L., Slottje, P., Timmermans, D.R., Kromhout, H., Reedijk, M., Vermeulen, R. C., Smid, T., 2017. Modeled and perceived exposure to radiofrequency electromagnetic fields from mobile-phone base stations and the development of symptoms over time in a general population cohort. Am. J. Epidemiol. 186 (2), 210–219.
Martin, S., De Giudici, P., Genier, J.C., Cassagne, E., Doré, J.F., Ducimetière, P., et al., 2021. Health disturbances and exposure to radiofrequency electromagnetic fields from mobile-phone base stations in French urban areas. Environ. Res. 193, 110583.
Maskarinec, G., Cooper, J., Swygert, L., 1994. Investigation of increased incidence in childhood leukemia near radio towers in Hawaii: preliminary observations. J. Environ. Pathol. Toxicol. Oncol. 13 (1), 33–37.
McKenzie, D.R., Yin, Y., Morrell, S., 1998. Childhood incidence of acute lymphoblastic leukemia and exposure to broadcast radiation in Sydney—a second look. Aust. N. Z. J. Publ. Health 22 (3 Suppl. l), 360–367.
Meo, S.A., Alsubaie, Y., Almubarak, Z., Almutawa, H., AlQasem, Y., Hasanato, R.M., 2015. Association of exposure to radio-frequency electromagnetic field radiation (RF-EMFR) generated by mobile phone base stations with glycated hemoglobin (HbA1c) and risk of type 2 diabetes mellitus. Int. J. Environ. Res. Publ. Health 12 (11), 14519–14528.
Meo, S.A., Almahmoud, M., Alsultan, Q., Alotaibi, N., Alnajashi, I., Hajjar, W.M., 2019. Mobile phone base station tower settings adjacent to school buildings: impact on students' cognitive health. Am. J. Men's Health 13 (1), 1557988318816914.
Michelozzi, P., Ancona, C., Fusco, D., Forastiere, F., Perucci, C.A., 1998. Risk of leukemia and residence near a radio transmitter in Italy. Epidemiology 9 (4), S111.
Michelozzi, P., Capon, A., Kirchmayer, U., Forastiere, F., Biggeri, A., Barca, A., Perucci, C.A., 2002. Adult and childhood leukemia near a high-power radio station in Rome, Italy. Am. J. Epidemiol. 155 (12), 1096–1103.
Milham Jr., S., 1988. Increased mortality in amateur radio operators due to lymphatic and hematopoietic malignancies. Am. J. Epidemiol. 127 (1), 50–54.
Mortazavi, S.M.J., 2014. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. J. Biomed. Phys. Eng. 4 (1).
Mortazavi, S.M.J., 2017. RE:"Modeled and perceived exposure to radiofrequency electromagnetic fields from mobile-phone base stations and the development of symptoms over time in a general population cohort". Am. J. Epidemiol. 186 (10), 1217, 1217.
National Academies of Sciences, 2020. Engineering, and medicine. An assessment of illness in US government employees and their families at overseas embassies. https://doi.org/10.17226/25889.
Navarro, E.A., Segura, J., Portolés, M., Gómez-Perretta de Mateo, C., 2003. The microwave syndrome: a preliminary study in Spain. Electromagn. Biol. Med. 22 (2–3), 161–169.
Neitzke, H.P., Osterhoff, J., Peklo, K., Voigt, H., 2007. Determination of exposure due to mobile phone base stations in an epidemiological study. Radiat. Protect. Dosim. 124 (1), 35–39.
Pachuau, L., Pachuau, Z., 2014. Study of cell tower radiation and its health hazards on human body. IOSR J. Appl. Phys. (IOSR-JAP) 2278–4861.
Pachuau, L., Pachuau, Z., Zothansiama, 2015. Comparisons of non specific health symptoms faced by inhabitants exposed to high and low power density from mobile phone tower radiation. Int. J. Recent Innov. Trends Comput. Commun. 3 (2), 94–98.
Pall, M., 2016. Electromagnetic fields act similarly in plants as in animals: probable activation of calcium channels via their voltage sensor. Curr. Chem. Biol. 10 (1), 74–82.
Panagopoulos, D.J., Karabarbounis, A., Margaritis, L.H., 2002. Mechanism for action of electromagnetic fields on cells. Biochem. Biophys. Res. Commun. 298, 95–102.
Panagopoulos, D.J., Karabarbounis, A., Yakymenko, I., Chrousos, G.P., 2021. Human-made electromagnetic fields: ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage. Int. J. Oncol. 59 (5), 1–16.
Park, S.K., Ha, M., Im, H.J., 2004. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. Int. Arch. Occup. Environ. Health 77 (6), 387–394.
Premlal, P.D., Eldhose, N.V., 2017. Mobile tower radiation-an assessment of radiation level and its health implications in the residential areas of western ghats in idukki, Kerala. Int. J. Appl. Eng. Res. 12 (20), 9548–9554.
Regel, S.J., Negovetic, S., Röösli, M., Berdiñas, V., Schuderer, J., Huss, A., et al., 2006. UMTS base station-like exposure, well-being, and cognitive performance. Environ. Health Perspect. 114 (8), 1270–1275.
Regel, S.J., Tinguely, G., Schuderer, J., Adam, M., Kuster, N., Landolt, H.P., Achermann, P., 2007. Pulsed radio-frequency electromagnetic fields: dose-dependent effects on sleep, the sleep EEG and cognitive performance. J. Sleep Res. 16 (3), 253–258.
Riddervold, I.S., Pedersen, G.F., Andersen, N.T., Pedersen, A.D., Andersen, J.B., Zachariae, R., et al., 2008. Cognitive function and symptoms in adults and adolescents in relation to rf radiation from UMTS base stations. Bioelectromagnetics: J. Bioelectromag. Soc., Soc. Phys. Regul. Biol. Med., European Bioelectromag. Assoc. 29 (4), 257–267.
Rodrigues, N.C.P., Dode, A.C., Andrade, M.K.D.N., O'Dwyer, G., Monteiro, D.L.M., Reis, I.N.C., et al., 2021. The effect of continuous low-intensity exposure to electromagnetic fields from radio base stations to cancer mortality in Brazil. Int. J. Environ. Res. Publ. Health 18 (3), 1229.
Röösli, M., Huss, A., 2008. Mobile phone base station exposure and symptoms. Environ. Health Perspect. 116 (2), A62–A63.
Röösli, M., Frei, P., Mohler, E., Hug, K., 2010. Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations. Bull. World Health Organ. 88, 887–896.
Santini, R., Santini, P., Danze, J.M., Le Ruz, P., Seigne, M., 2002. Enquête sur la santé de riverains de stations relais de téléphonie mobile: I/Incidences de la distance et du sexe. Pathol. Biol. 50 (6), 369–373.
Santini, R., Santini, P., Le Ruz, P., Danze, J.M., Seigne, M., 2003a. Survey study of people living in the vicinity of cellular phone base stations. Electromagn. Biol. Med. 22 (1), 41–49.
Santini, R., Santini, P., Danze, J.M., Le Ruz, P., Seigne, M., 2003b. Symptoms experienced by people in vicinity of base stations: II/Incidences of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors. Pathol. Biol. 51 (7), 412–415.
Satta, G., Mascia, N., Serra, T., Salis, A., Saba, L., Sanna, S., et al., 2018. Estimates of environmental exposure to radiofrequency electromagnetic fields and risk of lymphoma subtypes. Radiat. Res. 189 (5), 541–547.
Schmiedel, S., Brüggemeyer, H., Philipp, J., Wendler, J., Merzenich, H., Schüz, J., 2009. An evaluation of exposure metrics in an epidemiologic study on radio and television broadcast transmitters and the risk of childhood leukemia. Bioelectromagnetics 30 (2), 81–91.
Shinjyo, T., Shinjyo, A., 2014. Significant decrease of clinical symptoms after mobile phone base station removal–an intervention study. Umwelt medizin gesellschaft (Environ. Med. Company) 27, 294–301.
Schoeni, A., Roser, K., Bürgi, A., Röösli, M., 2016. Symptoms in Swiss adolescents in relation to exposure from fixed site transmitters: a prospective cohort study. Environ. Health 15 (1), 1–8.
Seitz, H., Stinner, D., Eikmann, T., Herr, C., Röösli, M., 2005. Electromagnetic hypersensitivity (EHS) and subjective health complaints associated with

electromagnetic fields of mobile phone communication—a literature review published between 2000 and 2004. Sci. Total Environ. 349 (1–3), 45–55.
Singh, M.M., Pati, A.K., 2016. Effects of radiation emanating from base transceiver station and mobile phone on sleep, circadian rhythm and cognition in humans–a review. Biol. Rhythm. Res. 47 (3), 353–388.
Singh, K., Nagaraj, A., Yousuf, A., Ganta, S., Pareek, S., Vishnani, P., 2016. Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. J. Int. Soc. Prev. Community Dent. 6 (1), 54.
Smith-Roe, S.L., Wyde, M.E., Stout, M.D., Winters, J.W., Hobbs, C.A., Shepard, K.G., Witt, K.L., 2020. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ. Mol. Mutagen. 61 (2), 276–290.
Starkey, S.J., 2016. Inaccurate official assessment of radiofrequency safety by the advisory group on non-ionising radiation. Rev. Environ. Health 31 (4), 493–503.
Stewart, A., Rao, J.N., Middleton, J.D., Pearmain, P., Evans, T., 2012. Mobile telecommunications and health: report of an investigation into an alleged cancer cluster in Sandwell, West Midlands. Perspect. Public Health 132 (6), 299–304.
Swanson, R.L., Hampton, S., Green-McKenzie, J., Diaz-Arrastia, R., Grady, M.S., Verma, R., et al., 2018. Neurological manifestations among US government personnel reporting directional audible and sensory phenomena in Havana, Cuba. JAMA 319 (11), 1125–1133.
Szmigielski, S., Sobiczewska, E., Kubacki, R., 2001. Carcinogenic potency of microwave radiation: overview of the problem and results of epidemiological studies on Polish military personnel. Eur. J. Oncol. 6, 193–200.
Taheri, M., Roshanaei, G., Ghaffari, J., Rahimnejad, S., Khosroshahi, B.N., Aliabadi, M., Eftekharian, M.M., 2017. The effect of Base Transceiver Station waves on some immunological and hematological factors in exposed persons. Hum. Antibodies 25 (1–2), 31–37.
Urbinello, D., Joseph, W., Huss, A., Verloock, L., Beekhuizen, J., Vermeulen, R., et al., 2014. Radio-frequency electromagnetic field (RF-EMF) exposure levels in different European outdoor urban environments in comparison with regulatory limits. Environ. Int. 68, 49–54.
Viel, J.F., Clerc, S., Barrera, C., Rymzhanova, R., Moissonnier, M., Hours, M., Cardis, E., 2009. Residential exposure to radiofrequency fields from mobile phone base stations, and broadcast transmitters: a population-based survey with personal meter. Occup. Environ. Med. 66 (8), 550–556.
Vijay, S., Choudhary, M.P., 2017. Study on health effects of mobile tower radiation on human beings. Int. Res. J. Eng. Technol 4 (11), 1548–1552.
Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., Balmori, A., 2016. Radiofrequency radiation injures trees around mobile phone base stations. Sci. Total Environ. 572, 554–569.
Wang, J., Su, H., Xie, W., Yu, S., 2017. Mobile phone use and the risk of headache: a systematic review and meta-analysis of cross-sectional studies. Sci. Rep. 7 (1), 1–7.
Wallace, D., Eltiti, S., Ridgewell, A., Garner, K., Russo, R., Sepulveda, F., et al., 2010. Do TETRA (Airwave) base station signals have a short-term impact on health and well-being? A randomized double-blind provocation study. Environ. Health Perspect. 118 (6), 735–741.
World Health Organization (WHO), 2015. International EMF Project – Progress Report. https://cdn.who.int/media/docs/default-source/radiation-international-emf-project-reports/emf-iac-2016-progress-report.pdf?sfvrsn=7b2836c0_2.
Wiedemann, P.M., Thalmann, A.T., Grutsch, M.A., Schütz, H., 2006. The impacts of precautionary measures and the disclosure of scientific uncertainty on EMF risk perception and trust. J. Risk Res. 9 (4), 361–372.
Wolf, R., Wolf, D., 2004. Increased incidence of cancer near a cell-phone transmitter station. Int. J. Cancer Prev. 1 (2), 123–128.
Yakymenko, I., Sidorik, E., Kyrylenko, S., Chekhun, V., 2011. Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems. Exp. Oncol. 33, 62–70.
Yetiş, C., Kayili, M.T., 2021. Determination of EMF pollution in the context of urban health: the case of safranbolu. Comput. Res. Prog. Appl. Sci. Eng.: Transact. Civil Environ. Eng. 7, 1–10, 2021 Article ID: 2418.
Yildirim, M.S., Yildirim, A., Zamani, A.G., Okudan, N., 2010. Effect of mobile phone station on micronucleus frequency and chromosomal aberrations in human blood cells. Genet. Counsel. 21 (2), 243.
Zinelis, S.A., 2010. The precautionary principle: radiofrequency exposures from mobile telephones and base stations. Environ. Health Perspect. 118 (1), A16. A16.
Zothansiama, Zosangzuali, M., Lalramdinpuii, M., Jagetia, G.C., 2017. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn. Biol. Med. 36 (3), 295–305.
Zwamborn, A.P.M., Vossen, S.H.J.A., van Leersum, B.J.A.M., Ouwens, M.A., Mäkel, W. N., 2003. Effects of Global Communication System Radio-Frequency Fields on Well Being and Cognitive Functions of Human Subjects with and without Subjective Complaints.

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Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office

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Abstract

The 5th generation, 5G, for wireless communication is rolled out without previous studies on potential effects on human health and the environment. In this case study we describe two men, case 1 and case 2, working in three office rooms close to base stations. After the deployment of 5G, both men developed symptoms typical for the microwave syndrome, e.g., headache, tinnitus, dizziness, balance disorder, concentration and attention deficiency, and fatigue. Radiofrequency Radiation (RFR) after the 5G deployment was measured in the three offices. In office one maximum (peak) RFR during one minute varied from 463 to 1,180,000 μW/m^2, in office two from 6,230 to 501,000 and in office three from 13,700 to 613,000 μW/m^2. The symptoms disappeared in both men within a couple of weeks (case 1) or immediately (case 2) after leaving the office for other offices with much lower maximum peak RFR emissions, maximum for case 1 =16 and for case 2 =2,920 μW/m^2. This case report may be regarded as a provocation study on health from 5G RFR. The clinical picture in both men was clearly related to the exposure, although the exposures were well below the guidelines recommended by ICNIRP that are claimed to protect against all health effects. We conclude that the guidelines for RFR exposure based only on tissue heating by ICNIRP are inadequate to protect human health and that 5G appears to provoke symptoms of microwave syndrome in previously healthy people.

Keywords: Base station; 5G; Radiofrequency radiation; Electromagnetic hypersensitivity microwave syndrome; Health

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Introduction

Guidelines for exposure to Radiofrequency Radiation (RFR), also called microwaves, from ICNIRP [1] and the FCC [2] are based on outdated assumptions that ignore current scientific evidence on health effects. Tissue heating within very short exposure time is the only accepted basis for these guidelines. Thereby these guidelines do not protect against numerous non-thermal health effects observed for RFR exposure at non-thermal levels [3]. Microwaves are frequencies in the range of 300 MHz to 300 GHz and it is within this range of frequencies that modern wireless technologies for instance 3G, 4G, 5G and Wi-Fi operate. People may react to RFR with e.g., insomnia, heart palpitations, tinnitus, skin disorders, headache, and neurological symptoms at exposure levels clearly below the guidelines suggested by ICNIRP and FCC. The terms microwave syndrome, microwave illness, radiofrequency sickness or Electromagnetic Hypersensitivity (EHS) have been attributed to these health effects. The symptoms develop at levels of RFR exposure well below the guidelines from ICNIRP, and are alleviated by elimination of or reduced exposure, but may in some cases persist to some degree. Individuals suffering from EHS react with health symptoms already at very low non-thermal exposure levels to RF-radiation [4]. The symptoms of microwave syndrome or illness were described already in the 1960's by researchers in East European Countries [5] as a consequence of long-term occupational exposure to microwaves/RFR. These non-thermal effects depend primarily on the modulation and/or pulsation of the signal and also on the peak and average intensity of the RFR. The symptoms decline and may disappear completely after exposure has ceased and may after a few days to several weeks have disappeared completely [6]. Recently we published a case report on two persons, who developed the microwave syndrome after installation of base station for 5G on the roof just above their apartment [7]. Due to the severity of the symptoms caused by the sharp increase in non-thermal levels of microwaves from the 5G base station, the couple had to move to



Figure 1: Top floor apartment adjacent to base stations. Office 1 = number 1 in figure (see Table 3), Office 2 = number 2 in figure (see Table 4), office 3 = number 3 in figure (see Table 5).

another accommodation with low radiation whereby most of their symptoms quickly alleviated. This was a clear case of the microwave syndrome or illness. In this article we describe two cases with a similar medical history after installation of 5G base stations on the roof above their office. They were asked to evaluate prevalence and severity of microwave syndrome symptoms experienced at different places. The list of symptoms is adapted after Belpomme et al. [8].

Case History

Two men aged 57 and 42 years, respectively, developed symptoms typical of the microwave syndrome shortly after start of exposure to a 5G-base station that was installed and activated in November, 2021 on the roof of their office. All symptoms were self-assessed.

Man aged 57, case 1

The man is a director of a small company and an IT and management consultant like the other two men in this case study. He hired the office and used it from May 2019. At that time a base station for 3G and 4G was already at the same spot on the roof of the building where the new 5G base station was installed in November 2021. The man worked in the office below the base station without any health issues from May 2019 until November 2021. His own office room was placed right below the base station, see Figure 1, room number 1. The man spent very little time in this office during the first period after the 5G deployment, from November 2021 until end of April 2022, due to his work in other areas. However, from the end of April 2022 he worked full time in the office located below the 5G base station. He also slept overnight in the conference room within the office space next to his own office from May to the end of July 2022, see Figure 1, room no 2. In consequence, during the months of May, June and July 2022, he spent both days and nights close to the 5G base station. Within a couple of weeks, during May, he developed headache. He noticed that the headache disappeared when he left the building but reappeared when he returned.

The list of symptoms the man experienced over time during his stay in the office room and the conference room below the 5G base station is presented in Table 1. The grading of the symptoms was grade 0 (no symptoms) to 10 (unbearable pain and/or discomfort). As shown in Table 1 the most severe symptoms were headache (5), arthralgia (10), tinnitus (5), concentration and attention deficiency (7), fatigue (6), early wake-up (7), and skin burning (7). Apart from the symptoms listed in table 1 the man experienced sudden and very sharp pain in the elbows while working and living below the 5G antennas and also pain upon touching the skin with his own hand. The man left the office on August 1st, 2022. Most of his symptoms disappeared after a couple of weeks after moving to another combined office and apartment in another small town with no 5G base station antenna in proximity. All symptoms had completely disappeared by September 15th, 2022 one and a half month after he left the office. However, arthralgia and headache reappear rather quickly whenever he visits places with high radiation such as in Stockholm city [9-13]. He estimates that his sensitivity to RFR has increased after the period when he stayed in the office below the 5G base station.

Man aged 42, case 2

The man worked and slept since February 2021 in a combined office/apartment, se Figure 1, room no 3. Soon after the deployment of the 5G-base station several symptoms appeared that he did not have previously. The list of symptoms he experienced during his stay in the office are presented in Table 2. He experienced worsened insomnia (6), tendency of depression (6), anxiety/panic (7), emotivity (5), headache (3), concentration/attention deficiency (3) and to a lesser extent irritability (2), tinnitus (1), dizziness (1), balance disorder (1), confusion (1), and hair loss (1). Toothache was a major problem (not in list of symptoms). He had a history of very healthy teeth, no amalgam fillings, or any other problems. Further, the man experienced during his stay in the office a light pressure around the whole head. He describes himself as a previously very healthy person who has never had any problems with either his teeth or with headaches. The toothache, the head-pressure, and the tinnitus disappeared immediately when he left the office on December 20th, 2021. He moved to a house on the countryside with no 5G or other telecommunication masts in the near vicinity. All symptoms that he had experienced in the office disappeared rapidly. In November 2022 he declared himself completely symptom free.

Exposure to radiofrequency radiation (RFR)

All measurements of RFR exposure in the office below the 5G base station were made daytime on June 10th, 2022 with the device Safe and Sound and Pro II. It has a true response detection range between 400 MHz and 7.2 GHz. It was calibrated by the manufacturer and has an accuracy of ± 6 dB. (https://safelivingtechnologies.com/products/safe-and-sound-pro-ii-rf-meter.html). In Sweden in city

Table 1: Clinical symptoms grades 0-10. 0= no symptoms, 1= mild symptoms, 10= unbearable pain and/or discomfort. A man aged 57 years with diabetes type II.

Symptom	Office with no 5G	Office with 5G	New office without 5G
Headache	0	5	0
Dysesthesia	0	8	0
Myalgia	0	3	0
Arthralgia	0	10	0
Ear heat/otalgia	0	0	0
Tinnitus	3	5	3
Hyperacusis	0	0	0
Dizziness	0	3	3
Balance disorder	0	2	0
Concentration/Attention deficiency	0	7	0
Loss of immediate memory	0	2	0
Confusion	0	0	0
Fatigue	2	6	2
Insomnia	0	0	0
Early wake-up	0	7	0
Depression tendency	0	0	0
Suicidal ideation	0	0	0
Transitory cardiovascular abnormalities, heart rate variability	0	0	0
Ocular deficiency	0	0	0
Anxiety/Panic	0	0	0
Emotivity	N.A.	N.A.	N.A:
Irritability	N.A.	N.A.	N.A:
Global body dysthermia	0	0	0
Lungs; dyspnea, cough,	0	3	0
Stomach, diarrhea (involuntary)	0	0	0
Skin (face, arms, legs)	0	8	4
-burning, lancinating skin on hands and arms	0	8	0
Nose bleeding	0	0	0
Blood pressure variability (high, low)	N.A.	N.A.	N.A.
Hair loss	0	0	0

N.A.: Not Assessed

Table 2: Clinical symptoms grades 0-10. 0= no symptoms, 1= mild symptoms, 10= unbearable pain and/or discomfort. A man aged 42, previously healthy without any symptoms.

Symptom	Office with no 5G	Office with 5G	New office without 5G
Headache	0	3	0
Dysesthesia	0	0	0
Myalgia	0	0	0
Arthralgia	0	0	0
Ear heat/otalgia	0	0	0
Tinnitus	0	1	0
Hyperacusis	0	0	0
Dizziness	0	1	0
Balance disorder	0	1	0
Concentration/Attention deficiency	0	3	0
Loss of immediate memory	0	0	0
Confusion	0	1	0
Fatigue	0	3	0
Insomnia	3	6	0
Early wake-up	4	6	0
Depression tendency	0	6	0
Suicidal ideation	0	0	0
Transitory cardiovascular abnormalities, heart rate variability	0	0	0
Ocular deficiency	0	0	0
Anxiety/Panic	0	7	0
Emotivity	0	5	0
Irritability	0	2	0
Global body dysthermia	0	0	0
Lungs, dyspnea, cough	0	1	0
Stomach, diarrhea (involuntary)	0	0	0
Skin (face, arms, legs)	0	0	0
-burning, lancinating skin on hands and arms	0	0	0
Nose bleeding	0	0	0
Blood pressure variability (high, low)	0	0	0
Hair loss	0	1	0

environments, the frequencies around 3.5 GHz and below are most commonly used for 5G, i.e., frequencies covered by the exposimeter. Nineteen measurements, each during one minute, were performed in the office room where the 57-year-old man who developed microwave syndrome symptoms worked, see no 1 in Figure 1. Further 20 measurements each during 1 minute were performed in the small apartment/office where the 42-year-old man (case 1) developed symptoms, see no 3 in Figure 1, and in the conference room where the 57-year-old man stayed overnight during three months, see no 2, Figure 1. The highest maximum radiation level, 1,180,000 μW/m^2, was measured in the office room right below the 5G base station (no 1, Figure 1) where case 1 worked, see Table 3. The roof is covered only by roofing felt which probably contributes to the very high levels right below the antennas, i.e., less shielding than sheet metal. The peak exposure values over one minute varied very much between times of measurements, which reflects the high variation of exposure to radiation from the 5G base station.

In the conference room, see no 2 in Figure 1, where the 57-year-old man (case 1) slept for three months the highest peak maximum level measured was 501,000 μW/m^2, see Table 4. In the combined apartment/office room, see no 3 in Figure 1, where the 41-year-old man (case 2) worked and slept, highest measured peak maximum level was 613,000 μW/m^2, see Table 5. These results contrast to RFR in the new office of case 1. The radiation was low, 9 μW/m^2 to 15 μW/m^2 peak exposure, see Table 6. Also, at other places such as conference and resting rooms, and kitchen low peak RFR was measured. For case 2, lower emissions were measured in his new office/home with peak RFR from 51 μW/m^2 to 2,350 μW/m^2, see Table 7. The office was also used as bedroom. Low emissions were measured in the kitchen. Highest peak exposure was found in the living room, 2,920 μW/m^2.

Discussion

In 2020 the French government agency ANSES concluded that there were no studies on health or biological effects from microwaves

Table 3: Measurements of radiofrequency/microwave radiation in the office below the 5G base station June 10th, 2022. Office 1 in Figure 1. Each value represents maximum (peak) value during 1 minute.

Maximum value in µW/m²	Time
20,700	15:36
1,180,000	15:38
15,100	15:39
6,690	15:40
4,190	15:42
275,000	15:43
463	15:44
19,200	18:23
8,460	18:25
3,090	18:26
2,440	18:27
1,110	18:28
428,000	18:30
6,460	18:31
7,320	18:33
1,130	18:35
849	18:37
3,200	18:38
864	18:39

Table 4: Measurements of radiofrequency/microwave radiation in the office below the 5G base station June 10th, 2022. Office 2 in Figure 1. Each value represents maximum (peak) value during 1 minute.

Maximum value in µW/m²	Time
9,770	15:28
8,930	15:30
10,500	15:31
6,230	15:46
31,100	18:02
501,000	18:03
10,500	18:04
13,300	18:06
12,800	18:07
11,300	18:08
11,100	18:09
254,000	18:10
8,610	18:11
8,010	18:13
8,770	18:14
9,090	18:15
7,690	18:16
7,190	18:17
7,460	18:18
8,770	18:19

in the frequency range that is used for 5G in city areas (3.5 GHz) (https://www.anses.fr/fr/system/files/AP2019SA0006Ra.pdf). No studies on effects on human health from 5G radiation exposure have

Table 5: Measurements of radiofrequency/microwave radiation in the office below the 5G base station June 10th, 2022. Office 3 in Figure 1. Each value represents maximum (peak) value during 1 minute.

Maximum value in µW/m²	Time
13,700	15:19
17,800	15:20
17,500	15:21
19,600	15:24
91,300	15:25
27,300	18:44
38,900	18:47
25,800	18:49
19,200	18:51
19,900	18:52
154,000	19:12
490,000	19:13
613,000	19:14
19,900	19:49
22,700	19:50
17,200	19:51
25,400	19:52
20,700	19:53
18,500	19:54
23,500	19:56

Table 6: Measurements of radiofrequency/microwave radiation in the new office of case 1, Man aged 57, November 14th, 2022 at 1.30 pm to 2.30 pm. Each value represents maximum (peak) value during 1 minute.

Maximum value in µW/m²
Office
15
11
16
9
Conference room
13
8
6
5
Resting room
6
5
3
2
Kitchen
6
5
4
3

previously been published. The first rat study on effects from the 5G frequency 3.5 GHz (GSM modulated), published in October 2022,

Table 7: Measurements of radiofrequency/microwave radiation in the new office/living space of case 2, Man aged 42, November 22nd at 11.30 am and 12.30 am. Each value represents maximum (peak) value during 1 minute.

Maximum value in μW/m²
Kitchen
53
9
30
20
61
46
Living room
496
360
2,920
910
2,810
978
Bedroom/office
454
401
68
735
2,350
323
1,150
51

observed that 2 hours a day of exposure to 1,600,000 μW/m² 5 days a week during one month caused oxidative stress in the brain as well as an increase of degenerated neurons in the hippocampus region of the brain. Irisin levels were also decreased. The observed effects may trigger neurodegenerative diseases according to the authors of the study [14]. The level of exposure was non-thermal and well below the guidelines recoommended by ICNIRP [1]. Previous studies on health effects in people living near base stations and mobile phone masts have to a majority found health effects and symptom in line with the findings in this case study, also called radiofrequency sickness or microwave syndrome [15]. The effects have been observed at levels very much lower than the ICNIRP guidelines.

The presented symptoms in this case study after the deployment of 5G are typical for the microwave syndrome. They appeared after the deployment of a 5G base station on the roof right above the office and disappeared after the reduction of microwave exposure when the men left the office. The 57-year-old man's brother visited the office in May 2022 and was invited to stay overnight in the small apartment within the office space (see Figure 1, room no 3) The brother went to bed in the evening but woke up in the middle of the night with a heavy headache. He took an aspirin but the severe headache persisted. He therefore left the office space in the middle of the night and drove out of the town with his car. The headache disappeared within a couple of hours.

The headache returned when the brother again tried to stay overnight in the apartment one month later in June 2022. Also, this second time he woke up in the middle of the night with severe headache and also slight nausea. Again, he therefore left the apartment like the first time in the middle of the night and drove out to the countryside. The headache and nausea disappeared after some hours this second time as well. This case study may be regarded as a provocation study of real-life exposure to 5G.

Measurements of microwave radiation were made in the office and the living space of the men after the installation of the 5G base station on the roof. This investigation shows that the 5G base station emitted very high pulses of exposure to microwaves/RFR (maximum 1,180,000 μW/m²) and that 5G seems to be able to massively increase microwave/RFR exposure [13]. Within short time typical symptoms of the microwave syndrome are triggered, such as headache, sleep disturbances and tinnitus although the levels are well below the guidelines recommended by ICNIRP [1]. No health issues had appeared with the previous 3G and 4G equipment's at the same place. Previous measurements showed that deployment of 5G base station in addition to 3G and 4G increased microwaves/RFR peak exposure from 9,000 to 2,500,000 μW/m² [7]. Nevertheless, the guidelines for exposure to microwaves applied in most countries today are based only on thermal (heating) effects [1] that allow exposure to be as high as 10,000,000 μW/m² averaged over 30 min and 40,000,000 μW/m² local exposure averaged over 6 min [16]. The limits allow exposure to short peak exposure to be yet much higher, or 1000 × 10,000,000 μW/m². These thermal effects [17] occur at much higher intensities than those measured in the office that caused ill health effects within a short period of time.

Thus, humans are completely unprotected against all non-thermal effects of real-life exposure to microwaves/RFR from modern technology such as 3G, 4G, 5G. The harmful effects include cancer, DNA damage, oxidative stress, neurological, and other biological effects that may impair health [3]. The International Commission on the Biological Effects of Electromagnetic Fields [3] concluded that *"the assumptions underlying the FCC's and ICNIRP's exposure limits are invalid and continue to present a public health harm."* The Commission further points to the fact that 5G is being rolled out without any previous studies on health effects and that 5G creates radiation pulses from *"extremely fast data transmission rates"* that *"have the potential to generate bursts of energy"*. This case study illustrates these intense bursts of energy. The maximum peak levels varied considerably over time, see Tables 3-5.

The BioInitative Report suggested already in 2012, a limit for RFR radiation of 30 μW/m² to 60 μW/m², and even lower for sensitive persons and children, 3 μW/m² to 6 μW/m² [18] in order to protect against all known health effects based on the available evidence ten years ago. The EUROPAEM EMF guidelines proposed in 2016 maximum exposure to be 10 μW/m² to 1,000 μW/m², and lower at nighttime 1 μW/m² to 100 μW/m², and yet lower for sensitive persons 0.1 μW/m² to 10 μW/m² [19].

In addition, hundreds of scientists, medical doctors and organizations have called for a revision of the limits for better protection of humans and the environment (www.5gappeal.eu; www.emfcall.org; www.emfscientist.org). This study shows that 5G leads to very high microwave exposure with sharp peak pulses, which confirms previous measurements performed after the roll-out of 5G [13]. Several years before the roll out of 5G, scientists and medical doctors called for a moratorium on the 5G deployment due to the "*massive increase of mandatory exposure*" to microwaves and the

fact that the health hazards of this new technology had not been investigated [20], (www.5gappeal.eu). In a presentation at the ITU Workshop on 5G, EMF & Health Warsaw, December 5th, 2017, an employee of Ericsson, one of the world's leading 5G infrastructure providers, illustrated that 5G will lead to a substantial increase in RF radiation exposure [21]. If 100 times lower limits than ICNIRP's were to be used, i.e., those applied in countries such as Switzerland, 5G roll out would be a "*major problem or impossible*". Exclusion zone could be 35 meters below a base station on the roof of a building in cities.

Conclusion

5G is being rolled out without any studies showing that 5G is safe for humans and wildlife. To our knowledge, this is among the first studies of health outcomes in persons exposed to real life 5G microwave radiation. Within few weeks, a new 5G base station caused typical symptoms of the microwave syndrome or radiofrequency sickness in two men working and living in the office below the base station. The deployment of 5G also caused very high maximum (peak) microwave/RFR radiation non-thermal exposure, however far below the ICNIRP guidelines. The symptoms disappeared completely within some weeks after the men moved from the office to dwellings with much lower exposure. This case is in line with scientific findings reported over the last years on effects of exposure to microwave/RFR radiation at non-thermal levels. It also confirms previous findings that most symptoms disappear when the exposure is reduced or discontinued. This study adds to previously available studies that show that the microwave syndrome or illness appears at levels much below the current guidelines recommended by the ICNIRP.

References

1. International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys. 2020;118:483-524.
2. Federal Communications Commission (FCC). "Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies", FCC19-126, 2019.
3. International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). Environ Health. 2022;21:92.
4. Stein Y, Udasin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) - Review of mechanisms. Environ Res. 2020;186:109445.
5. Carpenter DO. The microwave syndrome or electro-hypersensitivity: Historical background. Rev Environ Health. 2015;30:217-22.
6. Marha K, Musil J, Tuha H. Biological effects of electromagnetic waves and their mechanism. In: Electromagnetic Fields and the Life Environment. San Francisco Press. 1971;29-38.
7. Hardell L, Nilsson M. Case report: The microwave syndrome after installation of 5g emphasizes the need for protection from radiofrequency radiation. Ann Case Report 2023;8:1112. DOI: 10.29011/2574-7754.101112.
8. Belpomme D, Campagnac C, Irigaray P. Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. Rev Environ Health. 2015;30:251-71.
9. Carlberg M, Hedendahl LK, Koppel T, Hardell L. High ambient radiofrequency radiation in Stockholm city, Sweden. Oncol Lett. 2019;17:1777-83.
10. Hardell L, Carlberg M, Koppel T, Hedendahl L. High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament. Mol Clin Oncol. 2017;6(4):462-76.
11. Hardell L, Carlberg M, Hedendahl LK, Koppel M, Ahonen M. Environmental radiofrequency radiation at the Järntorget Square in Stockholm Old Town, Sweden in May, 2018 compared with results on brain and heart tumour risks in rats exposed to 1.8 GHz base station environmental emissions. World Acad Sci J. 2019;1:47-54.
12. Koppel T, Ahonen M, Carlberg M, Hardell L. Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. Environ Res. 2022;208:112627.
13. Koppel T, Hardell L. Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA. World Acad Sci J. 2022;4:22.
14. Bektas H, Algul S, Altindag F, Yegin K, Akdag MZ, Dasdag S. Effects of 3.5 GHz radiofrequency radiation on ghrelin, nesfatin-1, and irisin level in diabetic and healthy brains. J Chem Neuroanat. 2022;126:102160.
15. Balmori A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Environ Res. 2022;214:113851.
16. Hardell L, Nilsson M, Koppel T, Carlberg M. Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 guidelines on radiofrequency radiation. J Cancer Sci Clin Ther. 2021;5:250-83.
17. Neufeld E, Kuster N. Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. Health Phys. 2018;115:705-11.
18. BioInitiative Working Group, Cindy Sage and David O. Carpenter, Editors. BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Radiation at www.bioinitiative.org.
19. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health. 2016;31:363-97.
20. Hardell L, Nyberg R. Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mol Clin Oncol. 2020;12:247-57.
21. Törnevik C. Impact of EMF limits on 5G roll out. ITU Workshop on 5G, EMF & Health Warsaw. December 5, 2017.

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Case Report

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Case Report: A 52-Year Healthy Woman Developed Severe Microwave Syndrome Shortly After Installation of a 5G Base Station Close to Her Apartment

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Base station; 5G; Radiofrequency radiation; Electromagnetic hypersensitivity; Microwave syndrome; Health

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1. Abstract

In this case report we present a woman aged 52 years who developed health problems consistent with the microwave syndrome after installation of a 5G base station facing her apartment at 60 meters' distance. These symptoms consisted of e.g., headache, dizziness, concentration difficulties, fatigue, arrhythmia, skin burning and nose bleeding corresponding to the microwave syndrome. High radiofrequency (RF) radiation levels were measured in her apartment especially in the part closest to the base station. In her living room at the window 17 500 to 758 000 μW/m^2 peak levels were obtained during 10 measurements, each over 1 minute. At the place of her sofa in her living room peak levels from 36 800 to 222 000 μW/m^2 were measured. It is noteworthy that very high radiation was found at the balcony facing the base station. All ten measurements at that place yielded within 10-15 seconds peak levels >2 500 000 μW/m^2, which is the highest measurable level with the meter used in this study. At the playground about 40 meters from the base station peak levels of 1 120 000 μW/m^2 and 479 000 μW/m^2 were measured, respectively. After temporally leaving the apartment for another dwelling with much lower RF radiation, 96 to 2 810 μW/m^2 peak levels, almost all symptoms disappeared within a short time. After moving back to her own apartment the symptoms reappeared. This study is in line with the results of our two previous case studies showing that installation of 5G caused an extreme increase in exposure and rapid development of the microwave syndrome. These case studies indicate that implementation of 5G cannot be done without the risk of harmful effects on human health.

2. Introduction

The fifth generation, 5G, for wireless communication is rolled out worldwide despite no previous research on possible negative effects on human health and the environment. Exposure to pulse-modulated microwave (radiofrequency; RF) radiation has increased dramatically on a world-wide basis [1,2]. Microwave radiation are frequencies in the range of 300 MHz to 300 GHz within the RF spectrum. In city environments in Sweden, frequencies used for 5G are currently in the 3.5 GHz band (https://pts.se/sv/5g/inforande-av-5g/). Studies on possible health effects from exposure to the 5G frequencies around 3.5 GHz were until recently non-existent [3]. In a study published in October 2022, animals were exposed to the 5G frequency 3.5 GHz (GSM modulated) for 2 hours a day to 1 600 000 μW/m^2, 5 days a week during one month. The exposure caused oxidative stress and an increase of degenerated neurons in the hippocampus region of the brain in addition to decreased Irisin levels. The observed effects may trigger neurodegenerative diseases [4]. The level of exposure was non-thermal and well below the guidelines recommended by the International Commission on Non-Ionizing Radiation (ICNIRP)

[5]. We recently published two case studies on health effects from 5G base stations [6,7]. These studies showed that the study persons developed the microwave syndrome after the installation of 5G base stations that yielded high pulsed RF radiation to their dwellings.

The safety limits for exposure to RF radiation applied by most countries around the world are still based on heating (thermal) acute effects that appear within short time of exposure, thereby excluding protection against long-term exposure and any other harmful effects that are not based on heating (non-thermal) [5,8,9]. The guidelines for reference values based on heating are set by ICNIRP, a self-appointed private organization based in Germany [5,9]. ICNIRP has managed to get world-wide influence and dominance on the evaluation of scientific evidence of negative health effects from RF radiation. Their guidelines are based on evaluations that have rejected all scientific evidence on non-thermal effects, despite growing evidence of a range of harmful effects well below the ICNIRP levels. That unscientific evaluation is in the interest of industry thereby facilitating the deployment of 5G and the wireless society [10,11].

2.1. The Microwave Syndrome

Microwave sickness or illness as an effect of microwave exposure, was reported already in the 1960's and 1970's in the East European countries [12]. Most affected were the neural, cardiovascular, and endocrine functions. Investigations of exposed workers showed that microwave exposure at non–thermal levels caused symptoms such as fatigue, dizziness, headache, sleep disorders, anxiety, problems with attention and memory [13]. A review of these studies, as well as studies on animals, concluded that "a surprisingly wide variety of neurological and physiological reactions are to be expected" because of exposure to non-thermal levels of RF/microwave radiation [14].

Other terms for the illness were radiofrequency sickness syndrome or microwave syndrome [15,16]. The non-thermal effects depend primarily on the modulation and/or pulsation of the signal and also on the peak and average intensity. Pulsed signals and simultaneous exposure to several frequencies caused more effects and were thus considered more hazardous. The observed effects increased with time of exposure [17,18]. In general, the symptoms declined after the exposure had ceased. According to Marha et al "at a certain time after exposure had ended (sometimes as long as several weeks or more) (see page 31), the organism usually returns to its original physiological state and all subjective and objective complaints vanish" [13].

2.2. Previous Studies on 5G

Recently we published a case report of two previously healthy persons, a man aged 63 years and a woman aged 62 years, who quickly developed symptoms compatible with the microwave syndrome after installation of a 5G base station on the roof above their apartment [6]. Very high radiofrequency (RF) radiation with maximum (highest measured peak value) level >2 500 000 $\mu W/m^2$ was measured in the bedroom located only 5 meters below the new 5G base station on the roof. That is the upper detection limit for the used exposimeter, Safe and Sound Pro II. Before the deployment of the 5G base station peak level of 9 000 $\mu W/m^2$ was measured from the 3G/4G base station that had been located at the same place since several years. Due to the severity of the experienced symptoms, the couple left the apartment within a couple of days for another dwelling with much lower maximum RF radiation of 3 500 $\mu W/m^2$. Their symptoms abated within few days. This is an example of a provocation test. In our second study we presented two men that also developed the microwave syndrome after installation of 5G base station on the roof of the building where their office was located at the top floor [7]. High RF radiation levels were measured in the office with highest radiation level of 1 180 000 $\mu W/m^2$ after the deployment of the 5G base station. Within short time after leaving the offices the symptoms disappeared. As in the first study, a base station for 3G/4G was already at the spot since several years prior to the replacement by 5G. This was another clear example of a provocation test with the persons being their own control subjects. These two studies are to our knowledge among the first studies ever to be made of health effects in persons exposed to real life 5G microwave radiation.

2.3. This Case Study

In this article we present a new case, a woman aged 52 years, suffering of the microwave syndrome after installation of a 5G base station on 25 November 2022. The base station is located 60 meters from her apartment, see Figure 1. The 5G antenna is placed on the roof of a three-floor building and projected towards her apartment on the second floor, see Figure 2. There was previously a 4G base station antenna at the same spot, see Figure 3, but it was only after it was replaced by the 5G antenna that the woman quickly developed severe symptoms of the microwave syndrome. The 4G antenna was removed shortly after the 5G deployment.

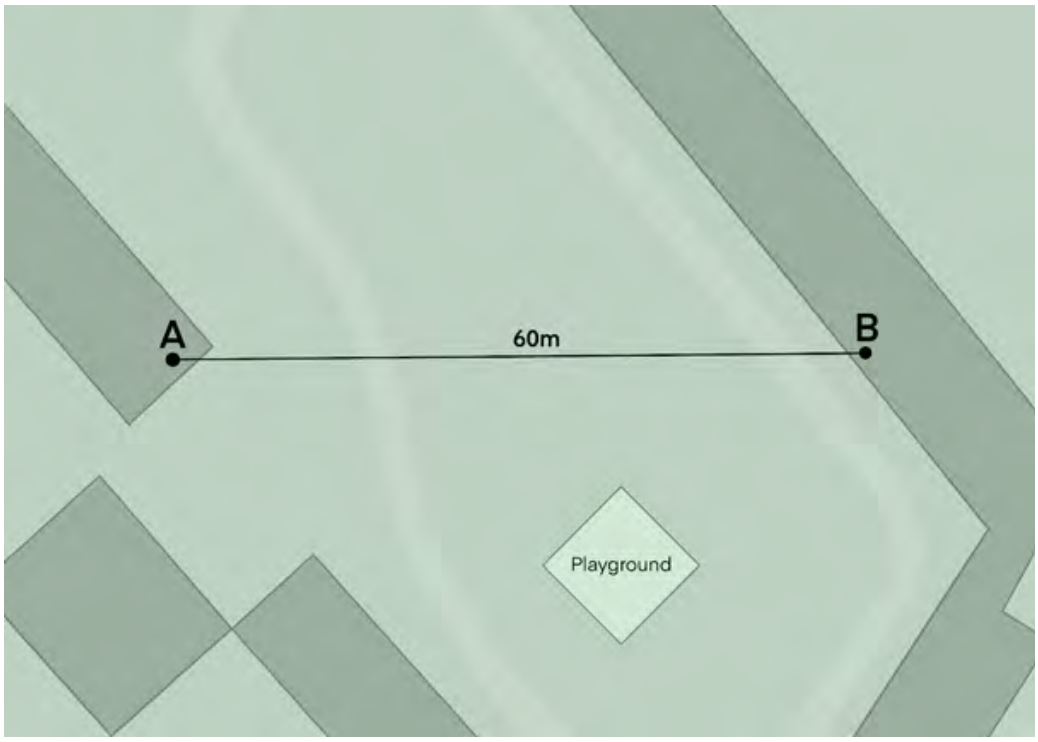


Figure 1: Distance between the 5G base station, A, and the apartment B, Note the location of the playground



Figure 2: 5G base station on the roof of a three floor building located 60 meters from the study apartment



Figure 3: 5G base station on the roof of a three floor building located 60 meters from the study apartment. Initial figure after the 5G installation showing the previous base station attached to the chimney

3. Methods

On 13 January 2023, the authors visited the study person at her home. Thereby her symptoms were investigated and discussed in person. She had previously answered a questionnaire on health with a list of symptoms adapted after Belpomme el al [19]. Four time periods were investigated. The first time period was in her home without 5G, the second at home with 5G, the third time staying in another apartment without 5G, and finally returning to her home with 5G exposure. Thereby the wash-out period of no 5G exposure between the third and fourth time period gave the possibility to investigate health during on and off exposure to RF radiation from 5G. The measurements were made during daytime with the device Safe and Sound Pro II. The true response detection range is between 400 MHz and 7.2 GHz.

It was calibrated by the manufacturer and has an accuracy of ±6 dB (https://safelivingtechnologies.com/products/safe-and-sound-pro-ii-rf-meter.html). The frequencies used for 5G in city environments in Sweden are mostly around 3.5 GHz. The upper detection limit for peak values of the exposimeter is 2 500 000 $\mu W/m^2$. At every investigated place in the apartment 10 or 20 measurements were made for 1 minute each.

4. Results

4.1. Health Symptoms

Table 1 gives the results for self-assessed health at four time periods. In July 2022 she was healthy. The base station for 5G that was installed in October 2022, was located opposite to her apartment with a small playground between the buildings, see Figure 1-3. After installation of 5G she rather quickly developed severe health problems with unbearable pain and/or discomfort due to a large number of symptoms such as headache, dizziness and balance problems, concentration problems, loss of immediate memory, confusion, fatigue, anxiety, emotive, cough, nose bleeding, symptoms from lungs, stomach, urinary system, and the skin. Interestingly one month later, staying in another apartment with no 5G, all symptoms disappeared except for minor problems with dizziness and tiredness both with grade 2, see Table 1. Within short after returning to her apartment in January 2023 the symptoms reappeared. This time her health declined and was even worse adding insomnia, suicidal ideation, heart problems, and irritation to the list of severe health issues.

Table 1: Clinical symptoms grades 0-10. Grade 0 = no symptoms, 10 = unbearable pain and/or discomfort in a 52 years old woman.

Symptom	Before 5G July 2022	With 5G October-November 2022	No 5G other place end of December 2022, beginning of January 2023	With 5G mid- January 2023
Headache	0	10	0	10
Dysesthesia	0	8	0	8
Myalgia	0	10	0	10
Arthralgia	0	10	0	10
Ear heat/otalgia	0	0	0	0
Tinnitus	0	2	0	8
Hyperacousis	0	0	0	0
Dizziness	0	10	2	10
Balace disorder	0	10	0	5
Concentration/Attention deficiency	0	10	0	10
Loss of immediate memory	0	10	0	10
Confusion	0	10	0	10
Fatique	0	10	2	10
Sleeping difficulty	0	7	0	9
- insomnia	0	7	0	10
- waking night time	0	0	0	0
- early wake-up	0	7	0	0
Depression tendency	0	6	0	10
Suicidal ideation	0	0	0	10
Cardiovascular abnormalities	0	7	0	10
- transitory high pulse	0	9	0	7
- irregular pulse	0	9	0	10
- slow pulse	0	0	0	10
Occular deficiency	0	8	0	8
Anxiety/Panic	0	10	0	10
Emotive	0	10	0	10
Irritability	0	6	0	10
Global body dysthermia	0	5	0	0
Dyspnoea	0	9	0	10
Chest squeeze	0	10	0	10
Cough	0	10	0	10
Nausea	0	10	0	10
Diarrehea (involuntary)	0	10	0	10
Urinary system -urgency	0	10	0	10
Skin (face, arms, legs))	0	10	0	10
-burning, lancinating skin on hands and arms	0	10	0	10
Nose bleeding	0	10	0	0
Hair loss	0	0	0	0

4.2. Measurement of RF Radiation

Table 2 displays the results for measurements of RF radiation. The highest levels were found in the part of the apartment facing the base station. In the living room close to the window at 30 cm distance, the peak radiation varied between 17 500 to 758 000 µW/m^2. Figure 4 illustrates the considerable variation of RF radiation within the measured time periods of 1 minute each and that 5G emits high repetitive pulses of microwave radiation. Also very high RF radiation was measured at the sofa in her living room 220 cm from the window facing the 5G antenna; 36 800 to 222 000 µW/m^2, see Figure 5 (note different scale for RF radiation compared with Figure 4). High radiation was also found in the bathroom, highest in the bathtub closest to the window. Considerably lower RF radiation was measured in the bedroom yielding peak level variation from 120 to 616 µW/m^2. Also, in the kitchen lower peak levels were measured from 156 to 1 420 µW/m^2. Both the bedroom and the kitchen are facing the other side of the apartment, thus with larger distance to the base station and additional walls in-between. The balcony of the apartment is facing the base station at 60 meters distance. RF radiation was measured 10 times 1 minute each time. Within 10-15 sec the highest measurement peak level for the meter, >2 500 000 µW/m^2, was obtained each time. Thus, the highest peak level was not possible to measure with the used exposimeter. The courtyard with a playground is located between the study subject's house and the building with the base station on the roof, see Figure 1. The distance is approximately 40 meters. Two measurements were made, 3 minutes each with circular walk around the playground. This yielded peak levels of 1 120 000 µW/m^2 and 479 000 µW/m^2, respectively.

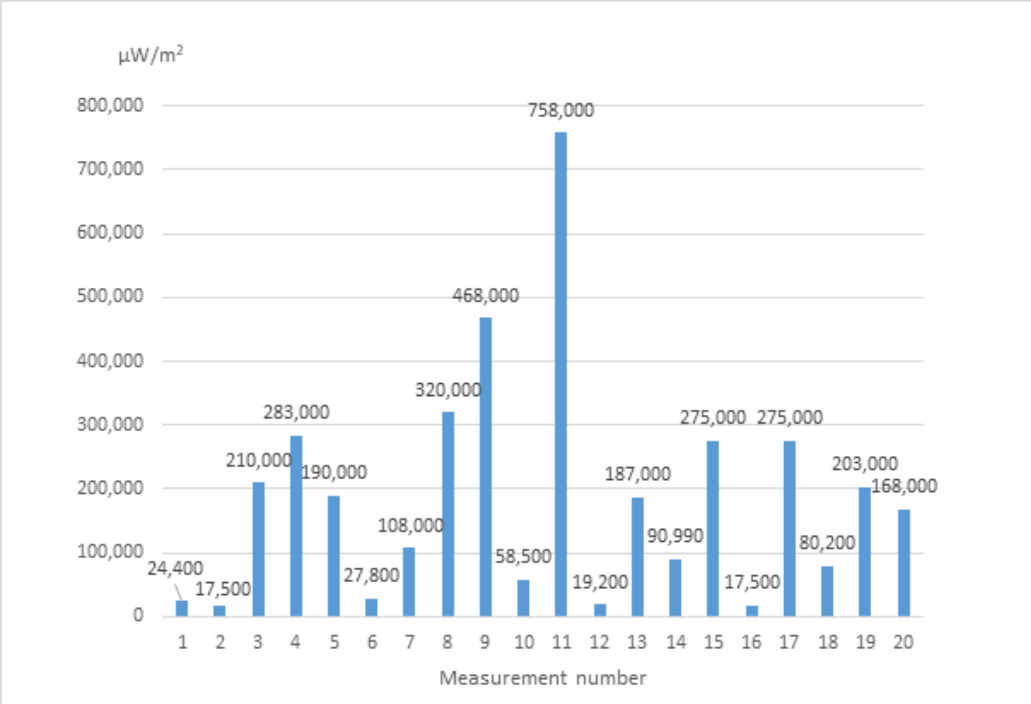


Figure 4: Results of 20 measurements in µW/m^2, each during 1 minute, for peak radiation from 5G in the living room 30 cm from the window

Table 2: Measurement of RF radiation in an apartment on January 13, 2023.

	Distance wall, cm	Distance floor, cm	Max (peak)
Kitchen, table	100	90	156-1420
Bedroom, pillow	80	80	120-616
Hall	440	110	2860-9390
Living room, window	30	120	17500-758000
Living room, sofa	220	80	36800-222000
Bathroom, bath	30	90	65400-150000
Bathroom, sink	180	100	8610-28900
Balcony		100	>2 500 000

Max (peak) value is given for every measurement during 1 minute each. Ten measurements were made during midday at each place and the results show the range of levels (µW/m^2). Twenty measurements were made at the window in the living room.

Note: At the balcony the level exceeded maximum for the used device within 10-15 sec each time for measurement.

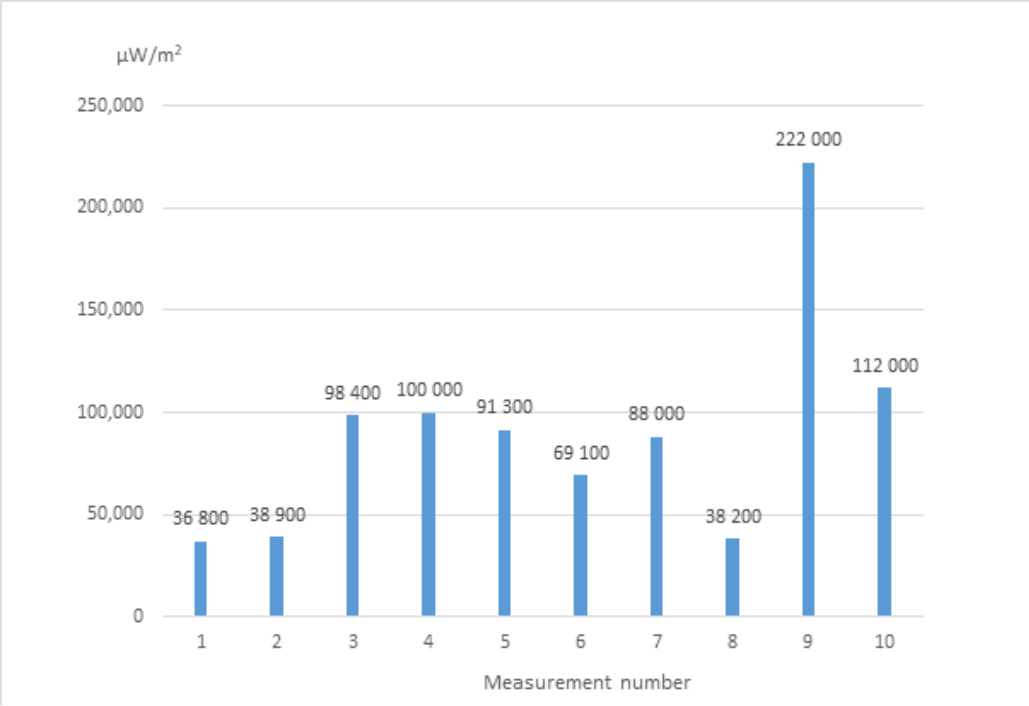


Figure 5: Results of 10 measurements in µW/m², each during 1 minute, for peak radiation from 5G at the place of the sofa in the living room 220 cm from the window

5. Discussion

In this article we present a 52-year-old woman who developed the microwave syndrome within short time after installation of a 5G base station 60 meters from her apartment. A 4G base station antenna was previously active at the same spot but it was not until the 5G deployment that her symptoms developed. Her home is located on the second floor and the base station is installed on the roof of a three floor building on the other side of the courtyard and directed towards her apartment, Figure 1,2.

This person answered a structured questionnaire on a series of symptoms associated with the microwave syndrome. This formula was similar as the one we had used in previous case studies, thus allowing the possibility to compare symptoms in different persons with similar exposure [6,7]. Of course the response is self-assessed and the evaluation of the health effects and their severity subjective. However, there were obvious signs of bruises on her arms as an objective marker of her complaint. It should also be noted that the study person has education in medicine, working as an assistant nurse. There is a truism in medicine that 'the patient is always right". Early research on effects of long term non-thermal microwave exposure concluded that the sensitivity to radiation may vary considerably among individuals and that women in general are more sensitive than men [13,18].

As presented in Table 1 the study person had a large number of severe symptoms inherent in the microwave syndrome. These included pain and a number of neurological symptoms such as dizziness, balance problems, concentration difficulties, loss of immediate memory and confusion. Nose bleeding and headache were severe problems as well as cardiac symptoms with irregular and transitory high pulse. In spite of fatigue she described insomnia as a problem. Body pain was another major symptom including skin burning on hands and arms. Nausea was also a major problem, grade 10, as well as diarrhea and urgency to urinate. Almost all symptoms disappeared after leaving her home to another accommodation with no 5G radiation. Using the same exposimeter RF radiation was measured at that place from 1 210 to 2 810 µW/m² in the living room 30 cm from the window, and 96 to 183 µW/m² in the kitchen 30 cm from the window. These measurements were done daytime and five times at each place during 1 minute each. Only slight dizziness and fatigue remained, both graded 2 on the 10 grades scale.

As presented in Table 1 her symptoms recurred after moving back to her dwelling. Some were worse such as tinnitus, grade 8, cardiovascular abnormalities, grade 10, and irritability grade 10. This time she did not note any nose bleeding.

This woman had since before slight hypertension. Living in her apartment she had no health complaints consistent with the microwave syndrome since before, although there was a 4G antenna at the same spot as the 5G base station. However, she had only lived in the apartment since October 1, 2022, thus less than 2 months of exposure to the 4G. No measurements are available of the radiation in the apartment before the 5G deployment. Our first case study indicated a sharp increase in radiation exposure from 5G compared to previous 4G antennas [6]. The windows of her apartment are energy efficient with thin metallic layers which are known to reduce incoming RF radiation. Our measurements also

showed clearly lower peak levels inside of the window compared to the balcony on the outside.

Since almost all symptoms disappeared after moving to another dwelling with no 5G exposure and low RF radiation levels and returned within short after moving back to her apartment, this must be regarded as a classic example of a provocation test.

The woman's dog also showed signs of ill health after the 5G deployment. According to her, the dog got diarrhea soon after the 5G deployment. This disappeared during the washout period in the other apartment with no 5G, but returned when they moved back to her own apartment. The dog also reluctantly returns to the 5G apartment after walks.

RF radiation levels were measured with Safe and Sound Pro II. Ten measures were made at every place during one minute each, except for 20 measures made at the window in the living room. There was a high variation of the peak level during that time, which is shown in Figure 4 and 5. As expected, highest levels were measured in the part of the apartment facing the building with the 5G base station on the roof. The levels measured in this study, and in our two previous case studies, were very high. These levels apparently provoked, within a short time period, ill health in the studied persons. They are far above levels that have been reported to provoke ill health from previous generations of wireless technology [20-27], and also far above levels recommended by experts. In 2012, the BioInitiative Report suggested a limit of 30-60 $\mu W/m^2$ for human exposure, lower for sensitive persons and children, 3- 6 $\mu W/m^2$ [28]. Even lower guidelines were proposed in 2016, maximum 10 – 1 000 $\mu W/m^2$, lower at night time 1-100 $\mu W/m^2$, and for sensitive persons 0.1-10 $\mu W/m^2$ [29]. On the other hand, the measured levels from 5G are still far below the levels recommended by ICNIRP [5] and the FCC [30]. According to ICNIRP 2020 exposure can be as high as 10 000 000 $\mu W/m^2$ for whole body exposure averaged over 30 minutes, thus allowing peak levels to be even very much higher [31].

5G apparently leads to very high microwave exposure with sharp peak pulses confirming warnings on high RF radiation from scientists several years before the 5G roll out. In the 5G Appeal, scientists and medical doctors called for a moratorium on the 5G deployment due to the "massive increase of mandatory exposure" to microwaves and the fact that the health hazards of this new technology had not been previously investigated [10] (www.5gappeal.eu).

The children's playground is located 40 meters from the base station, Figure 1. High RF levels were measured on the playground. For medical reasons it must be regarded to be a harmful place to be used, especially by children. Children are more vulnerable to RF radiation exposure than adults [32]. The microwave syndrome is similar to electromagnetic hypersensitivity; EHS [12]. However, unlike the microwave syndrome, individuals suffering from EHS can develop deliberating symptoms at extremely low exposure levels that are tolerated by most other people. That is in contrast to the very high RF radiation levels seen in our three case studies where healthy individuals, with no prior major reactions to wireless technology, quickly developed symptoms due to the sharp increase in exposure from 5G.

The sensitivity to RF radiation is known to vary considerably between different persons [33,34]. Most prevalent symptoms are related to the nervous system, the heart, the skin and the hormone system just as exemplified for this presented case and in our previous cases. For occupational exposure similar symptoms including also headache, sleeping problems, heart palpitations, mood swings and balance disorders were described some 50 years ago [17,18].

The microwave syndrome has previously been associated with living close to base stations in several studies since almost two decades [20-27]. A German study found effects on biological markers such as neurotransmitters and symptoms similar to the microwave syndrome among inhabitants living in a village after the activation of a GSM base station [35]. An increased frequency of micronuclei and lipid peroxidation was seen in cultured human lymphocytes in persons living within 80 meters from the base station, compared with a distance of 300 meters [36]. In 2011 the International Agency for Research on Cancer (IARC) classified RF radiation as a possible human carcinogen, Group 2B [37]. Additional research both on humans and laboratory animals since 2011 has confirmed the risk for cancer associated with RF radiation [8] appearing below the ICNIRP thermal limits. In spite of that, current guidelines for exposure propagated by ICNIRP [5] and the Federal Communications Commission in USA [30] have not been lowered although the scientific evidence of various health effects below these guidelines has increased over the years. They are based only on acute thermal effects, observed within very short exposure from extremely intense RF radiation [5]. These guidelines do not take account of e.g., long-term exposure, people's sensitivity, particularly vulnerable persons such as children, sick and old ones, and important physical properties of the RF radiation for instance pulse modulation [8,9]. They are clearly not adapted to prolonged 24 hours a day during lifetime.

It is obvious that during the recent two decades there has been increasing evidence on detrimental effects on both human health and the environment from RF radiation. Unfortunately, the recommendations of much lower limits than those by ICNIRP and FCC have not resulted in any practical steps to reduce the obvious risks for the public. On the contrary ambient RF radiation has increased [1,2]. In a recent article a former long-time member of ICNIRP concluded that "There are substantial abnormalities in these putative health safety protection guidelines and standards. Some of the safety limits are irrelevant, debatable, and absent of scientific justification from the standpoint of safety and public health protection" [9].

In a recent review on health risks from the wireless technology it was concluded that "A wide range of evidence indicates that there are numerous non-thermal effects from wireless radiation on reproduction, development, and chronic illness" [38]. Further, in an Essay it was stated that "Based on the precautionary principle, the author echoes the calls of others for a moratorium on the further roll-out of 5G systems globally, pending more conclusive research on their safety…In short, one should 'err on the side of caution'. In the case of 5G transmission systems, there is no compelling public health or safety rationale for their rapid deployment" [39].

6. Conclusion

This study confirms our previous publications on microwave syndrome caused by RF radiation emissions from 5G [6,7]. Our three studies are to our knowledge among the first to have investigated health effects from 5G base stations. 5G substantially increases exposure to microwave radiation and in the present case, as well as in the previous case studies, the 5G deployment was followed by a rapid development of symptoms known as the microwave syndrome. Urgent attention is needed to the 5G health hazards by the responsible governmental agencies.

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9. Availability of Data and Materials

The information generated and analyzed during the current study is available from the corresponding author on reasonable request.

10. Authors' Contributions

Both authors participated in the conception, design and writing of the manuscript, and have read and approved the final version.

11. Ethics Approval and Consent to Participate

Not applicable.

12. Patient Consent for Publication

Not applicable.

13. Competing Interests

The authors declare that they have no competing interests.

References

1. Koppel T, Ahonen M, Carlberg M, Hardell L. Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. Environ Res. 2022; 208: 112627.
2. Koppel T, Hardell L. Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA. World Acad Sci J. 2022; 4: 22.
3. ANSES Exposition aux champs électromagnétiques liée au déploiement de la technologie 5G. 2021. https://www.anses.fr/fr/system/files/AP2019SA0006Ra.pdf
4. Bektas H, Algul S, Altindag F, Yegin K, Akdag MZ, Dasdag S, et al. Effects of 3.5 GHz radiofrequency radiation on ghrelin, nesfatin-1, and irisin level in diabetic and healthy brains. J Chemical Neuroanatomy. 2022; 126: 102160.
5. International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys. 2020; 118: 483-524.
6. Hardell L, Nilsson M. Case Report: The Microwave Syndrome after installation of 5G emphasizes the need for protection from radiofrequency radiation. Ann Case Report. 2023; 8: 1112.
7. Nilsson M, Hardell L. Development of the microwave syndrome in two men shortly after installation of 5G on the roof above their office. Ann Clin Case Reports. 2023; 8: 2378.
8. International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF). Environ Health. 2022; 21: 92.
9. Lin JC. Incongruities in recently revised radiofrequency exposure guidelines and standards. Environ Res. 2023; 2222: 115369.
10. Hardell L, Nyberg R. Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mol Clin Oncol. 2020; 12(3): 247-257.
11. Nyberg NR, McCredden JE, Weller SG, Hardell L. The European Union prioritises economics over health in the rollout of radiofrequency technologies. Rev Env Health. 2022. https://doi.org/10.1515/reveh-2022-0106.
12. Carpenter DO. The microwave syndrome or electro-hypersensitivity: historical background. Rev Environ Health. 2015; 30: 217–222.
13. Marha K, Musil J, Tuha H. Biological effects of electromagnetic waves and their mechanism. In: Electromagnetic Fields and the Life Environment. San Francisco Press. 1971; 29-38.
14. Dodge, C. Clinical and hygienic aspects of exposure to electromagnetic fields: a review. 2022. https://www.magdahavas.com/wp-content/uploads/2010/08/Dodge_1969.pdf.
15. Johnson Liakouris AG. Radiofrequency (RF) sickness in the Lilienfeld study: An effect of modulated microwaves. Arch Environ Health. 1998; 53: 236-238.
16. Pollack H. The microwave syndrome. Bull NY Acad Med. 1979; 55: 1240-1243.
17. Healer J. Review of studies of people occupationally exposed to radiofrequency-radiations. In: Biological Effects and Health Implications of Microwave Radiation. Cleary SF (Ed).U.S. Symposium Proceedings Richmond, Virginia, September 17-19, 1969 Department of Health, Education and Welfare. Public Health Service Bureau of Radiological Health Rockville, Maryland 20852.
18. Marha K. Maximum admissible values of HF and UHF electromagnetic radiation at work places in Czechoslovakia. In: Biological Effects and Health Implications of Microwave Radiation. Cleary SF (Ed).U.S. Symposium Proceedings Richmond, Virginia, September 17-19, 1969 Department of Health, Education and Welfare. Public Health Service Bureau of Radiological Health Rockville, Maryland 20852.

19. Belpomme D, Campagnac C, Irigaray P. Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. Rev Environ Health. 2015; 30: 251-271.
20. Hutter HP, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. Occup Environ Med. 2006; 63: 307-313.
21. Eger H, Jahn M. Spezifische symptome und mobilfunkstrahlung in Selbitz (Bayern) - Evidenz für eine dosiswirkungsbeziehung; Umwelt-Medizin-Gesellschaft. 2010; 23: 130-139.
22. Alazawi SA. Mobile phone base stations health effects. Diyala J Med. 2011; 1: 44-52.
23. Martin S, De Giudici P, Genier JC, Cassagne E, Doré JF, Ducimetière P, et al. Health disturbances and exposure to radiofrequency electromagnetic fields from mobile-phone base stations in French urban areas. Environ Res. 2021; 193: 110583.
24. Gómez-Perretta C, Navarro EA, Segura J, Portolés M. Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study. BMJ Open. 2013; 3(12): e003836.
25. Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M, Ahonen M, et al. Epidemiological evidence for health risks from mobile phone base stations. Int J Env Occup Health. 2016; 16: 263-267.
26. Singh K, Nagaraj A, Yousuf A, Ganta S, Pareek S, Vishnani P, et al. Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. J Int Soc Prev Community Dent. 2016; 6: 54-59.
27. Balmori A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. Env Research. 2022; 214: 113851.
28. BioInitiative Working Group, Cindy Sage and David O. Carpenter, Editors. BioInitiative Report: A rationale for a biologically-based public exposure standard for electromagnetic radiation. https://bioinitiative.org/.
29. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health. 2016; 31: 363–397.
30. Federal Communications Commission (FCC). “Proposed Changes in the Commission’s Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies”, FCC19–126, 2019.
31. Hardell L, Nilsson M, Koppel T, Carlberg M. Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 guidelines on radiofrequency radiation. J Cancer Sci Clin Ther. 2021; 5: 250-283.
32. Uche UI, Naidenko OV. Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach. Environ Health. 2021; 20(1): 84.
33. Hedendahl L, Carlberg M, Hardell L. Electromagnetic hypersensitivity – an increasing challenge to the medical profession. Rev Environ Health. 2015; 30(4): 209-315.
34. Stein Y, Udasin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) - Review of mechanisms. Env Res. 2020; 186: 109445.
35. Buchner, K, Eger, H. Changes of clinically important neurotransmitters under the influence of modulated RF Fields-A long-term study under real-life conditions. Umwelt-Medizin-Gesellschaft. 2011; 24: 44-57.
36. Zothansiama, Zosangzuali M, Lalramdinpuii M, Jagetia GC. Impact of radiofrequency radiation on DNA damage and anti¬oxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med. 2017; 36: 295 305.
37. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. IARC Monogr Eval Carcinog Risks Hum. 2013; 102: 1-460.
38. Davis D, Birnbaum L, Ben-Ishai P, Taylor H, Sears M, Eng M, et al. Wireless technologies, nonionizing electromagnetic fields and children: Identifying and reducing health risks. Curr Probl Pediatr Adolesc Health Care. 2023; 53: 101374.
39. Frank JW. Electromagnetic fields, 5G and health: what about the precautionary principle? Essay. J Epidemiol Community Health. 2021; 75: 562-566.

Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks

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Children today are conceived and live in a sea of wireless radiation that did not exist when their parents were born. The launch of the digital age continues to transform the capacity to respond to emergencies and extend global communications. At the same time that this increasingly ubiquitous technology continues to alter the nature of commerce, medicine, transport and modern life overall, its varied and changing forms have not been evaluated for their biological or environmental impacts. Standards for evaluating radiation from numerous wireless devices were first set in 1996 to avoid heating tissue and remain unchanged since then in the U.S. and many other nations. A wide range of evidence indicates that there are numerous non-thermal effects from wireless radiation on reproduction, development, and chronic illness. Many widely used devices such as phones and tablets function as two-way microwave radios, sending and receiving various frequencies of information-carrying microwave radiation on multiple simultaneously operating antennas. Expert groups advising governments on this matter do not agree on the best approaches to be taken. The American Academy of Pediatrics recommends limited screen time for children under the age of two, but more than half of all toddlers regularly have contact with screens, often without parental engagement. Young children of parents who frequently use devices as a form of childcare can experience delays in speech acquisition and bonding, while older children report feelings of disappointment due to 'technoference'—parental distraction due to technology. Children who begin using devices early in life can become socially, psychologically and physically addicted to the technology and experience withdrawal upon cessation. We review relevant experimental, epidemiological and clinical evidence on biological and other impacts of currently used wireless technology, including advice to include key questions at pediatric wellness checkups from infancy to young adulthood. We conclude that consistent with advice in pediatric radiology, an approach that recommends that microwave radiation exposures be As Low As Reasonably Achievable (ALARA) seems sensible and prudent, and that an independently-funded training, research and monitoring program should be carried out on the long term physical and psychological impacts of rapidly changing technological milieu, including ways to mitigate impacts through modifications in hardware and software. Current knowledge of electrohypersensitivity indicates the importance of reducing wireless exposures especially in schools and health care settings.

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Abbreviations: EMF, Electro-magnetic field; EMR, Electromagnetic Radiation; FCC, Federal Communications Commission (U.S.A.); ICNIRP, International Commission on Non-Ionizing Radiation Protection; IEEE, Institute of Electrical and Electronics Engineers; MF, Magnetic field; GSM, Global System for Mobile Communications; RFR, Radiofrequency radiation; SAR, Specific Absorption Rate (a measurement of the rate at which energy is absorbed into particular tissues, when exposed to RFR); SAM, Specific Anthropomorphic Mannequin (a physical model used to estimate SAR, based on a 220 pound male with a 12 pound head); HPG, Hypothalamic-Pituitary-Gonadal axis; HSP, Heat Shock Proteins; ORSAA, Oceania Radio Frequency Scientific Advisory Association; DECT, Digital Enhanced Cordless Telecommunications; ICBE-EMF, International Commission on the Biological Effects of Electromagnetic Fields; ELF-EMF, Extremely Low Frequency Electromagnetic Fields (0 − 3 kHz); CDMA, Code Division Multiple Access; UMTS, Universal Mobile Telecommunications System; LTE, Long Term Evolution; ROS, Reactive Oxygen Species

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Introduction. Children's exposures to wireless radiation are increasing rapidly

We live in the age of technological wonder, where the ability to respond to emergencies, engage in routine commerce, and even conduct warfare has been radically altered by wireless communications. At the same time, we are also in an age of technological imperatives; that is, the fact that something *can* technically be done has been misconstrued as an argument that this *should be done,* i.e., in favor of implementing that technology. Parents understand that—just because you *can* go skateboarding without a helmet and other protective equipment does not mean that is a *good* idea. From wireless baby monitors to the iPad potty for toddlers learning to use the toilet, Wi-Fi Barbie, tablets and cell phones, today's infants, toddlers, young children, and adolescents are surrounded by wireless technologies. None has been tested for their impacts on children. Especially when used at early stages of life these devices can interfere with social development, learning, and socialization. They also can have lifelong and potentially irreversible adverse biological effects.

"Children are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation." American Academy of Pediatrics to the Federal Communications Commission (2013)[1]

Cell phones, tablets, and laptops typically operate as two-way microwave radios sending and receiving radiofrequency radiation (RFR) to and from internal and external antennas. Unchanged since 1996, RFR exposure standards for the use and operation of cell phones and other wireless devices rest on a crude physical model using an empty plastic ball for the head into which homogenous fluid is poured; this uniform medium cannot reflect the different densities and electromagnetic properties of developing physiology, morphology and tissues at different ages, and the greater vulnerability of infants, toddlers, and children. Health based standards have never been developed to take into account the vastly different technologies, uses and users employing devices today.

Although cellular communication systems and wireless technologies have demonstrated numerous direct benefits to society, they can also pose risks to the health and safety of the billions who are exposed to unnecessary levels of RFR throughout the life span. As demonstrated in this review, given the substantial experimental, epidemiological and clinical evidence that current levels of wireless radiation can be harmful, especially to the young, we concur with those experts who counsel that policies should be governed by the concept of ALARA—as low as reasonably achievable—while research continues to evolve.

The guiding principle of radiation safety, ALARA means avoiding exposure to radiation that does not have a direct benefit to you, even if the dose is small.[2]

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For more than a decade the American Academy of Pediatrics[3] and the American Academy of Child and Adolescent Psychiatry[4] advised that children age two and under have no screen time, yet infant and toddler use of devices is skyrocketing. That advice has now been modified to allow parentally supervised video calls for ages 18 to 24 months. The Pew Research Foundation surveyed parents in 2020 and 2021 and found that 8 out of 10 parents of a child who was age 11 or younger (81%) said their child had ever used a tablet computer in 2021 up from 68% in 2020[5]; 71% said their child had used a smartphone in 2021 (See Fig. 1). More recent numbers are sure to be higher, as the pandemic has led to increased reliance on digital

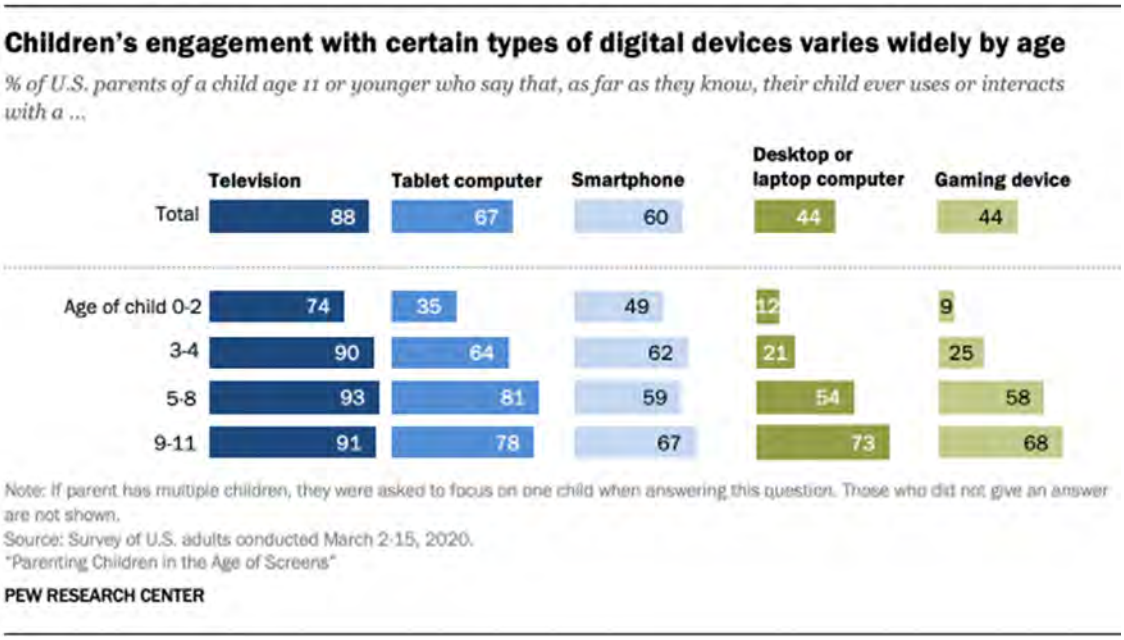


Fig. 1. Children's engagement with digital devices Survey 2020 by PEW Research Center. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

devices. Reports of serious behavioral problems including problems with self-control, socialization, language acquisition and the like have been associated with device addiction; and internet gaming disorder is on the rise in all age groups.[6]

Decades of research on RFR (including microwaves) indicate that everyday exposure to wireless devices can impact the physical, emotional and psychological health and well-being of adults and children.[7] A growing number of independent researchers find that while regulators, such as the U.S. Federal Communications Commission (FCC) and International Commission on Non-ionizing Radiation (ICNIRP) currently consider "low-level" exposures safe; these levels do in fact place children's endocrine, reproductive, and immune systems at risk. These current regulatory limits are based on the assumption that over-heating by high power RFR is the only established health effect to be avoided. Nevertheless, numerous studies find that nonthermal levels of RFR can cause major adverse effects such as induction of reactive oxygen species (ROS), DNA damage, cardiomyopathy, carcinogenicity, sperm damage, memory damage, and neurological effects.[8] As with many other chemical and physical hazards, there is evidence indicating that greater detrimental impacts take place when exposures occur during critical phases of growth and development, including pregnancy.[9]

Since the 1990s, member states of the European Union and the FCC have looked to the ICNIRP[10] and the Institute of Electrical and Electronics Engineers (IEEE)[11] for risk assessments and guidance on occupational and public exposure to RFR from all sources. These groups assume that only thermal effects (excessive heating) are to be avoided. In contrast, the International Commission on Biological Effects of Electromagnetic Fields (ICBE-EMF)[12] and the Oceania Radiofrequency Scientific Assessment Association (ORSAA),[13,14] among others, reject the assumptions on which ICNIRP relies, providing detailed grounds for their positions.[15] Moreover, the former editor-in-chief of the journal *Bioelectromagnetics*[16] contends that standards for evaluating wireless phones and other devices have not kept pace with developments in technology finding that nonthermal effects do occur and therefore current FCC standards do not protect public health.

Regulations on both sides of the Atlantic have in common that they are founded on risk assessments conducted in the 1980s and early 1990s by industry scientists and their affiliates in the IEEE. Despite a considerable weight of evidence indicating serious biological and environmental impacts of nonthermal levels of RFR, the FCC and the ICNIRP risk assessments of non-ionizing radiation from phones and other devices have remained unchanged for decades.

Several thousand apps have been developed for infants and toddlers to use on phones, watches and tablets with no research on their long-term physical or psychological impacts.

When phones were first brought to market, children's cell phone use was unheard of. Today children are exposed to wireless radiation from cell phones as well as numerous sources in their homes, child care settings and schools as shown in Fig. 2. Several thousand apps have been developed for infants and toddlers to use on phones, watches and tablets with no research on their long-term physical or psychological impacts. (Fig. 2)

This article assembles key scientific information regarding why and how to reduce wireless exposures to the young, including limiting prenatal and neonatal exposures. The latest scientific and clinical studies on the biological impacts of wireless radiation and models of exposure are considered briefly in terms of unexplained trends in cancer, autism spectrum disorder, learning difficulties, attention deficit, behavioral and psychiatric disorders, and other increasing pediatric disorders. Finally, health professional and U.S. national policy developments aimed at protecting children from inappropriate and harmful exposures are presented, with specific recommendations and practices for safer use of technologies.

Several thousand apps have been developed for infants and toddlers to use on phones, watches and tablets with no research on their long-term physical or psychological impacts.

Electromagnetic radiation and biological effects

Radio communications lie at the heart of the cell phone and wireless radiation revolution via electromagnetic "radio waves" or RFR.

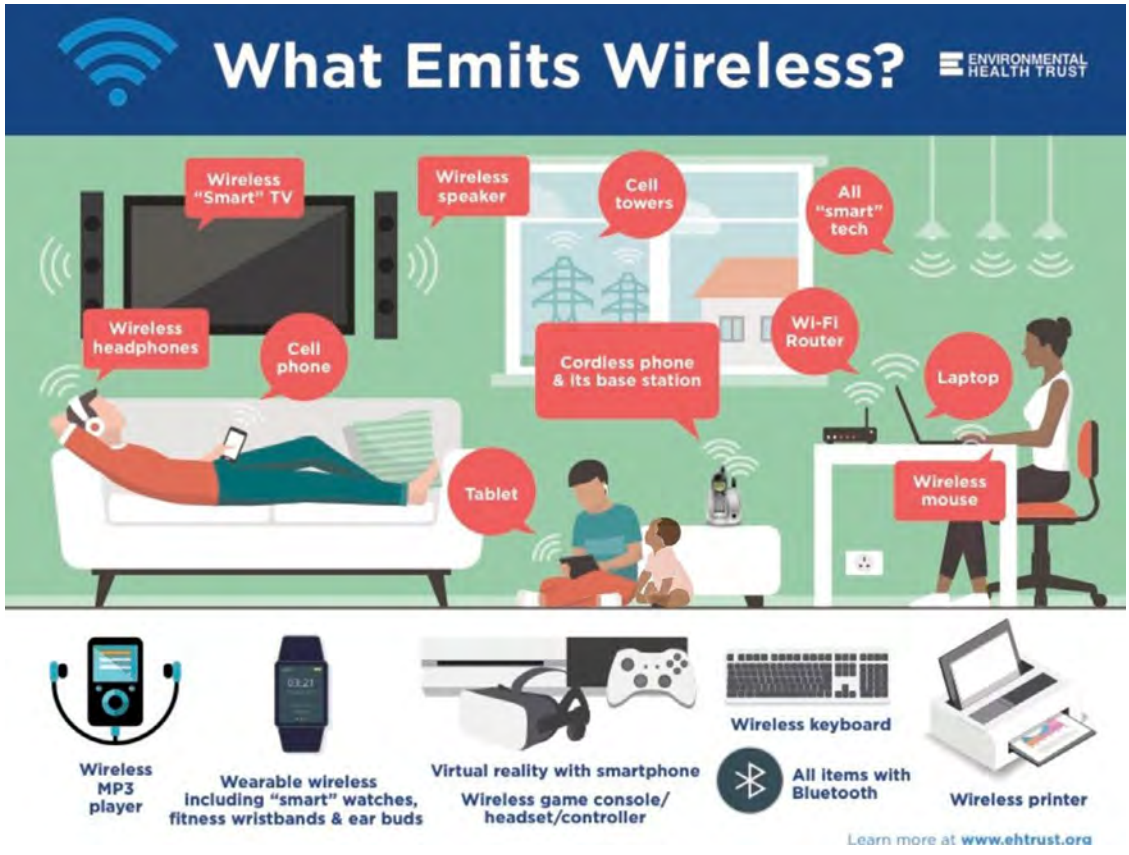


Fig. 2. Sources of wireless radiofrequency radiation in the home.

Electromagnetism

The theory of electromagnetism emerged in 1865 when James Clerk Maxwell unified Ampère's work on electricity, and Faraday's and others' work on magnetism into one unified theory.[17,18]

Simply put, an electric charge or the movement of electric charge (in electric currents through wires and devices) influences other charges or electrical currents at a distance. The influence, called a "field," results from attractive and repulsive forces between electrical charges. Positive and negative charges attract, while two charges of the same sign are forced apart. Of particular importance is how an oscillating charge creates a field that likewise oscillates, and this disturbance (called "radiation") propagates outward as a wave. Imagine a child flicking a skipping rope—the 'flick' propagates down the rope in the same fashion as the electric field propagates in the form of a wave. The theory was experimentally confirmed in 1887 by Heinrich Hertz.[19,20]

The duality of a wave is illustrated in Fig. 3. The oscillation can be described as a sine wave that depends both on the time and place of observation. The top frame of the Figure depicts the oscillation of the wave as seen by an observer standing in one place and looking over a period of time. One can imagine standing near the ocean and staring at a buoy as it undulates up and down as waves pass below. The bottom panel looks the same but depicts how at one instant in time the waves would look at every spot. Rather like standing on the same spot near the ocean and surveying open sea and all the waves before you. The characteristic features of the wave are its amplitude, A, its wavelength, λ (the distance between two sequential peaks) and its frequency, f (the number of oscillations per second, measured as Hertz [Hz] or reciprocal seconds [s^{-1}]). The relationship between these parameters, the cyclic frequency, ω, and the wavenumber, k, are illustrated in the Figure. Most importantly the multiplication of the frequency with the wavelength equals the speed of propagation, c.

Maxwell's theory predicted that the speed of light (visible light is a form of electromagnetic radiation) would be constant at 186,000 miles per second, confirming a measurement first made on earth (rather than by astronomical estimation as done by Ole Rømer and published in 1676[21]) by Hippolyte Fizeau in 1848.[22]

The frequencies of oscillation of electromagnetic waves can range from fractions of Hertz (a slow variation in field strength taking more than a second to complete) to billions of times a second. Each frequency can be exploited technologically in different ways and this is generally represented by the Electromagnetic Spectrum.

The electromagnetic spectrum

Physicians utilize electromagnetic radiation (EMR) in many forms. High-frequency, ionizing EMR is employed for diagnosis (e.g., X-ray and CAT scan imaging) and treatment (e.g., gamma-knife and other ionizing radiation treatments for cancer; non-ionizing ultraviolet radiation provides treatment of skin conditions such as psoriasis; infrared radiation is applied in physiotherapy and intensive care), while pulsed EMR are increasingly used in orthopedics and physical therapy. The electromagnetic spectrum includes visible light that forms a sliver of the spectrum (Fig. 4), with much of the remaining parts being invisible.

In public health, strong health and safety guidelines proscribe exposing infants and young children to the sun's rays beyond limited exposures. The problematic rays are found in the sun's ultraviolet (UV) light in the UVA and UVB frequency bands. While UVB is traditionally associated with direct DNA damage that leads to melanoma or less malignant forms of skin cancer, recent evidence indicates that UVA plays a greater role than previously assumed in the onset of skin cancers and can affect the immune system and other organs as well.[23] Other parts of the spectrum, especially that of blue light at 440 nanometers are used for their biological impacts on the skin to treat hyperbilirubinemia[24] by stimulating the production of di-hydroxy-vitamin D in the liver in jaundiced newborns. Untreated, the syndrome can result in bilirubin concentrations that can cause acute bilirubin encephalopathy and kernicterus− a permanent disabling neurologic condition. Blue light[25] is also known to interfere with sleep by impeding the production of melatonin, a natural hormone released by the pineal gland that is a potent anti-oxidant and free radical scavenger produced by sleeping in darkness.

Returning to the use of the spectrum for communication, the ability to transmit a travelling electrical field across space cannot itself establish a communication channel. For that to take place, information must be encoded into that transmission. The ability to code information on EMF was what Guglielmo Marconi

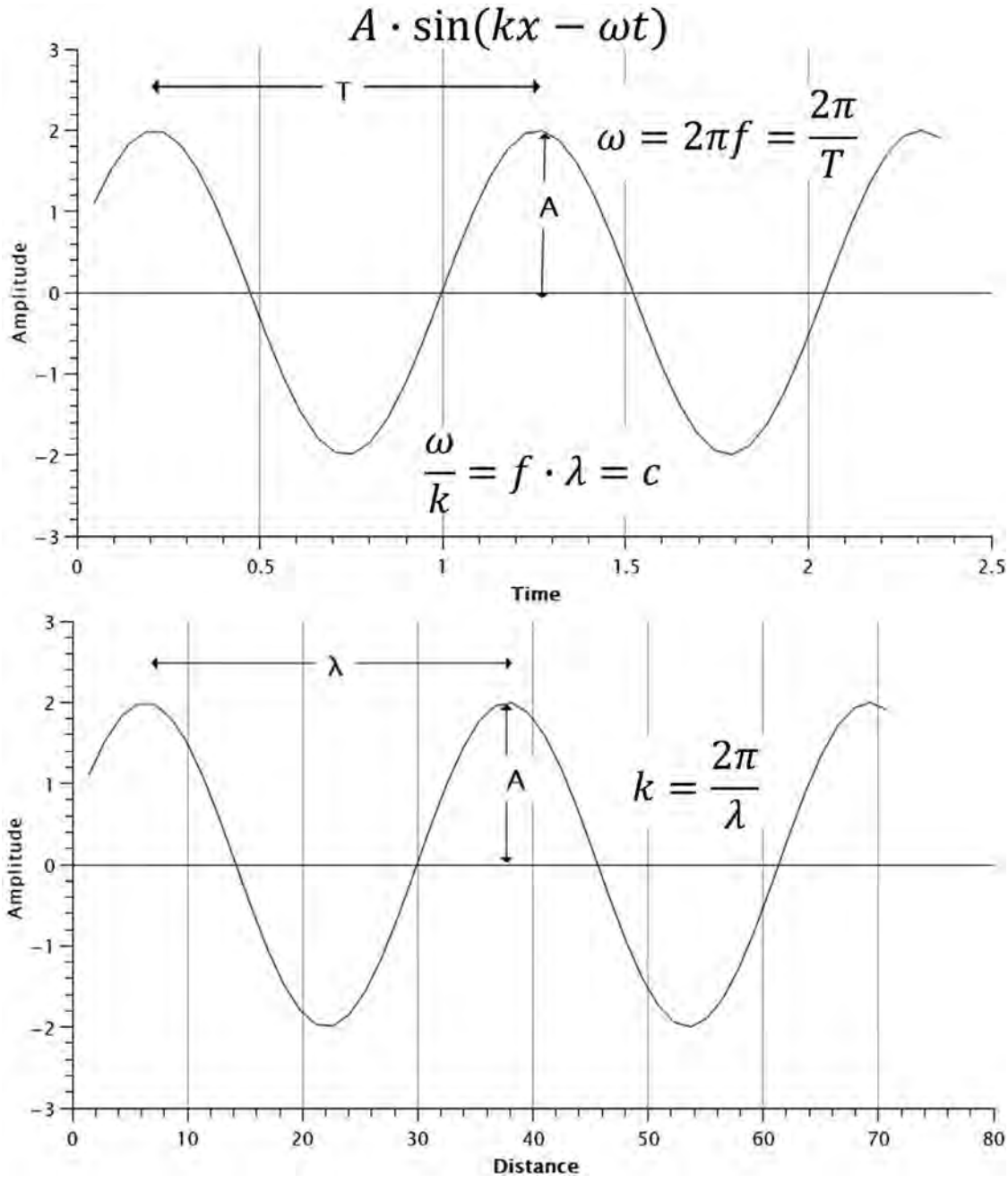


Fig. 3. Mathematical description of a continuous wave as a sine function. *A is the amplitude of the oscillation, f is the frequency, T is the time period for one complete oscillation, ω is the cyclic frequency (ω = 2pf) and k is the wave number.*

demonstrated in 1897[26] with his first transatlantic radio transmission.

Signals

The easiest way to encode information onto EMF is to turn the transmission on and off—Morse code in other words. Making a spark earned early Morse Code operators the moniker, "Sparky." Dots and dashes (a "digital" mode of communication) are comparable to the ones and zeros at the root of modern computing. More information can be transmitted by a careful modulation of the amplitude of the signal in proportion to the modulation of a sound, be it someone's

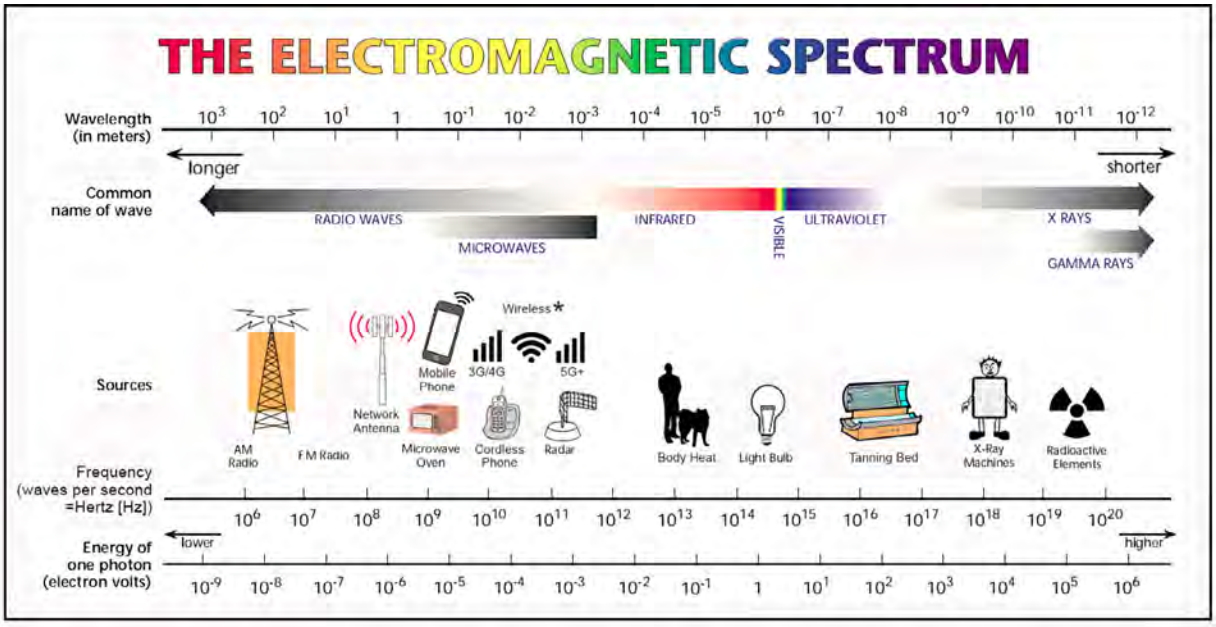


Fig. 4. Electromagnetic Spectrum

* Cellular and cordless phones; computers, laptops, tablets and peripheral equipment; antennae, Wi-Fi, access points and drones; monitors (e.g. security, medical, for babies); toys and entertainment systems; "smart" utility meters and appliances; control systems (e.g. indoor climate or lighting); "wearables"; power transfer/battery charging stations; and more. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

voice or music. This scheme, known as amplitude-modulated (AM) radio, dominated early radio and television broadcasts. However, there is a drawback with such a scheme in that only one operator can use the same radio frequency at a time. For two-way AM communication either, each side must wait for the other to stop and 'release' the frequency (hence the use of 'over' by radio operators) or there must be different carrier frequencies for each channel.

The first generation of cellular phones were little more than AM radio handsets working with 2 channel communication (by using a protocol known as Frequency Division Multiple Access[27] (FDMA) and transmitting to an antenna connected to the telephone network, often using relatively high powers of EMF, up to 5 Watts. Their transmissions could be famously picked up by ham radio operators, as the future King of England discovered to his chagrin, when an intimate conversation between then Prince Charles and his paramour, Mrs. Camilla Parker-Bowles was recorded by a scanner enthusiast.[28] Continuous analogue signals dominated telephone signals via copper wires that knitted together cities and countries, radio and television broadcasts right up until the early 1990s.

To overcome problems of limited exchange, and avoid interference and the embarrassment of royals, digital forms of transmission were introduced. The simplest form of digitization is to modulate a carrier signal, transmitting at a set frequency by multiplying it by zero or one. This is illustrated in Fig. 5.

The first panel in the Figure shows the base sinusoidal signal and is known as the "carrier frequency". The second panel is a digitization that turns on or off the signal. The bottom panel is the result of multiplying the two together, resulting in bursts - pulses- of transmission. A receiver tuned to the carrier frequency will translate the red envelope into ones and zeros, resulting in a digital series and information.

The increase in exposure to electromagnetic radiation

The quantity of data transmitted wirelessly and its associated radiation have increased many orders of magnitude since the inception of TV and radio programming. Rather than weekly anticipation of seeing a star on the Ed Sullivan Show or the next stage of a sitcom, we can now enjoy instant gratification with binge-watching, and endless offerings on many platforms, with important environmental implications,[29] including significantly increased energy and greenhouse gas emissions.

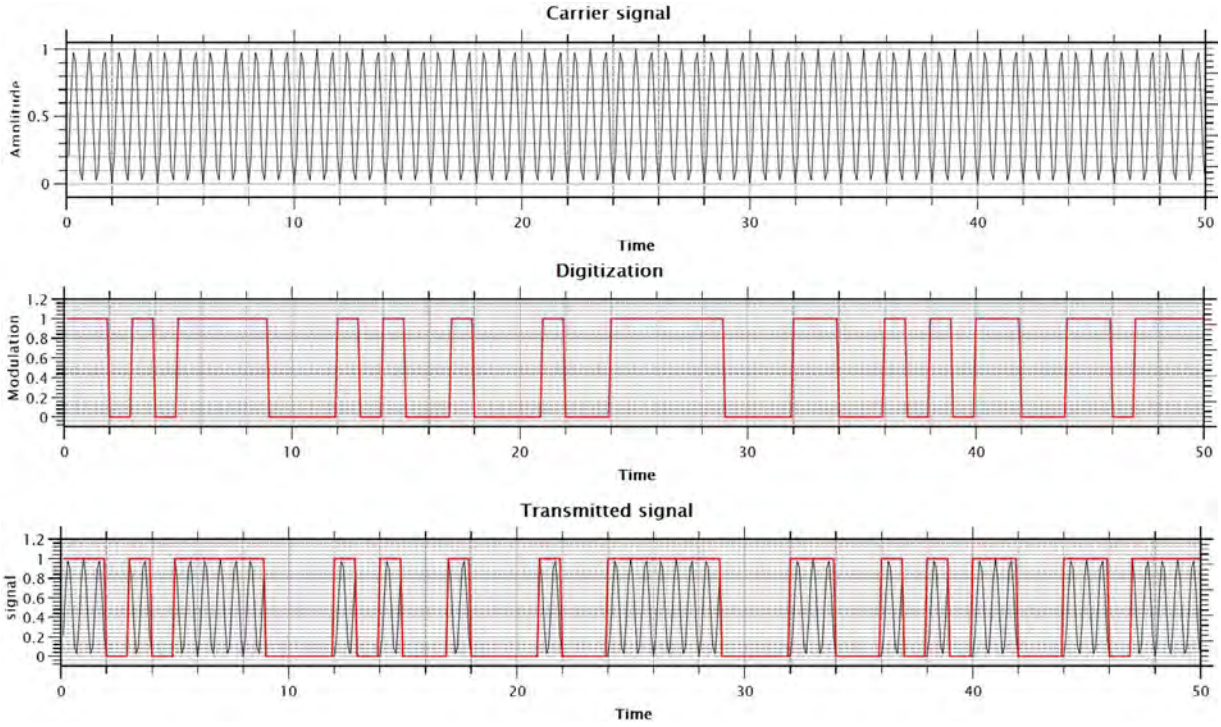


Fig. 5. A simple illustration of how a continuous carrier wave can be transformed into a pulsed signal for digital transmission. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Since the inception of the mobile telephone age (the first commercial cellphone hit the marketplace in 1983[30]) 40 years ago there have been 5 generations of technological advances (see Table 1) culminating in the last 5th Generation (5G) Mobile networks. Each generation has led to consequent increases in exposure to EMR.[31] One often trumpeted claim is that the latest 5G networks will in fact be greener and reduce exposure levels. However, in discussing the energy implications of 5G rollouts, López-Pérez et al. noted in a recent survey that a 5G network may consume over 140% more energy than an equivalent 4G network.[32] Additionally, there is no corroborated evidence that 5G networks will reduce exposures. There are number of studies indicating the opposite will be true[33–36] Some industry experts report that ambient environmental exposures from near antenna installations from 5G and the densification of new wireless infrastructure can exceed those of current 3 and 4G networks up to 46 times.[33,37] 5G networks have multiple beam-forming antennas, located about every 100 m.[32] The public health and environmental impacts of 5G remain untested.

Some industry experts report that ambient environmental exposures near antenna installations from 5G and the densification of new wireless infrastructure can exceed those of current 3 and 4G networks up to 46 times.

Part of the reason for this increase in exposure with 5G is due to the fact that as higher frequencies are used atmospheric absorption and scattering increases. Because 5G frequencies operate along the millimeter wavelengths and signals cannot travel as far as previous systems, they are more prone to disruption from objects that interfere, such as walls and other barriers. Therefore, to maintain the same signal strength more base stations are required, a process known as "densification." Some estimates put the number of additional 5G base stations required for coverage in an urban environment to a 100-fold increase compared to an equivalent 4G network.[34] More base stations translate to more radiation. Another reason that greater exposures can occur is a

TABLE 1. Common cellular technologies and their respective frequency bands in the MHz (106 Hz) and GHz (109 Hz) ranges.[30]

Cellular technology	MHz frequencies	GHz frequencies
GMS (2G)	380 – 900	1.8 – 1.9
CDMA (2G & 3G)	400 – 900	1.8 – 2.5
UMTS (3G)	699 – 900	1.7 – 2.69
LTE (4G)	400 – 900	1.9 – 5.925
5G NR (5G) FR1	600 – 960	1.5 – 6.7
Bluetooth		2.4
Wi-Fi		2.45, 5 and 6
5G NR (5G) FR2	———–	24.25 – 71.0

The acronyms stand for Global System for Mobile communications (GSM), Code Division Multiple Access (CDMA), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE) and 5th Generation New Radio Frequency Range (5G NR FR). **Currently 5G NR FR1 is being nationally deployed, with limited applications of 5G NR FR2 being deployed in some major cities.**

result of the fact that the 5G standard relies on a new technological advance termed Multiple Input Multiple Output (MIMO) antennas. The number of users that can connect to a single base station increases by sharing out the frequency band to many more frequency channels (hence the requirement for higher frequencies) and by dividing the time each individual channel utilizes the same frequency band. In contrast to 2G to 4G standards, this division of frequency bands in 5G is multiplied by using beam-forming antennas. By using many small antennas and by closely timing individual transmissions on the same frequency, it is possible to form the signal into a tightly confined spatial beam from the base station directly to the user's 5G phone, 5G tablet or 5G computer. As long as 2 users are not standing together, they can both use the same signal frequency and not interfere with each other's transmission. These are known as "phased array antennas" and will form the heart of multiple beam-forming antenna and the need for MIMO in the 5G standard.[33] The electromagnetic frequencies utilized for wireless and cellular communications, from 1G up to 5G occupy the Megahertz (MHz) and Gigahertz (GHz) frequency ranges as depicted in Table 1.

How is EMF exposure quantified?

The metric used for measuring personal exposure from cell phones is called SAR (Specific Absorption Rate). It is a gauge of the rate of absorption of electromagnetic energy by the flesh of the user. Properly defined it is the rate of absorption of energy from a cell phone or other wireless device, measured in Watts per Kilogram (W/kg) averaged over a time period of 6 or 30 minutes distributed into a 1 g or 10 g volume within the plastic phantom 12-pound head of a large adult male filled with homogenous fluid or his 220-pound plastic body phantom. A local SAR of 1.6 W/kg is allowed for head and torso, and 4.0 W/kg is permitted for extremities which include the ear (the pinna).

Using a computer-controlled probe that dips into the fluid-filled phantom head (see Fig. 6), the electromagnetic field strength is measured at various points inside the model of 12-pound head of a large adult male. The SAR is then calculated by the equation,

$$SAR = \frac{\sigma \left| E \right|^2}{\rho} \quad (1)$$

where σ is conductivity of the saline solution at the frequency of interest, E is the electric field strength and ρ is the density of the media. The protocol of measurement is dictated by the IEEE standard C95.1-2019.[38] The human phantom is known as the Specific Anthropomorphic Mannequin (SAM) and is standardized by the IEEE.[39] The SAR rating has been criticized as under-estimating absorption for smaller persons and for children by a number of authors[40] because the dimensions of the SAM are based on a model of the 90th percentile of 1989 United States military recruits.[41,42,38] The homogenized saline liquid used to electrically mimic flesh cannot account for the varied and widely differing conductivities and densities of different tissues of different ages.[43] Underlying this model for estimating exposure is the assumption that the only harm that can be caused by an electromagnetic wave is heating of brain or body. In summary, if exposure heating results in a rise in core body temperature of less than 1 °C, then it is considered not hazardous. Criticisms of the SAR are further discussed in Section 7 on the need to update regulatory limits.

A further metric is the Ambient Power Density (PD), measured in Watts per square meter or milliwatts per square centimeter. The ambient PD metric measures the flow of electromagnetic energy per square meter from a distant source, such as a cellphone base station. In the US the safety limit for general public exposure to sources such as base stations, is set at 10 W/m^2 (sometimes quoted equivalently as mW/cm^2).

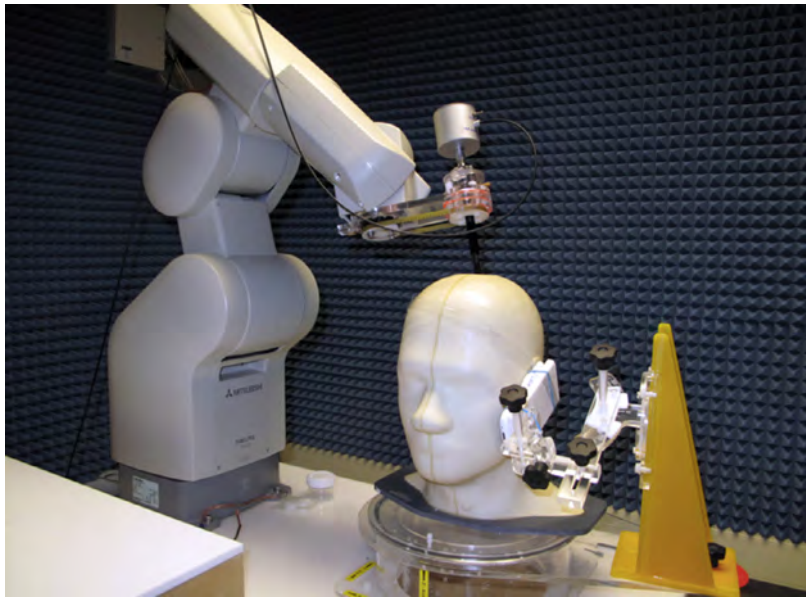


Fig. 6. Cell phone SAR RF test system using Specific Anthropomorphic Mannequin Model.

The origins of the ambient PD and the SAR regulations can be traced to the late 1950s when the U.S. Army and Navy became worried over potential harm to radar operators[44,45] from heating by carrying out studies on a handful of dogs, monkeys and rats. They had noted eye damage and burns from over exposure and the standard for PD was set at 10 W/m.[2,44,46] This became the established paradigm with the issuance of the first American standard in 1966 by the American Standard Association and then by the Institute of Electrical and Electronics Engineers (IEEE) for exposure to RFR and has remained ever since. Further research, including animal behavioral studies when exposed to EMF to a level that did not cause internal heating (of more than 1 ˚C) were used to confirm this initial assumption.[42] In 1996 the US Federal Communications Commission (FCC) set current guidelines for the allowable RFR exposure of the general public to RFR ranging from 300 kHz to 100 GHz (3G up to 5G and above).[47] based on a 1986 Report of the National Council on Radiation Protection & Measurements (NCRP) as well as the Institute of Electrical and Electronics Engineers (IEEE) C95.1-1991 standard.

In 2021, the U.S. Court of Appeals for the District of Columbia Circuit issued its judgment in* Environmental Health Trust et al v. FCC, *finding that the agency had failed to provide a rational record of review of all submitted science and specifically had not shown evidence of examination of studies provided to the agency on the greater vulnerability of children, the impacts of long term exposures, environmental impacts or the failure to update radiation test procedures for cell phones and other wireless devices which have not changed in more than 27 years.

Internationally, many national governments either take their cue for exposure levels from the FCC or from the International Commission for Non-Ionizing Radiation Protection (ICNIRP).[10]

A comparison of the allowed PD limits amongst counties is given in Fig. 7.

ICNIRP grew out of a working committee of the International Commission for Radiation Protection, a non-governmental organization representing professionals and bodies involved in radiation industries.[48]

Numerous publications have criticized ICNIRP as a close-knit invitation-only group that downplays and misrepresents research[49] indicating biological effects at nonthermal levels and

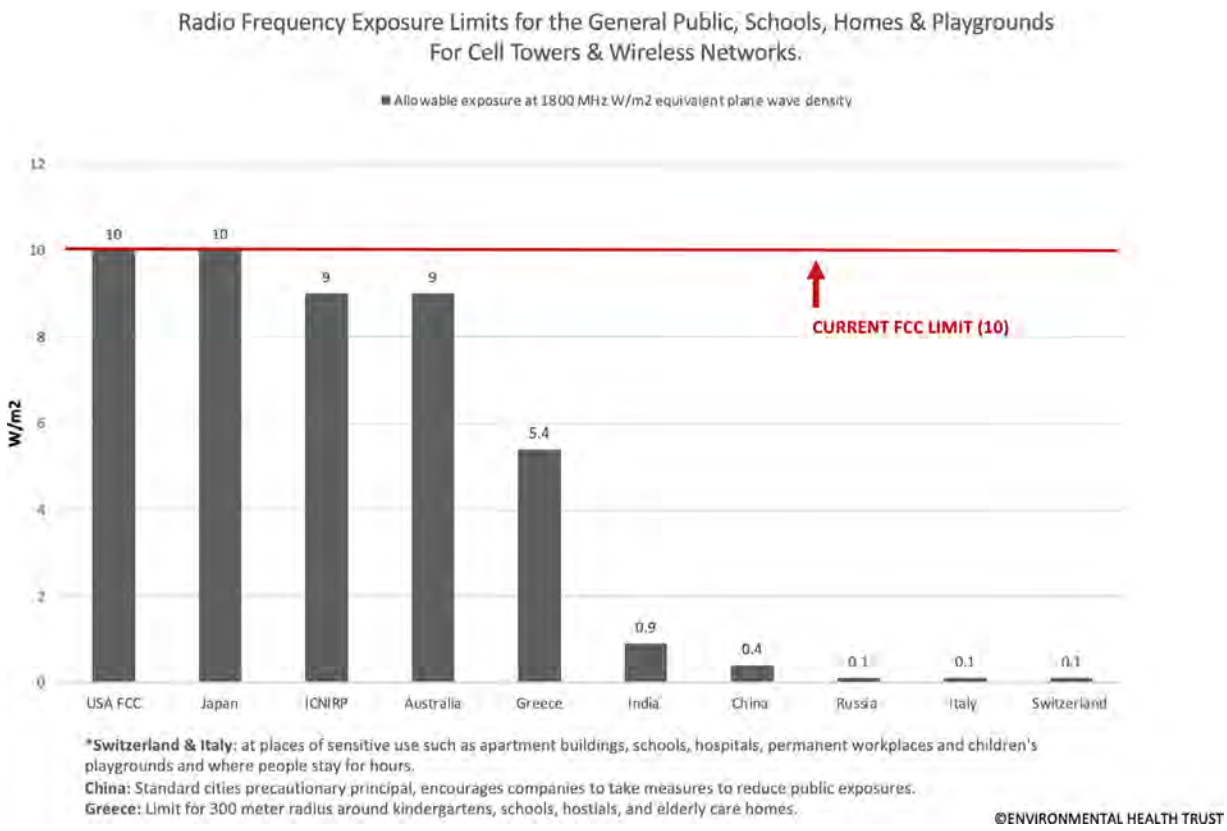


Fig. 7. Country variations for radiofrequency radiation exposure limits.

TABLE 2. ICNIRP and FCC SAR Limits in the U.S. and other countries

SAR Limits for Cell Phones and Wireless Devices	Whole -body average SAR (W/kg)	Head and Trunk * Localized SAR (W/kg)	Limbs and Extremities** Localized SAR (W/kg)	Examples of countries that adapted limits for cell phone and wireless device premarket tests
ICNIRP 100 kHz to 6 GHz All SAR limits averaged over 6 minutes. Local SAR averaged over 10 g of tissue.	0.4 W/kg 0.08 W/kg	Occupational 10 W/kg averaged over 10 grams tissue General Public 2 W/kg averaged over 10 grams tissue cube	20 W/kg averaged over 10 grams tissue 4 W/kg averaged over 10 grams tissue cube	Europe, Mexico, China, Greenland, Canada (for over 6 GHz), most countries in South America except Bolivia, most countries in Africa
ICNIRP (2020) >6-300 GHz *6 minute averaging *ICNIRP states, "Local Sab is to be averaged over a square 4-cm^2 surface area of the body. Above 30 GHz, an additional constraint is imposed, such that exposure averaged over a square 1-cm^2 surface area of the body is restricted to two times that of the 4-cm2 restriction."*	0.4 W/kg 0.08 W/kg	Occupational Local S_{ab} 100 mW/cm^2 General public Local S_{ab} 20 mW/cm^2		Australia
FCC Occupational, averaging time is 6 minutes. General public averaging time ranges from 6 minutes to 30 minutes.	0.4 W/kg 0.08 W/kg	Occupational 8 W/kg averaged over 1 gram of tissue cube General Public 1.6 W/kg averaged over 1 gram tissue cube	20 W/kg averaged over 10 grams tissue cube 4 W/kg averaged over 10 grams tissue cube	United States, India, Panama, Korea, Vietnam, Canada (for under 6 GHz), Iran, Republic of Bolivia, Cuba

ICNIRP's Head and Trunk tissues have both Type 1 and Type 2. ICNIRP defines Type 1 as all tissues in the upper arm, forearm, hand, thigh, leg, foot, pinna (visible portion of the outer ear) and the cornea, anterior chamber and iris of the eye, epidermal, dermal, fat, muscle, and bone tissue. ICNIRP defines Type 2 tissues: all tissues in the head, eye, abdomen, back, thorax, and pelvis, excluding those defined as Type-1 tissue. *Limbs do not contain any Type-2 tissue.

****FCC defines extremities as hands, wrists, feet, ankles, pinna/ ear.**

instead self-references its own commissioners, many of whom have a history of conflicts of interest.[50,51] ICNIRP and FCC limits for SAR are summarized in Table 2.

Despite innumerable studies demonstrating nonthermal biological effects of RFR, discussed below, ICNIRP and IEEE do not recognize non-thermal impacts as sufficiently "established" to be relevant to exposure limits.[7,8,31] Numerous scientific expert groups[7,29,52] such as ICBE-EMF and ORSAA emphatically do not agree with this view. Yet, the FCC reaffirmed their guidelines in 2019, by the expedient of simply reconfirming the existing 1996 standard.[53,54]

In 1996 the US Federal Communications Commission (FCC) set current guidelines for the allowable RFR exposure of the general public to RFR ranging from 300 kHz to 100 GHz (3G up to 5G and above).[47] This led to legal action against the FCC because more than 11,000 pages of published scientific studies and expert recommendations had been submitted to the FCC regarding the need to strengthen its RF exposure guidelines.[55] The FCC failed to provide a rational record of review of submitted science, and specifically did not take into account evidence on the greater vulnerability of children or environmental impacts. Human exposure limits and radiation test procedures for cell phones and other wireless devices have not changed in more than 27 years.

Public exposure limits for radiofrequency radiation from cellphone towers in Italy, Switzerland and Russia are 100 times lower than those of the U.S., last set in 1996.

The World Health Organization (WHO) maintains a dedicated EMF project[56] which collates national government regulations[57] and offers advice to national government agencies. However, the WHO EMF Project has not performed health risk assessment of radiofrequency electromagnetic fields since 1993[58] and several have questioned its independence as well as its role in the global harmonization of EMF standards.[59,60] The World Health Organization International Agency for Research on Cancer (IARC) constitutes a separate entity from the WHO EMF project. IARC classified RFR as a class 2B possible carcinogen in 2011.[61] Within the past few years, the IARC advisory group has recommended a re-evaluation of the body of evidence on cell phone risks to human health, in light of mounting evidence of adverse impacts discussed here.

Public exposure limits for radiofrequency radiation from cellphone towers in Italy, Switzerland and Russia are 100 times lower than those of the U.S., last set in 1996.

Since 1996, measurement of radiation permitted from any particular cell phone is made by testing temperature changes inside a plastic phantom 12-pound head of SAM (Specific Anthropomorphic Mannequin), filled with homogenous saline liquid to mimic the human brain with its diverse tissues and densities, making a 6 to 30 minute phone call, with a spacer between the head and the tested phone to allow for the ear/pinna.

Since 1996, measurement of radiation permitted from any particular cell phone is made by testing temperature changes inside a plastic phantom 12-pound head of SAM (Specific Anthropomorphic Mannequin), filled with homogenous saline liquid to mimic the human brain with its diverse tissues and densities, making a 6 to 30 minute phone call, with a spacer between the head and the tested phone to allow for the ear/pinna.

Physical mechanisms of the interaction of RFR and tissues

New 5G networks are using the frequencies of previous generations, but they can in addition employ higher submillimeter and millimeter wave frequencies. The higher the frequency, the less the radiation penetrates the body, but less penetration does not mean little or no biological impact. To the contrary, UVA and UVB are entirely absorbed in the skin, and can cause important immunological effects throughout the body including on the production of vitamin D. Indeed, immune effects of UV skin exposure can have consequences for the liver, kidney and other major organs, just as do the lower MHz and GHz frequencies that can penetrate deeper into the

body. Importantly, man-made RFR used in wireless and medical devices can be modulated, polarized and pulsed, which greatly influences and can alter their ultimate impacts.[62,63] Electroceuticals constitute an expanding field of clinical applications involving a range of medical devices, from pain control in orthopedics to cancer treatment, biofeedback, and the use of low-strength pulsed electromagnetic fields.[64] As with pharmaceuticals, any agent that promotes healing may also promote illness. It is therefore pertinent to explore potential mechanisms of interaction between tissues and electromagnetic waves.

An important division in the spectrum happens at a frequency of approximately 10^{15} Hz (wavelength 10^{-8} m). While Maxwell's theory, as described above, considers light as classical waves, modern quantum theory embraces a dualism in considering light as both a particle and concurrently as a wave.[65] One can consider an oscillating packet of waves confined spatially and moving as one through space. This is known as a photon and the energy it contains is proportional to the frequency of its oscillation. As the frequency is reduced and wavelengths get macroscopically longer (the wavelength of visible light is measured in hundreds of nanometers, whereas of radio waves in the MHz range the wavelengths are measured in hundreds of meters) the quantum description of light is indistinguishable for the classical theory of Maxwell.

The energy inherent in a photon of light at frequencies of UV and above is enough to cause the ionization of biological molecules. That means that the absorption of the photon by the molecule can result in the breaking of chemical bonds, leading to the destruction of the molecule. Specifically for DNA such an occurrence can lead to the promotion of cancers. At frequencies of radio waves direct ionization of DNA or other molecules cannot happen.

Physical mechanisms of the interaction of RFR and tissues

At the submicroscopic level molecules can be regarded as collections of potentially charged atoms held together by chemical bonds as they share electrons. RFR also affects atoms that tend to be charged; either positively charged "cations" (sodium Na^+ or calcium $Ca^{2+}$for example) or negatively charged "anions" (chloride Cl^-). Consequently, bonds will react to an external electromagnetic field, even if its frequency is not high enough to lead to direct ionization. One can view such a perturbation as gently "nudging" ions. Under certain conditions bonds can change and form new chemicals. Indeed, microwaves are used commercially to speed up and alter products of chemical reactions using "microwave catalysis".[66] Dysfunctional chemical reactions can lie at the root of many distinct forms of ill health for living organisms.

Biological pathways for non-ionizing effects

There are several pathways[67–71] that may be involved in biological effects of RFR, including the induction of ROS leading to oxidative stress, activation of the ERK1/2 signaling pathway, and induction of heat shock proteins. One of the more accepted pathways to damage is the perturbation of Voltage Controlled Calcium Gates (VCCG) by pulsed EMF.[72] VCCGs are an integral part of cell membranes that are responsible for the transport of Calcium ions across the cellular membrane for signaling and regulation of the cellular homeostasis. In 2000 Panagopoulos et al. concluded that the ELF EMF components of wireless communication signals are a critical factor in understanding how exposures can lead to pathology.[72,73] Repeated irregular gating of electro-sensitive ion channels disrupts the cellular electrochemical balance and homeostasis leading to the overproduction of reactive oxygen species. The cascading effects of repeated exposures can lead to numerous biological endpoints including the weakening of cell membranes.

Disturbance in ROS homeostasis leads to a pathological state[74] termed "oxidative stress", which plays an essential roles in regulation of cancer progression. ROS are understood to regulate every step of tumorigenesis and have been found to be upregulated in tumors; this can lead to aberrant signaling. In addition to cancer, oxidative stress plays a role[75] in the development of many other chronic diseases, including diabetes and neurodegenerative syndromes. Reviews of animal and cell studies consistently find even very low non-ionizing EMF exposures are associated with increased oxidative stress. Children whose immune systems are still developing are more vulnerable to these ROS effects.[76,77] In 2019 Lai found strong indications that exposure to static and extremely low frequency electromagnetic fields also affects oxidative status in cell cultures and experimental animals.[67–72]

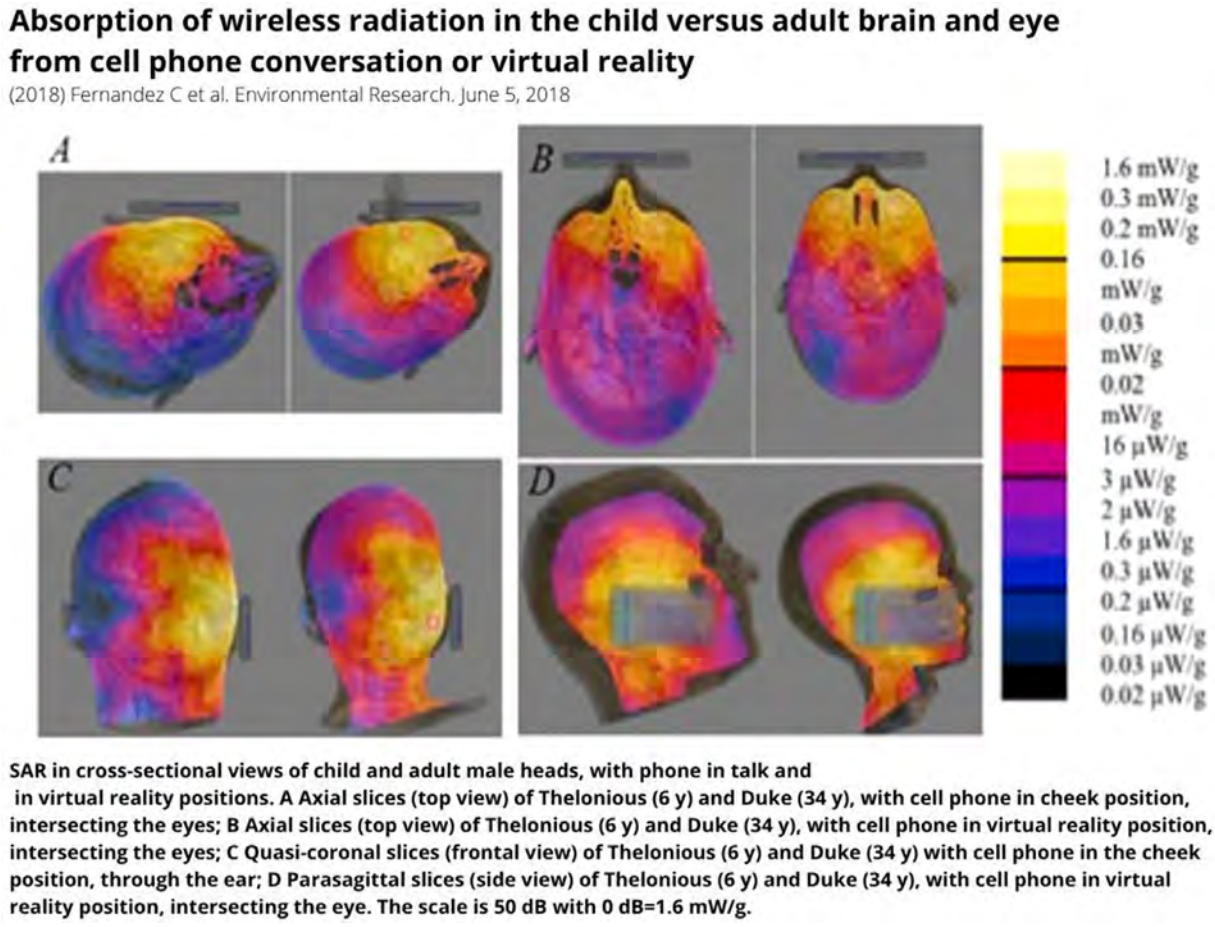


Fig. 8. Absorption of wireless radiation in child vs adult brain and eye from cell phone or Virtual Reality.[70] (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Children's unique vulnerability to wireless radiation

Children are more vulnerable to wireless radiation,[78–81] just as they are to other environmental pollutants[9] and medicines. Present and future generations will have many more hours of cumulative lifetime exposure to RFR, because exposures begin prenatally and continue throughout early and later life.

Children have a unique physiology, that results in proportionately greater RFR absorption compared with adults.[4] Children have smaller heads, resulting in shorter distances for RFR to travel to reach critical brain regions, and their brains contain more fluid that can absorb relatively more energy from radiofrequency radiation sources. Fig. 8[70] shows that simulations of exposure from cell phone use have determined that children absorb up to 2-fold greater RFR in the pediatric cerebellum, 10-fold greater in the bone marrow of the skull and up to 30-fold greater in the hippocampus.[82] Children's eyes can absorb 2 to almost 5-fold higher doses.

Children absorb proportionally more RFR than adults; about 2-fold greater in the pediatric cerebellum, ten-fold greater in the bone marrow of the skull and up to 30-fold greater in the hippocampus. Children's eyes can absorb 2- to almost 5-fold higher doses than adults.

Children's brain and body tissues have a higher dielectric constant, a measurement of the ease with which electromagnetic fields can move through different media. Peyman[83] documented how the young brain has a higher dielectric constant due to the higher water content and less developed myelin sheath. Bony tissues also change over time depending on the degree of mineralization of the bone matrix. The largest age-dependent variation in dielectric properties is observed in bone because as an animal grows, the high water content of red marrow is transformed to the high fat content of yellow marrow.

Every tissue in the body has unique dielectric properties. For example, the distinctive dielectric properties of normal and cancerous breast are being employed to enhance detection of abnormal cells[84] and to devise EMR-based treatments for the disease.[85]

Pregnancy, infancy and childhood are periods of critical susceptibility, especially for the brain, which is developing rapidly.[86] Children have a faster rate of neuronal cell growth and the fatty protective sheath of myelin is not fully formed until the mid-20s.[87] Even very low levels of an environmental exposure early in development can have lifelong implications for neurodevelopment. Stem cells[88] are more active in children and have been found to be more sensitive to wireless frequencies than differentiated cells.[88]

Cell phones and wireless devices have premarket RF emission tests using the large adult SAM model, with an empty twelve pound head into which homogenous fluid is poured. Devices are not tested using a child's smaller head and body, nor with models of pregnancy.[42] Devices are also tested at a distance from the body, without direct contact between the antenna and the body or skull. This is why most smartphones, Wi-Fi devices and other wireless electronics have instructions, deeply buried in user manuals, which advise that devices be kept at a distance from the body.

Fig. 9[77] shows the radiation pattern simulated from a Wi-Fi tablet into the head of a 6 year old.

Reproduction and pregnancy

Reproductive capacity

Several, but not all reviews[89] of the effects of EMFs on male and female reproductive function have identified numerous serious effects that occur at levels of RFR that do not heat tissues. Gye and Park[90] and Jangid et al.[91] present a number of *in vivo* and *in vitro* experimental studies demonstrating that non-ionizing nonthermal EMF exposure can alter cellular homeostasis, endocrine function, reproductive function, and fetal development. Impacts on both male and female reproductive parameters have been reported, including: male germ cell death, the estrous cycle, reproductive endocrine hormones, reproductive organ weights, sperm motility, early embryonic development, and pregnancy success.

Mechanisms that appear to be involved at the cellular level include increases in free radicals and calcium ions [Ca^{2+}] related to effects of EMFs, which lead to cell growth inhibition, protein misfolding and DNA breaks.

Reproductive parameters reported to be affected by EMF include male germ cell damage and death. Females may experience impacts on the estrous cycle affecting ovarian follicles, reproductive endocrine hormones and reproductive organ weights. Effects on reproduction include impairments of early embryonic development, fertilization, miscarriage and a variety of pregnancy-related outcomes. As with other endpoints, experimental effects on reproductive function differ according to frequency, polarity, wave-form, strength (energy), and duration of exposure.

A robust body of research on the male reproductive system specifically has found decreased testosterone[92] as well as impacts to sperm viability,[93] motility and morphology[68,94–100] from current levels of RFR resulting from use of cell phones or other devices.

The induction of oxidative stress[101] is understood to be a key pathway of action that underlies the biological impacts of RFR on the reproductive organs and also can play a major role in the induction of cancer as discussed below.[101] At the cellular level, increased free radicals impact mitochondrial metabolism and affect nitric oxide levels and antioxidant mechanisms.[102] RFR may alter membrane transport and integrity, affecting ion (e.g., calcium) transport; these are among mediators of effects of EMFs that lead to cell growth inhibition, protein misfolding and DNA breaks. See Fig. 10.[56,92]

Acute exposure can stimulate plasma membrane NADH oxidase and increase the production of ROS. Increases in ROS can stimulate endothelial growth factor (EGF) receptors which in turn activate extracellular signal regulated kinase (ERK) pathways. The ERK pathway consists of subsequent activation of

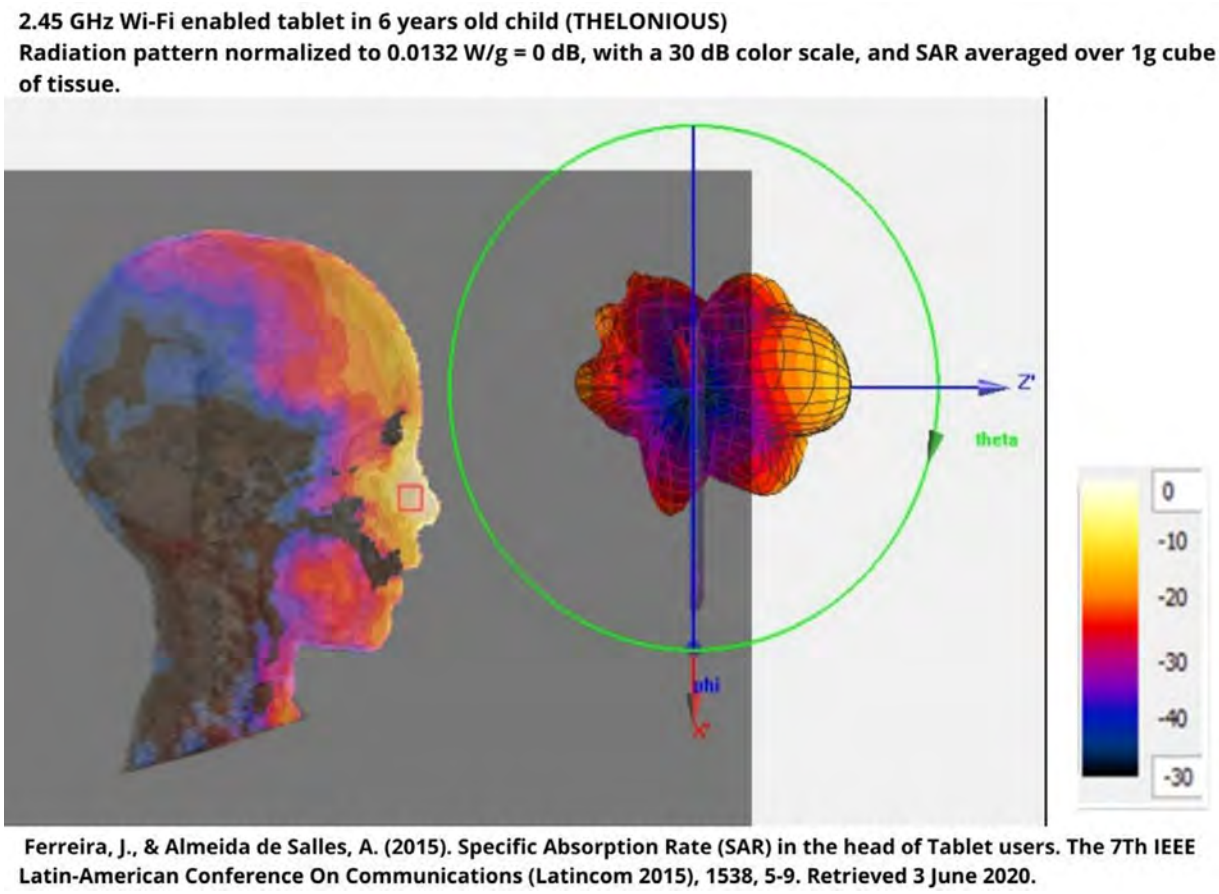


Fig. 9. Radiation pattern from 2.45 Wi-Fi enabled tablet into model of 6-year-old head. Radiation pattern normalized to 0.0132 W/g = 0 dB, with a 30 dB color scale, and SAR averaged over 1g cube of tissue.

Ras, Raf proteins, and mitogen-activated protein kinase (MAPK). The MAPK pathway also has a tumor promoting role. Chronic exposure to ROS can activate various stress kinases (p38 MAP kinase), stimulate the ERK pathway, and also lead to phosphorylation of heat shock proteins (Hsp) that inhibit apoptosis, thereby promoting survival of damaged cells and carcinogenesis. Hsp can increase the permeability of the blood-testis barrier and produce infertility. RFR also can interfere with membrane calcium channels and promote cancer by stimulating ornithine decarboxylase, a rate-limiting enzyme in polyamine synthesis.

Pregnancy is a critical window of vulnerability

In both animals and humans, prenatal EMF exposures have been linked with impaired development of structures and functions of the brain, as well as the reproductive organs and reproductive capacity of offspring. Experimental and epidemiological evidence indicates that prenatal impacts could range from impaired oogenesis and spermatogenesis, to reduced volume and number of brain pyramidal cells, other serious neuronal impairments, ovarian dysfunction[103] as well as increased DNA damage in multiple organs[104] of offspring.

Damage to oocytes in female offspring can in turn affect fertility as well as the health of following generations. Daily exposure of young Sprague-Dawley female rats for 2 h of GSM radiation for 1 and 2 months produced inflammation and impairment of ovarian function[103] consistent with endometritis, a growing problem for young adolescents. Intergenerational impacts are increasingly being understood; a 2021 study of more than 200 mother-daughter-granddaughter triads, found that granddaughters of those who had been in the top third of DDT exposure during pregnancy had 2.6 times the chances of having an unhealthy body mass index by their mid-twenties and

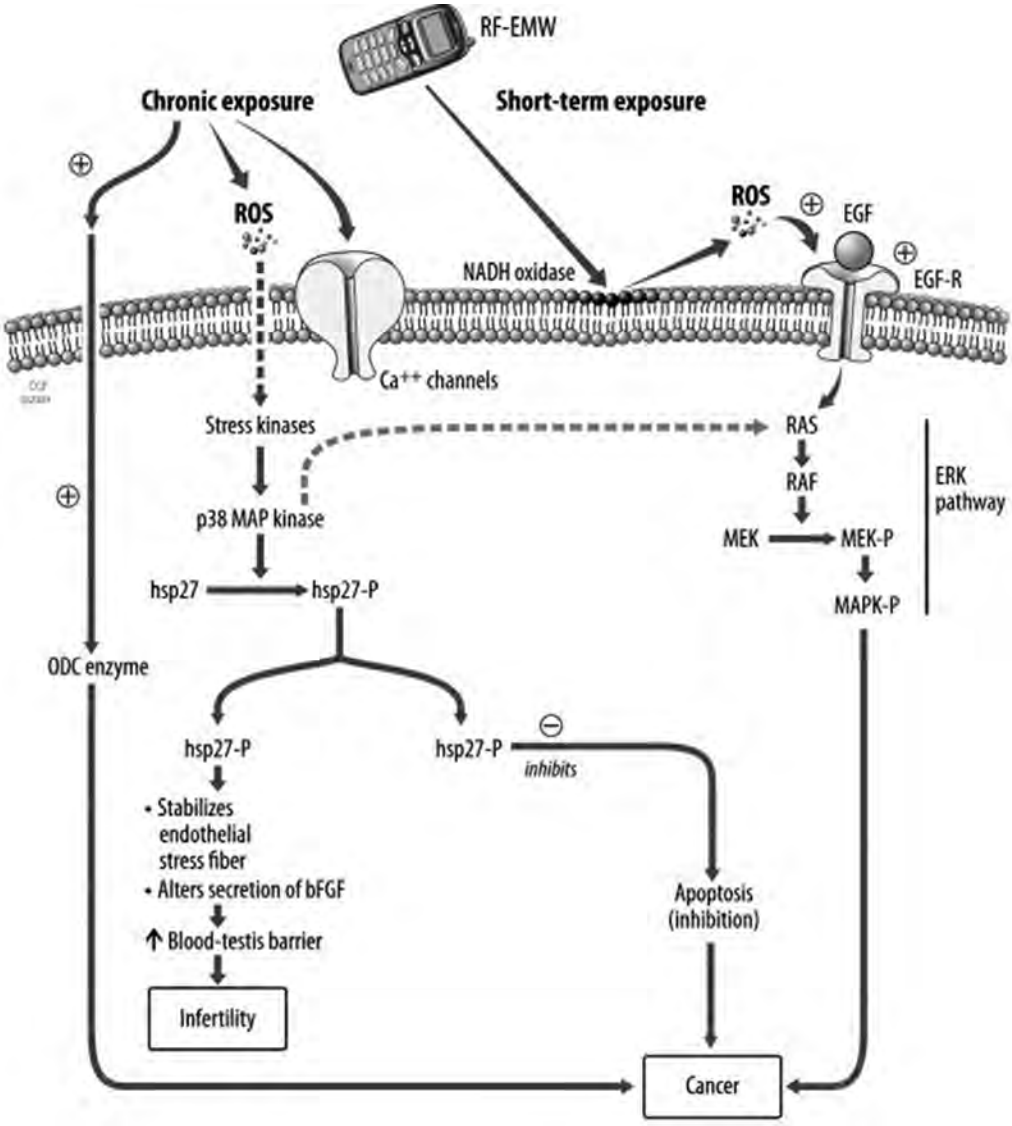


Fig. 10. Acute and chronic impacts of cell phone radiation on male reproduction. The Figure shows various acute and chronic cellular targets of radiofrequency electromagnetic waves (RF-EMW).[56,92]

were more than twice as likely to have started their periods before age 11—both of which increase their chances of developing breast cancer and other chronic illnesses later in life.[105]

Toxicological evidence of adverse impacts of RFR

Experimental studies form the foundation for evaluating pharmaceutical agents and other chemical and physical environmental exposures that can affect pediatric health. *In vitro* studies of well-established animal cell lines and human cell lines constitute one effective source of information that can be used to predict and prevent harm in humans. Employing validated rodent and other models, both short term and long-term *in vivo* studies on rodents and other animals are employed to clarify physiological consequences of exposures.

Studies of prenatal impacts can yield information on birthweight along with longer term consequences for health of offspring into adulthood. While the key male role ends at fertilization, damage to sperm *in utero* may have transgenerational effects on offspring.[106] There is growing evidence that male-mediated factors

relating both to preconception and fertilization, as well as prefertilization and perifertilization exposures also play roles in determining health outcomes of progeny. In addition, early-life RFR exposures have been demonstrated to cause a range of negative impacts on male and female reproductive health, including damage to the testicular proteome[107] and low birthweight. After a month of 4 h daily controlled exposure to nonthermal levels of cell phone radiation, signaling proteins in the rat testes and sperm production were significantly altered, indicating impaired reproductive function and increased cancer risk.

Experimental studies are especially useful in understanding the roles of avoidable early-life environmental exposures on outcomes that affect children and adolescents, since controlled human studies are unethical. As a result, most human studies that can be used to clarify the impact of RFR are observational. Frequently, such studies are opportunistic, complex and expensive, and also challenging to interpret with poor quality longitudinal data, and limited exposure data, particularly with evolving uses of ever-changing technologies. In the real world, children are exposed to numerous sources of RFR at various frequencies and modulations throughout their daily lives. Smart phones can operate with 5 or more antennae simultaneously sending and receiving radiation to and from towers or routers, as most apps are set to update automatically. Yet, most experimental studies only look at a single frequency at a time.

Prenatal exposures and the central nervous system

Over the past two decades a number of experimental investigations have found that prenatal exposure to some EMF negatively affects both the structure and function of the adult central nervous system (CNS).[108–110] As an example, a series of experiments by Odaci, Bas and Kaplan and colleagues measuring impacts through stereological analysis demonstrated that rodents exposed prenatally to 900 MHz had fewer cells and more indications of damage in various brain regions of the hippocampus responsible for learning and memory.[111] Likewise, studies on postnatal exposures of 8 week old rats also found impacts on hippocampal pyramidal cells.[112,113] This team also found prenatal and postnatal impacts occurred to the Purkinje cells in the cerebellum. The cerebellum is critical to memory, balance and impulse control and appears especially vulnerable to RFR. Others have hypothesized that RFR might also alter the membrane current of Purkinje cells within the cerebellum. Haghani et al. evaluated properties of Purkinje cells[108] following prenatal exposure to 900 MHz EMF and found that exposed progeny had significantly reduced spontaneous cell firing. While these areas of the brain have been well characterized after prenatal EMF exposure, it is likely that many other areas of the brain are similarly affected.

Prenatal exposures in humans alter behavior and cognition in offspring

Although they are few in number, human studies investigating *in utero* exposure to wireless and other non-ionizing EMF have found a variety of adverse effects on pregnancy outcomes as well as the health of offspring regularly exposed to EMF or EMF/RF.

Several studies by a team from Kaiser Permanente lead by Dr. De Kun Li report a range of impacts to pregnancy and offspring. They measured pregnant women's exposure to magnetic fields (MF) early in pregnancy using an EMDEX Lite meter (Enertech Consultants Inc.) that measures magnetic field MF exposure for 24 h during a typical day, and providing a detailed diary of activities to allow the researchers to: (1) identify locations of daily activities (at home, at home in bed, in transit, at work, and other); (2) verify if activities were reflective of a typical day; and (3) examine if locations and activities were associated with high MF exposure. Women and their progeny were followed over several years. After controlling for multiple other factors, they found that women who were exposed to higher MF levels had 2.7 times the risk of miscarriage compared to those with lower MF exposure, a finding that corroborated earlier research by the same team.[114] Later publications also found higher *in utero* MF exposures associated with childhood obesity, asthma, and ADHD.[115–117] Similarly designed research[118] that measured MF exposure with the EMDEX meter found lower neural volume and bud length, measured by ultrasound, in embryos of women with higher workplace and other exposures to EMF, who were seeking induced abortion of unwanted pregnancies that were terminated in the first trimester. Women in the top quartile of MF exposure had a four-fold increased risk of a shorter embryonic bud length than those in the bottom quartile.

Greater habitual self-reported maternal mobile device use was associated with less infant recovery upon reunion.[119]

Behavior and cognition in children and adolescents affected by cell phones

Researchers at the University of California School of Public Health in Los Angeles published studies in 2008 (13,159 children)[120] and 2012 (28,745 children)[121] that found that exposure to cell phones prenatally—and, to a lesser degree, postnatally—was associated with behavioral difficulties such as emotional and hyperactivity problems at the age of school entry. Although smaller studies have not found an association, in 2017 the largest study to date of 83,884 mother-child pairs in the five cohorts reported that high prenatal cell phone use was linked to hyperactivity/inattention problems in children, while no prenatal cell phone use was linked to low risk for any behavioral problems. The association was fairly consistent across and between these large cohorts. The nearly 40% of the cohort[122] reporting no cell phone use during pregnancy were much less likely to have a child with overall behavioral or emotional problems, while those with the highest reported use during pregnancy had 1.5 times more such problems documented in their children. The authors indicate that the "interpretation of these results is unclear as uncontrolled confounding may influence both maternal cell phone use and child behavioral problems." Greater habitual self-reported maternal mobile device use was associated with less infant recovery upon reunion.[119]

In addition, two studies reported consistent evidence associating RFR with lower figural memory performance in adolescents. Foerster et al.[123] confirmed Schoeni et al[124] in a larger study population of 843 adolescents. Teens who used the phone against one side of their head scored more poorly on tests that measured memory skills specific to the most highly exposed brain regions

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Behavior in animals

In addition to effects on brain development, pre- and post natal EMF exposures in numerous studies have found that cell phone radiation significantly affects a range of learning, memory, and behavior disorders in rodents.[125–136] Thus, Aldad et al. showed that prenatal exposures to conventional cell phone radiation throughout pregnancy resulted in impaired memory and hyperactive behavior, as well as altered neuronal developmental programming, glutamatergic-synaptic transmission onto pyramidal neurons of the prefrontal cortex. Fragoupoulou and Margaritis demonstrated in several studies that animals exposed to radiation have impaired performance on several standard measures of learning. Employing the standard Morris water maze test of hippocampal-dependent spatial memory, they showed that just 2 h per day of exposure to pulsed nonthermal cell phone signals of 900 MHz resulted in significant deficits in performance in exposed animals. Moreover, sham-exposed animals showed the expected preference for the target quadrant, while exposed animals showed no preference. These results indicated that the RFR exposed mice had deficits in their capacity to consolidate and/or retrieve and recall learned spatial information.

Despite these and numerous other studies demonstrating nonthermal impacts of RFR, standard setting groups such as IEEE and ICNIRP generally dismiss experiments that use actual transmitting devices (cell phones, Wi-Fi routers) in their studies, arguing that the exact exposures are not adequately quantified. Indeed, it is true that real devices emit constantly varying signals and erratic pulsation patterns that are more bioactive than can be produced through controlled laboratory simulations.[137] A number of other expert groups including the ICBE-EMF and ORSAA contend that employing actual phones and devices in controlled studies with shielded systems can yield important findings that are more realistic than those achieved through other means. In fact, experimental

studies employing real mobile phone exposures are fairly consistent in showing adverse effects.[138] As an example, Aldad and colleagues[139] provided evidence that prenatal exposures to RFR from an operating phone significantly alter behavior of offspring.

Mice prenatally exposed to cell phone radiation from operating phones (800-1900 Mhz) through gestation exhibited behavioral and neurophysiological alterations that persisted into adulthood.

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The prenatally exposed mice were more hyperactive, with diminished memory and decreased anxiety. Findings further demonstrated impairment of glutamatergic synaptic transmission among pyramidal cells in the prefrontal cortex associated with these behavioral changes, suggesting a mechanism by which these exposures could lead to increased prevalence of neurobehavioral disorders. There was a significant trend across the groups treated for 0, 9, 15, and 24 h/day demonstrating that evidence of damage increased in direct proportion to the amount of exposure the animals experienced. Mice prenatally exposed to cell phone radiation from operating phones (800-1900 Mhz) through gestation exhibited behavioral and neurophysiological alterations that persisted into adulthood.

Mice exposed to mobile phone radiation at levels well below the permissible ICNIRP exposure limits for human-head exposure (SAR 2 W/kg) induced hippocampal lipidome and transcriptome changes that may underlie brain proteome changes and memory deficits.

In another example, Broom exposed mice to non-thermal levels of long-term evolution wireless (LTE) 1846 MHz downlink from late pregnancy (gestation day 13.5) to weaning (postnatal day 21) and observed 28-day-old offspring. They found significant effects on both eating behaviors and activity, and concluded that repeated exposure to low-level RFR in early life may have persistent and long-term effects on adult behavior.[140]

After finding cell phone radiation exposure affected spatial memory in mice, researchers from the Department of Cell Biology and Biophysics at the University of Athens, Greece conducted experiments investigating brain proteome responses in mice following whole body exposures to mobile phone or wireless DECT base radiation.[141] They found that long-term irradiation from both sources significantly altered the expression of 143 proteins in total, in critical brain regions such as the hippocampus, cerebellum, and frontal lobe. They speculated that these "underexpressed" or "overexpressed" proteins following EMF exposures may play a role in short term or long-term effects of RFR reported in humans as a consequence of mobile phone exposure, including memory deficits, headaches, sleep disorders, and brain tumors.

Mice exposed to mobile phone radiation at levels well below the permissible ICNIRP exposure limits for human-head exposure (SAR 2 W/kg) induced hippocampal lipidome and transcriptome changes that may underlie brain proteome changes and memory deficits.

Thus, Fragopoulou et al. showed that phone radiation (SAR 0.022−0.366 W/kg), well below ICNIRP limits for human-head exposure but comparable to SAR levels produced in human brain regions induces substantial phospholipid fatty acid remodeling in the brain, on the one hand, and on the other hand, alters the expression of genes that are implicated in lipid metabolism. These mechanisms are hypothesized to account for the deficits in memory that this group has reported.[142] Mice exposed to mobile phone radiation at levels well below the permissible ICNIRP exposure limits for human-head exposure induced hippocampal lipidome and transcriptome changes that may underlie brain proteome changes and memory deficits.

Carcinogenicity

In 2011 WHO/IARC designated wireless RFR as a Class 2B "possible" carcinogen based largely on

studies of heavy cell phone users, that found increased risks for tumorsboth glioblastoma brain tumors and acoustic neuroma, as well as some experimental data with animals. Earlier, in 2002, magnetic field ELF-EMF was also classified Group 2B possible carcinogen due to studies associating residential magnetic field exposure with childhood leukemia.[143] This association continues to be observed.[144,145]

Since the 2011 WHO/IARC designation, several large animal[71,146–148] and case-control human[149–152] studies investigating carcinogenicity have been published associating RFR with cancer. A 2020 systematic review and meta-analysis[153] of case-control studies found that 1,000 or more hours of cell phone use, or about 17 min per day over 10 years, was associated with a statistically significant increase in tumor risk.

Experimental carcinogenicity evidence

Every agent proven to cause cancer in humans will also produce it in animals when adequately tested—World Health Organization, International Agency for Research on Cancer

The international gold standard for rodent carcinogenicity studies has been developed by the U.S. National Toxicology Program (NTP), a program supported by several major federal agencies (NIH, CDC, FDA) that carries out transparent studies. To date the NTP has evaluated more than 600 different physical and chemical agents for their potential to cause cancer in animals under carefully controlled conditions. Every agent proven to cause cancer in humans will also produce it in animals when adequately tested—World Health Organization, International Agency for Research on Cancer.

In 2018, the NTP released the results of their large-scale rodent studies on cell phone radiation, which used non-thermal levels of RFR designed to mimic cell phone exposures. Especially relevant for pediatrics and long-term human impacts is the finding that the rodents exposed prenatally to RFR had significantly lower birth weights compared to unexposed animals. This finding constitutes an important signal that nonthermal radiation levels can impair development, as low birth weight is understood to reflect an important lifelong risk factor for adult health.

The NTP found significant increases in relatively rare and highly malignant schwannomas of the heart and gliomas in male rats. These tumor types are the same histotype found to be increased in epidemiological studies of long-term cell phone users.

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The NTP study also reported increases in DNA damage[71] in both mice and rats and the induction of cardiomyopathy of the right ventricle in male and female rats.[147,148]

When it was completed in 2018, the NTP study, which followed long-established protocols, was the largest rodent bioassay ever conducted on cell phone radiation that began with prenatal exposures and ended after 24 months of exposures. Soon afterwards, the Ramazzini Institute[146] employing similarly controlled protocols released its findings from an even larger animal study of 2448 rats, which employed both similar and lower exposures comparable to those of base stations such as Wi-Fi, and observed the same types of malignant tumors—schwannomas of the heart—in male rats. Overall, these two large scale animal studies alongside the human data[153] provide reasonably strong evidence of the potential for non-thermal levels of RFR to cause cancer in humans.

Every agent proven to cause cancer in humans will also produce it in animals when adequately tested—World Health Organization, International Agency for Research on Cancer

Analysis of the NTP and Ramazzini data according to current risk assessment guidelines concluded that to be consistent with other toxicological assessments, the protection of children requires that U.S. government

FCC limits should be strengthened by 200 to 400 times.[154]

U.S. RFR exposure standards would lower current standards by 200 to 400 times, if they were consistent with usual methods for assessing risks for chemical and other hazards.

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Cancer epidemiology—Case-control studies

The multi-nation Interphone case-control study[155] from 2010, defined a cell phone user as someone who made one call a week for 6 months. That study did not include any cases from the U.S., was led by the IARC, and reported no overall increased risk of brain cancer with cell phone use, but did find that the highest users of phones incurred the greatest risk. Combining participants with little phone use with those with heaviest use diluted the chances of finding any effect.

The case-control MobiKids study of 352 brain cancer patients between the ages of 10 to 24 reported cell phone use; it also found no overall increased risk for brain tumors in the age group diagnosed between 2010 and 2015. The latency for brain cancer in adults is known to range up to four decades; in children it is believed to be shorter. In fact, only 5% of the study participants—17 individuals—had used cell phones for more than 5 years. Unsurprisingly, no evidence of significant association emerged. This study has also been criticized as methodologically flawed[156] especially as so few of the participants had significant exposures to cell phones. Although no overall increased risk was reported for brain tumors in the temporal region of these young cases an increased risk was found in the age groups 10–14 and 20–24 years—age groups that had lived long enough to have incurred more exposure than the younger children included in this study.

Researchers examining the Canadian MobiKids cohort carried out sophisticated statistical modeling including potential sources of biases and probabilistic methods, and did not find strong evidence of an association between reported cell-phone use and meningioma, acoustic neuroma, or parotid gland tumors—tumors plausibly linked with cell phone radiation, but they did note a significant association with glioma.

For glioma, when comparing those in the highest quartile of use (>558 lifetime hours) to those who were not regular users, the odds ratio among Canadian children participating in Mobikids was 2.0 (95% confidence interval: 1.2, 3.4). After adjustment for selection and recall biases, the odds ratio was 2.2 (95% confidence interval: 1.3, 4.1).

Despite major limitations in design, the Mobikids study of cell phone use in Canadian children reported a doubled risk of glioblastoma multiforme from using cell phones, a risk that should provide a sobering message to those that seek to prevent such disease from occurring in the first place.

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More recent case-control studies of glioma in adults from Sweden[157] and France,[149] and systematic analyses that combine data on adult cell phone users carried out in China find 10 years or more of cell phone use significantly associated with increased risk of glioblastoma, with 20 years of exposure resulting in a more than doubled risk. Analyses of shorter-term exposures, such as predominated in the Interphone study, do not find such an association, suggesting that there is a latency of 10 years or more for glioblastoma. Thus, in those few studies that have followed longer term users, more hours of use and longer time periods of use have been found significantly associated with between a 40% to more than 200% increased risk of glioblastoma.

Cancer epidemiology—Cohort studies

In contrast to case controls studies, the UK 'Million' Woman Cohort study and the Danish Cohort Study constitute two studies often cited as proof that there is no relationship between cell phone use and brain cancer. Both have been roundly criticized for serious shortcomings. For example, in the UK cohort study of almost 800,000 older menopausal women, only 18% of cell phone users[158] talked 30 or more minutes per week, as self-reported from 2001 to 2011. Yet, the U. K. study combined slight and regular mobile phone users into a single category and compared them with those who reported no phone use. More than 80% of UK households had landlines during the study period. It is likely many in this cohort also used cordless phones, yet, this significant additional source of RF was not evaluated. In fact, the UK cohort authors acknowledge[159] their study was unable to assess the risks associated with considerably greater levels of exposure. Consequently, the authors note that: "advising heavy users on how to reduce unnecessary exposures remains a good precautionary approach."

Other cancers plausibly reported in epidemiological studies to be tied with cell phone radiation include: thyroid cancer, early-onset breast cancer, early-onset colorectal cancer, and testicular cancer. In a certain subset of those with a common genetic susceptibility, heavy cell phone usage is associated with significantly doubled risk of thyroid cancer.[69] Since the advent of smart phones in 2010, phone antennas tend to be located at the bottom of phones As a result, peak phone RFR exposure is more likely to occur in the neck than in the brain.[160] Smart phones include several different antennas, each one of which can send and receive RFR, with multiple antennas for data, photos, video and other applications located around the phone perimeter. In addition, women who have carried phones in their bras or worn Vocera devices next to their chest have developed unusual patterns of breast cancer, with tumors sometimes appearing precisely under the areas where their phone antennas were located.[161,162]

In those few studies that have followed longer term users, more hours of use and longer time periods of use have been found significantly associated with between a 40% to more than 200% increased risk of glioblastoma.

Several independent analyses published since the original IARC assessment in 2011 conclude that if the criteria that the WHO/IARC relied on when determining carcinogenicity were applied to current science, this would result in classification of cell phone radiation as a probable carcinogen (Group 2A) or proven (Group 1) human carcinogen.[7,8,16,163–167]

Unexplained increases in pediatric and young adult cancers are consistent with increasing wireless exposures

Trends in cancer can provide signals about underlying etiologic factors, as occurred with increases in lung cancer in male and female smokers in the mid-twentieth century, and increases in the rare clear-cell adenocarcinoma of the cervix in young women whose mothers had used diethylstilbestrol to prevent miscarriage.[168] Cancers tend to have multiple contributory causes, which can ebb and flow over time. Over the last several decades, incidence of several different early-onset cancers in adults[169] below 50 years of age have increased in many nations, including those of the breast, colorectum, bone marrow, and thyroid. Although explanations for these patterns will certainly be multi-factorial, wireless radiation is one of the factors that should be more widely explored.

Rates of rectal cancer have quadrupled in those under age 24 in the past decade in the U.S. and Iran and risen rapidly[170] in the U.K, Egypt, and Brazil. One recent study[171] asserts that these increases could, in part, be associated with radical changes in exposures to cell phone radiation due to devices kept close to the body for extended periods of time. More and more children and young adults keep transmitting smartphones with their multiple antennas that are constantly updating apps next to their abdomens inside their tight clothing for hours a day, along with a wireless earpiece in their ear. Thus, although speaking directly into phones has declined, close proximity to their radiation has not.

What makes the potential connection between colorectal cancer increases and cell phone exposures

especially plausible is an experimental study showing that colon and rectal cells are exquisitely sensitive to non-ionizing radiation like that emitted by phones today. Moreover, exposure to non-ionizing mobile phone radiation can lead to effects on treated colon tissues of rats similar to those observed from ionizing 3Gy gamma radiation. Mokarram et al.[172] reported that epigenetic patterns of the estrogen receptor (ERα) after exposure to ionizing radiation paralleled those occurring after exposure to non-ionizing RFR. Using biomarkers that have previously been established to signal damaging exposures, they further found that methylation patterns may constitute an important validated biomarker of exposure to radiofrequency radiation that has the potential to play a role in the expression and promotion of colorectal cancer.[172]

EMFs as endocrine disruptors

Endocrine disruptors are understood to be agents, either natural or man-made, which can mimic or interfere with the body's hormones and disrupt development leading to a range of developmental, reproductive, neurological, and immune problems, as well as cancers. Common sources include plastics, metal can liners, detergents, flame retardants, and pesticides.

EMF exposures have been linked to a range of classical endocrine disrupting effects.

A team from the California Institute of Behavioral Neurosciences & Psychology reviewed the effects[173] of both RFR and ELF on thyroid gland hormones and histopathology and found evidence that RFR was associated with alterations in T3, T4, and TSH hormone levels, disruption of the function of the HPG axis leading to thyroid insufficiency and hyper-stimulation of thyroid gland follicles. This caused apoptosis of follicular cells. Non-ionizing radiation was seen to be significantly associated with histopathological changes in the thyroid gland follicles and the authors contend that non-ionizing EMF radiation might be responsible for the recent increase in the incidence of thyroid insufficiency and cancer in the general population.

Critical research needs to be conducted to understand the effects especially to future generations. Cantürk et al.[174] investigated the effects of pre- and postnatal 2450 MHz RFR on the thymus of rats over four generations and found that the number of pups and weight of all rats decreased significantly in the third-generation.

RFR has all the classic hallmarks of endocrine disruptors that affect reproduction, development of the hypothalamic-pituitary-gonadal axis (HPG) and alter normal male and female reproductive endpoints.

Thus, it appears that non-ionizing [175] RFR has all the classic hallmarks of endocrine disruptors that affect reproduction, development of the hypothalamic-pituitary-gonadal axis (HPG) and alter normal male and female reproductive endpoints. Alterations in spermatogenesis and oogenesis, for example, in turn affect a number of endocrinological and other functions throughout life, including fertility and behavior in offspring along with the risk of cancer, neurological disorders and other chronic illnesses.

Animal studies of additive or synergistic effects of RFR with other agents

Replicated experiments show that RFR can have important co-carcinogenic and tumor promoting effects when combined with known carcinogens. Lerchl et al.[152] found carcinogen-induced tumor rates were significantly higher in mice exposed to nonthermal doses of radiofrequency below current regulatory limits. The authors argued that it was a "very clear indication that in principle tumor-promoting effects of life-long RFR exposure may occur at levels supposedly too low to cause thermal effects."

The Ramazzini Institute performed two large lifespan rat cancer studies[176] combining magnetic field non-ionizing EMF with either acute exposure to gamma radiation or chronic exposure to formaldehyde in drinking water and found significantly greater incidence of malignant tumors with either co-exposure than occurs without such combined exposures.

Investigators from the Beijing Institute of Radiation Medicine in China have also produced important evidence of synergistic effects. They determined that combining 2.8 GHz and 1.5 GHz microwaves[177] impaired spatial memory much more strongly than exposures to a single frequency. It is important to realize that such combined frequencies can easily occur at this time within a single smart phone that can operate on different frequencies at the same time. This same team has reported[178] that exposure to nonthermal levels of 2.8 GHz and 9.3 GHz—as could occur with 5G networks— led to significant impacts to the thymus and spleen, such as congestion and nuclear fragmentation of the lymphocytes, and more severe injuries. Their transcriptomic and proteomic analysis of peripheral blood and spleen suggested that alterations of DNA replication, cellular metabolism, and signal transduction might be involved in microwave-induced immune activation. The spleen not only filters blood-borne pathogens and antigens but also plays a critical role in immune system regulation.

Higher levels of adolescent screentime,[179] social media access[180] and cell phone use in teenagers' bedrooms are associated with reduced sleep time[181] as well as negative effects on daily functioning,[180] behavior[182] and mood.

Effects of screen time

Higher levels of adolescent screentime,[179] social media access[180] and cell phone use in teenagers' bedrooms are associated with reduced sleep time[181] as well as negative effects on daily functioning,[180] behavior[182] and mood. An ever growing body of evidence[183] is associating[184] children's addictive and excessive use of screens and digital media with a myriad of adverse social (relationships, social skills, cyberbullying), psychological (anxiety, depression, suicidal ideation, obsessive compulsive disorder[185]) neurodevelopmental (cognitive development, behavior, attention, speech[186]) and physical (obesity, high blood pressure) consequences. Key factors[187] determining screen time effects include duration, content, media type, degree of access to social media, whether screens are located in the bedroom[180] and the amount of after dark/evening use.[180,187]

Higher levels of adolescent screentime,[179] social media access[180] and cell phone use in teenagers' bedrooms are associated with reduced sleep time[181] as well as negative effects on daily functioning,[180] behavior[182] and mood.

Axelsson et al.[188] found the amount of time spent with screens predicted shorter sleep in preschoolers. Regardless of the time of day that screens were accessed by children, greater screen time was associated with poorer sleep quality, poor communication, poor problem solving and greater attention problems. The AAP notes,[184] "the prevalence of problematic Internet use among children and adolescents is between 4% and 8%.

Up to 8.5% of U.S. youth 8 to 18 years of age and 4.6 % of Chinese youth meet criteria for Internet gaming disorder defined by the World Health Organization in its standard Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (DSM-5) as an uncontrollable, persisting need to engage directly with digital media and games that cannot be stopped.

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This diagnostic code is included in the DSM-5,[189] and in the 11th Revision of the International Classification of Diseases (ICD-11[6]), signaling interference with socialization, including disturbing important areas of life such as family relationships, school, work, eating, bathroom habits and sleep. In its criteria for gaming disorder, the WHO does not include in its criteria any specific number of hours spent with screens, but instead focuses on the inability to engage in normal social life of young children and teens, including outdoor activities as well as socializing indoors with family and at school. The category of internet gaming disorder was added in 2019. According to Pew,[190] 97% of teen boys and 83% of girls play games on

some kind of device. How many of them are addicted is a matter that should be seriously examined, as the toll on pediatric mental and physical health continues to mount.

Higher screen time has been associated with a higher prevalence of prospective disruptive behavior disorders.[191] Clinicians[187,192] posit that the effects of electronic screen time can mimic or exacerbate psychiatric disorders as the interactive media can lead to chronically high arousal levels which can lead to nervous system dysregulation. As a consequence, treating physicians have developed treatments including an "electronic fast" to rebalance the brain and relieve overstimulated reward (addiction) and sensory pathways. Interventions such as reducing screen media have been found to result in a substantial increase in children's engagement in physical activity[193] and increasing outdoor "green" time[194] is beneficial to mental health as well as lowering myopia incidence[195] in school-aged children.[196]

Technoference contributes to speech and bonding delays

Studies[116] of infant parental dyads find that more frequent reported mobile device use was associated with less room exploration and positive affect, and less recovery (i.e., engagement with mother, room exploration positive affect) even when controlling for individual differences in temperament. Delays in speech acquisition[197] and the development of interactive skills also have been reported in infants of parents that use devices more frequently. In addition, the phenomenon of "technoference"[198] is receiving increased attention from experts in behavioral and development psychology. Heavy parental digital technology use has been associated with suboptimal parent-child interactions. Parental problematic technology use—termed "technoference" — is associated with technology-based interruptions in parent-child interactions and potentially associated with a range of child behavior problems.

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Parental distraction in early infancy can be problematic for obvious reasons. This remains a topic of increased research attention and a matter that should be routinely queried at every well child visit, beginning with infancy throughout the school years. Simple questions noted below can provide the foundation for teachable moments that convey the need for direct parental involvement in early years when lifelong benefits can accrue. Harried young parents, especially those who are raising children without partners, may rely heavily on digital devices as a form of childcare. They should be informed about the importance of direct eye and verbal contact with infants, as well as reading aloud starting in infancy, as these practices have been shown to have lifelong benefits to social and emotional development.

Clinical practice guidance

Avoidable environmental exposures can profoundly affect and alter children's development and health. Along with the benefits of nutrition and regular physical and social activity, clinicians are aware of adverse effects of lead, pesticides, food additives, air pollution, ultraviolet radiation, and more broadly climate change, on children's health. Exposures that take place early life can have disproportionately large impacts on later life health and well-being.

As recommended by the AAP, clinicians can integrate developmental as well as EMF issues in practice

by regularly discussing screentime and digital media use. AAP guidance regarding phones and other wireless devices should be widely shared and employed. These include:

- For children under 18 months, avoid screen-based media except video chatting.
- For children 18 months to 24 months, parents should choose high-quality programming and watch while interacting with their children, on a limited basis.
- For children 2 to 5, no more than one hour per day of high-quality screen time and engage with children regarding content and experiences.
- For children 6 and up, establish consistent limits on the time spent using media and the types of media.

Recognizing that RFR may contribute to ill health provides further incentive to include clinical practices such as:

- Query use of screens, digital media, cell phones and Wi-Fi linked devices at yearly physicals;
- Provide guidance to patients and their families on how to decrease excessive screen time and to reduce RFR exposure (See Section 7);
- Respond with additional interview questions, resources and referrals as appropriate if symptoms potentially related to use of screens or exposure to EMFs are reported;
- Engage in continuing education and training on EMF issues, and screen use;
- Record and report cases where links have been identified between EMF and symptoms or health outcomes;
- Encourage undistracted reading out loud to infants and young children; and
- Develop family media plans for parents as well as children, explaining that parental distraction with devices can impair child development including speech acquisition.

Practitioners also need training in EMF-related effects to be able to discern whether common pediatrics complaints such as headaches and problems sleeping could, in fact, be due to the excessive use of technologies in the home or school environment. Clinicians encountering patients presenting with unexplained symptoms can consider the complete clinical picture and health history, and investigate, treat if necessary, or exclude commonly recognized etiologies. For example, patients may come into the office with unexplained array of symptoms such as headaches and rashes that may be related to EMF (e.g., cell antennas recently mounted nearby, or upgraded school Wi-Fi system recently installed). Clinicians need greater awareness so that in differential diagnosis they include the possibility that symptoms may be associated with EMF and evaluate the patient in a systematic fashion.

Clinical practice guidelines for EHS have been developed by trained clinicians and experts,[199] EUROPAEM group,[200] Dr. Riina Bray, Medical Director, Environmental Health Clinic, at Women's College Hospital, University of Toronto[201] and the Austrian Medical Association,[202] among others.

Clinical practice guidelines include:

- Comprehensive case history that includes environmental exposure history including questions regarding typical daily EMF/ RFR exposure, toxic metal exposures, diet, mold, and other potentially toxic chemical exposures at home, child care settings, school, work and play, and in the community.
- Assess community, work, school and home exposures to EMFs: proximity of cell phone towers, routers, DECT cordless phones, and any other wireless technology, especially in sleeping areas
- Assess variation of health problems depending on time and location. For example, do headaches or other unexplained symptoms attenuate in different areas, but return chiefly when the child is in one specific location? Did headaches or symptoms begin when a new router or cell antenna was installed?

As technologies (and healthier alternatives) evolve and knowledge advances, there is a need for clinicians periodically to update their knowledge through continuing medical education with technical experts in bioelectromagnetics—a field that is not widely taught or studied in medical schools at this juncture. Some accredited programs[203] offering up to 24.5 continuing medical education credits can be found online.

Electromagnetic sensitivity—An underdiagnosed pediatric problem

The phenomenon of hyper-reactivity to chemical and physical phenomena remains poorly understood but is believed to be a serious and sometimes disabling problem.

Electromagnetic hypersensitivity (EHS)[204] is believed to affect a small but significant segment of the population—with estimates up to 15%. Its prevalence in children has never been evaluated, but could prove to be important in cases in which vague symptoms of headache, numbness, tingling and rash cannot otherwise be alleviated. EHS is characterized by headaches, sleeping problems, memory problems, nosebleeds, unexplained skin rashes, digestive problems, neurological problems, heart palpitations and fatigue. Symptoms[200] vary from person to person, making this a challenging subject to study and to treat. Notably, prenatal and postnatal exposure to cell phone RFR is linked to increased headaches in children,[205] adolescents,[206] and adults,[205] and use of smartphones have been identified as a trigger for migraines.[207]

EHS symptoms[208] have been linked to exposures to non-ionizing EMF, including from nearby cell towers and base station wireless antennas and routers. No studies have been conducted on EHS in children. Dieudonné[209] studied forty individuals convinced that they were sensitive to electromagnetic fields, and concluded that contrary to allegations of nocebo responses, attribution of their symptoms followed a common linear model: (1) onset of symptoms; (2) failure to find a solution; (3) discovery of EHS; (4) gathering of information about EHS; (5) implicit appearance of conviction; (6) experimentation; and (7) conscious acceptance of this knowledge.

Further evidence of the importance of identifying sources of exposure and reducing them comes from a recent report from Sweden on the sudden acquisition of highly reactive biological responses to a newly introduced source of RFR. Following the introduction of 5G networks in a dense urban environment, a previously healthy couple reported disabling symptoms of headache, palpitations, tingling, tinnitus and major discomfort. Upon detailed examination of their environment, it was determined that 5G network had recently been installed quite close to their apartment. A thoroughly detailed case report[210] documents this sudden change in RF exposure and the onset of severe symptoms in this couple just a few days after the installation of a 5G base station on the roof above their apartment. The deployment of 5G caused a dramatic increase in maximum (peak) microwave radiation exposure, from 9 000 μW/m2 to >2 500 000 μW/m2. The symptoms quickly reversed when the couple moved to a dwelling with much lower exposure.

Symptoms often are misdiagnosed as health professionals lack training on the matter. Preliminary clinical practice guidelines[201] have been developed. The U.S. Access Board[211] has recognized that "electromagnetic sensitivities may be considered disabilities" under the Americans with Disabilities Act, and the Job Accommodations Network supported by the U.S. Department of Labor's Office of Disability Employment Policy has issued a list of guidelines[212] for accommodation of electromagnetic sensitivity.[213] Adults in the U.S. are often accommodated in the workplace (being provided hardwired computer connections, or moving to a lower-EMF office) but in many cases they have had to file legal actions.

The U.S. Access Board[211] has recognized that "electromagnetic sensitivities may be considered disabilities" under the Americans with Disabilities Act, and the Job Accommodations Network supported by the U.S. Department of Labor's Office of Disability Employment Policy has issued a list of guidelines[212] for accommodation of electromagnetic sensitivity.[213]

Despite these accommodations for adults, parents seeking accommodations in U.S. public schools for children who experience EHS have been challenging as schools will refuse to accommodate and the families often must resort to homeschooling. In the UK, parents won a legal battle[214] against local authorities who are now compelled to provide an environment with reduced wireless radiation so that their child can attend school. There are also other examples internationally of legal decisions mandating workplace accommodations or payment for injuries[215] from EMF exposure.

In Canada, EHS is described in the report, Medical Perspectives on Environmental Sensitivities[216] to the Canadian Human Rights Commission.[217] Medical and legal[216] reports underpin a policy[218] for accommodation under the *Canadian Human Rights Act.*

Synergistic and combined toxic exposures in children

Children are exposed to numerous combinations of environmental exposures over their lifetime. Even where exposures are low, they can interact with each other resulting in additive or synergistic results.

Animal and human studies[219] indicate that non-ionizing EMF can act synergistically when combined with other toxic agents. For example, Sueiro-Benavides et al.[220] found that 2.45 GHz, a frequency used in Wi-Fi networks, combined with carbon black (CB) increased CB-induced toxicity and prolonged inflammatory immune responses. Exposures to non-ionizing EMF from magnetic resonance imaging (MRI) or cell phones has been found to enhance the release of mercury from dental amalgam.[221] RFR has been found in several studies to impact the integrity of the blood-brain barrier that protects the brain from toxic molecules circulating in the blood.[132,222–225]

A longitudinal study[226] of 2,422 children at 27 elementary schools in 10 Korean cities examined effects and interactions between voice call cell phone use and blood lead levels (lead levels were comparable to those in U.S. children). Attention-deficit/hyperactivity disorder symptom risk was significantly greater in the children with above-median lead levels and above-median weekly cell phone call duration.

A similar interaction was reported by Choi et al.[227] Across the cohort, maternal cell phone use during pregnancy was not associated overall with child neurodevelopment during the first three years. Among children exposed to higher maternal blood lead level *in utero*, however, a greater risk of both a poorer psychomotor development index and a lower mental development index up to 36 months of age was associated with higher cell phone calling time or frequency during pregnancy.

A theoretical role for RFR in the etiology of autistic spectrum disorder

Autism remains a puzzling and troubling problem for growing numbers of children, their families and their physicians. The disease[228] is increasing among both males and females, and among nearly all racial/ethnic subgroups, from 4.2 per 1,000 in 1996 to 15.5 per 1,000 in 2010. A recent report from the U.S. Centers for Disease Control and Prevention notes that rates have continued to increase. The prevalence of autism spectrum disorder (ASD) among 11 surveillance sites is 1 in 54 among children aged 8 years in 2016 (or 1.85%). This constituted a 10% increase from 2 years previously when it was 1 in 59, and the highest prevalence since the CDC began tracking ASD in 2000. Consistent with previous reports, boys were 4 to 5 times more likely to be identified with ASD than girls. The rate for ASD is 1 in 34 among boys (2.97 percent) and 1 in 145 among girls (0.69%). Although many environmental factors[229] have been posited, including air pollution, pesticides, and heavy metals, the potential role of RFR should also be seriously explored.

Experimental studies showing that prenatal exposures to RFR can disrupt the development of the hippocampus provide some foundation for speculating that EMFs could also be a contributing factor. Thus, RFR has plausibly been hypothesized to play a role in the development of ASD via disruption of the developing poorly myelinated central nervous system. When presented with serious behavioral disorders including autism, some psychiatrists have employed successful treatment protocols that involve family management systems to facilitate cessation and withdrawal from use of digital devices. Psychiatrist Victoria Dunckley[192] notes that early use of digital devices can create a heightened state of fight or flight among young brains and bodies, placing them under constant stress. Children are easily addicted to routines of falling asleep, eating and even using the toilet accompanied, not by parents soothing assurances, but by digitized music, visions and sounds that increase dopamine—the brain chemical tied with pleasure and addictive behaviors. Providing several impressive case reports of toddlers that had been out of control and unable to give up their digital fixations, Dunckley notes that digital fasting can yield impressive results, especially with children on the autism spectrum. Her book provides several detailed instances where altering children's access to digital devices can radically improve behavior. Other published reports also offer corroboration for this hypothesized connection.[230,231]

Psychiatrist Martha Herbert and research analyst and editor of the *Bioinitiative Report*, an ongoing record of relevant scientific findings, Cindy Sage, among others,

have called for more aggressive investigation of the possible connections between RFR uses and exposures and disorders on the autism spectrum. They speculate that behaviors on the autism spectrum could emerge from alterations of electrophysiological oscillatory synchronization and EMF/RFR could contribute and "worsen challenging biological problems and symptoms; conversely, reducing exposure might ameliorate symptoms of ASD by reducing obstruction of physiological repair."[232,233]

Inadequate regulatory limits

FCC and ICNIRP regulatory limits have been long criticized by experts and the court because they do not address children's unique vulnerability, the biological and health effects of long-term exposure nor the current ways that children are exposed to cell phone and wireless radiation. In 2012, the AAP wrote the FCC and other federal agencies calling for an update to the FCC's 1996 exposure limits stating, "it is essential that any new standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes." A decade later that call remains unanswered.

Cell phone and wireless device limits

Regulations regarding human exposure to RFR include: 1. allowable limits for ambient exposures created by cell tower network emissions and wireless networks, called maximum permissible exposure limits in the U.S.; and 2. exposure limits for localized exposures into areas of body tissue from phones, and personal and household devices, referred to as Head and Body SAR limits. The ICNIRP and IEEE[38] standards used as the basis for many governments' limits remain largely unchanged since the 1990s and they are intended to protect for effects caused by short term high powered exposures. These limits are not designed to protect for effects from long term, low level chronic exposures because ICNIRP and IEEE do not consider such effects as "established." As former ICNIRP member James C. Lin describes them: "*They are flawed and are not applicable to long-term exposure at low levels. Instead of advances in science, they are predicated on misguided assumptions with outdated exposure metrics that do not adequately protect children, workers, and the public from exposure to the RF radiation or people with sensitivity to electromagnetic radiation from wireless devices and systems. Thus, many of the recommended limits are debatable and absent of scientific justification from the standpoint of safety and public health protection.*"[16]

Wireless network exposure limits

U.S. limits for RFR were promulgated by the FCC in 1996, based largely on a 1986 Report of the National Council on Radiation Protection & Measurements (NCRP)[234] and the Institute of Electrical and Electronics Engineers (ANSI/IEEE) C95.1-1991 standard.[235] The U.S. limits for environmental RF levels are among the most lenient in the world, and are similar to those of Australia, Japan, Germany and other countries that also adopted inadequate ICNIRP limits.

However, some countries, including Italy, Switzerland, China, and Russia have adopted regulatory limits for cell towers and base station network emissions that are far more stringent[236] than the thermally based limits of the U.S. FCC and ICNIRP.

European nations with more stringent regulatory limits set their policies based on the precautionary principle, a key framework used in their decision making process. This principle rests on the sage advice of Benjamin Franklin—better to be safe than sorry.

In 2011, the Parliamentary Assembly of the Council of Europe (PACE) Resolution 1815: The potential dangers of electromagnetic fields and their effect on the environment " [237] strongly recommends that the ALARA (as low as reasonably achievable) principle is applied, covering both the so-

In 2011, the Parliamentary Assembly of the Council of Europe (PACE) Resolution 1815: The potential dangers of electromagnetic fields and their effect on the environment " [237] strongly recommends that the ALARA (as low as reasonably achievable) principle is applied, covering both the so-called thermal effects and the athermic or biological effects of electromagnetic emissions or radiation."

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In contrast, the more strict RF limits in Russia and China[238] are considered "science based," not precautionary, and were developed based on their own government scientists' studies of the biological effects of nonthermal RFR levels. India lowered its limits to 1/10 of ICNIRP limits in 2012[239] in response to a report from an Inter-Ministerial Committee that reviewed the research[240] on impacts to wildlife, including honeybees and other pollinating insects, and concluded[239] that the "vast majority of published literature indicate deleterious effects of EMFs in various species." (See Fig. 7 for comparisons) It is notable that other groups have recommended even lower limits. For example, the Ecolog Report, commissioned by T-Mobile and Deutsche Telekom in 2000, reviewed the science recommended a limit of 0.01 W/m2 to" be rigorously adhered to by all base stations near sensitive places such as residential areas, schools, nurseries, playgrounds, hospitals and all other places at which humans are present for longer than 4 hours."[241]

Why the SAR standard is inadequate to protect children

Pre-market tests for cell phones and wireless devices measure the Specific Absorption Rate (SAR), which is the standard accepted measurement of the rate of RF (radiofrequency) energy absorption. (See Table 2.) For cell phones and other handheld wireless devices, many countries have adopted either FCC or the ICNIRP limits for premarket RF compliance. Although the FCC limit is slightly more restrictive compared to ICNIRP limits, both rest on avoiding the effects of heating as measured by the SAR.

The SAR metric is criticized as a heat-based measure unable to capture[72] the numerous characteristics[242] of nonthermal exposure considered relevant to bioeffects such as pulse, modulation, variability or duration of exposure.

That said, even if the SAR was a valid measure for health effects thresholds, the SAR testing protocol itself has long been criticized as unrealistic for numerous reasons. To start, it does not take into account the smaller sizes of women, infants and children, and other properties of children that place them at greater vulnerability. Thus, the child brain sits in a thinner skull that contains more fluid which can absorb more radiation per unit volume than the adult brain with its thicker skull.

In regards to children's exposure, the AAP[1] wrote the FCC in 2012 noting that, "although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma," and also that, "The current metric of RF exposure available to consumers, the Specific Absorption Rate, is not an accurate predictor of actual exposure."

The head and body phantom are filled with a homogenous liquid that does not capture the way the electromagnetic field moves through different tissues in the head such as brain tissue, which is of varying thicknesses and characteristics. The dielectric properties of tissues in children's head and brain differ from adults because children's tissues have more water content and thus are more conductive than adults.

The SAM model has long been argued to provide a conservative estimation of the exposure from a mobile phone, even for children. However, research supporting this position has generally used a scaled down version of an adult head which did not account for all age dependent variations in children, such the anterior fontanels which close between 7 and 18 months. When these more realistic variations are accounted for, the SAR values for children are significantly higher. For example, Mohammed[243] used realistic head models in several scenarios simulating young children between 3 months and 18 months holding phones near their ear and mouth as well as a person holding a mobile phone near a child's head. They found that 10g SAR values in the heads of young children are significantly higher than those for adults and also noticeably higher than the scaled models used in previous studies that considered dosimetry for children over 3 years old.

Research supporting the SAM model[244] is based on early phone models that were designed with antennas on the top of the phone body and more recent research has found that for newer phone models with antennas integrated along the bottom of the phone, the SAM does not always ensure[40] a conservative estimation.

Phones are tested while operating at the highest power level, in specific positions against the phantom head and body. Devices generally operate at the minimum necessary power, in order to maximize battery

life, but in many situations the power output is much higher, to ensure reception at the receiving antenna in the cellular base station. Low incoming signal strength triggers a significant increase a phone's emissions; people encounter low signal strength in rural areas far from base stations and also, for example, in rooms in basements or buildings where building materials block the signal. The many real world exposure scenarios result in highly variable emissions from any one cell phone model, regardless of the stated SAR value.

Although the standardized SAR test positions are supposed to simulate the way people typically hold a cell phone, the standardized positions do not test in body contact positions for body SAR tests. The test positions do not mimic a cell phone in full body contact such as in a pants pocket or resting against the abdomen. Parents today often hold their newborns with the cell phone right up against the baby and yet premarket SAR tests do not include such positions.

In summary, the SAR test and SAM have been roundly criticized as underestimating and not adequately capturing the real world exposures of children, babies, and toddlers, and children who are positioned in direct or close body contact with cell phones or other devices.

Furthermore, manufacturers SAR test phones at various distances from the body. In the U.S. a manufacturer can decide to test for body SARs at 5, or 10, or even 25 mm. The measured SAR value will increase the closer the phone is tested to the body phantom. Thus, the manufacturer posted SARs of different models that use different separation distances cannot be directly compared to each other.

Although SAR levels often are used to compare cell phones in terms of which phone emits more RF than others, the SAR value does not necessarily reflect a difference in a consumer's actual exposure for these reasons. Hence a phone with a lower SAR level does not necessarily mean lower RF exposure. Nonetheless, the SAR is the metric in use and the basis for exposure limits worldwide.

Regulatory gaps affecting children

The AAP[1] has long advocated[1] that federal agencies strengthen regulations calling for:

- A reassessment of human exposure limits and testing requirements to ensure children's unique vulnerabilities are addressed and to reflect the way children use phones today in close proximity to the body;
- Establishing a federal research program as the basis for exposure standards;
- Cell phone and wireless device product labeling requirements to "enable parents to better understand the potential dangers of RF energy exposure and protect their children."

The AAP supported[245] national legislation, the Cell Phone Right To Know H.R. 6358,[246] proposed in 2012, which would have addressed numerous regulatory gaps in federal policy regarding stating that, "Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults."

Prevention: medical organization, public health, government policy and actions to mitigate risk to children

Based on the established science, including children's special vulnerabilities, trajectories of exposures and diseases, clinicians need to know that they are supported by medical associations, have the resources to support their patients, and finally have the evidence in hand to advocate for them. A few of the supportive agencies and recommendations are noted below. Others can be found at www.ehtrust.org.[247]

Medical organizations and public health agencies

The AAP and several international medical organizations[248–251] have recommendations[252] on how to reduce cell phone radiation exposure. The AAP has long advocated for more protective[245] federal regulations and issued ten ways to decrease exposure in 2016[252] including "avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level."

"Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level." American Academy of Pediatrics.[252]

In 2017, the California Department of Public Health (CDPH) released an advisory on cell phones.[253] CDPH's scientists had evaluated the RFR from almost[254] two dozen phones and found that when they transmit at their highest power due to use in areas of low service (one or two bars) the emissions can be up to 10,000-fold higher than when the phone is used in areas of strong signal. The CDPH's advice initially was based on the University of Pittsburgh Cancer Institute's 2008[253] cell phone radiation reduction advice to doctors and staff, constituting the first ever U.S. medical institution advisory on cell phone radiation.

In 2022, the Maryland State Children's Environmental Health and Protection Advisory Council[255] issued information on how families can reduce wireless and non-ionizing EMF exposures at home and also made recommendations to schools.

A summary of basic recommendations from these organizations and agencies is presented below.

"Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level." American Academy of Pediatrics.[252]

How families can reduce EMF exposure

Cell phones

- Cell phones are not toys or teething items.
- When parents hold their babies or children in their arms, they should not simultaneously use or hold mobile phones or wireless devices as this will expose the child to RFR.
- Decrease overall time spent on wireless phones and prefer corded phones for long calls.
- Delay purchasing a first cell phone for a child. Cell phones should only be used by children for emergencies.
- Prefer text messaging over voice and video calls.
- Decrease exposure to and through the brain by using cell phones in speaker mode, away from the head and body, or wired airtube headsets with the phone away from the body. Avoid airpods. While Bluetooth signals are much weaker than cell phones, children and teens keep them in their ears for hours a day and the long term impact has never been independently evaluated.
- Avoid carrying cell phones against the body like in a pocket, sock, or bra.
- Do not talk or text while driving.
- Learn how to switch phone to airplane mode with Bluetooth, Wi-Fi, Hotspot antennas toggled off in settings. Many applications on phones can still be utilized in airplane mode. For example, in order to play movies and music but avoid unnecessary RFR exposure, download the files first, then switch the device to airplane mode and play.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. It's better to wait until you have a stronger signal before using your device.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Learn how to connect the cell phone to the internet with ethernet cables.

Computer, laptop and tablet internet connections in buildings

- Install internet access via a hardwired ethernet connection instead of Wi-Fi.
- Wi-Fi routers should be distanced from areas where children sleep, play and school.
- At a minimum, power Wi-Fi networks off at bedtime and during periods when not in use.
- Connect computer/laptop/tablet accessories and peripherals such as printers, speakers, keyboard and mouse with cords, rather than Wi-Fi or Bluetooth.

At home

- Replace cordless phones with corded phones. Cordless phones and their base stations emit RFR.

- Avoid wireless digital baby monitors. If necessary, choose wired monitoring systems.
- Remove screens, electronics and wireless devices from the bedroom.
- Turn off devices at night and ensure sleep areas are not against a wall where utility meters are installed on the other side as "smart" meters are sources of RFR and other EMF.

Additional considerations during pregnancy

Simple preventive measures during pregnancy can significantly decrease fetal exposures, especially the high intensity exposures from a wireless device resting directly on the abdomen.

- Distance cell phones and wireless devices away from your abdomen.
- Power off cell phones when carrying them near your body.
- Always use laptops and tablets on a desk, not on your lap or close to your abdomen.
- For voice calls, use corded phones instead of cell phones or cordless phones.
- Use ethernet connections instead of Wi-Fi to connect devices.

Several governments, such as France, Israel, Greece and Switzerland have RFR measurement programs in place along with easy access to the data. For example, in France, the National Frequency Agency ANFR "Observatoire des Ondes"[257] posts online the RFR measurements taken numerous times a day in various cities.

Cell tower emission and ambient limits

As shown in Fig. 7 numerous countries such as India, Israel, Greece, China,[256] Russia and eastern European countries have RFR limits for cell tower network emissions that are much stricter than the limits of the US/FCC (although there is not always documented reliable monitoring or enforcement in every country). Australia, Japan, Italy and Switzerland have limits for areas such as schools and apartment buildings and areas where people spend several hours a day. Several governments, such as France, Israel, Greece and Switzerland have RFR measurement programs in place along with easy access to the data. For example, in France, the National Frequency Agency ANFR "Observatoire des Ondes"[257] posts online the RFR measurements taken numerous times a day in various major cities. Countries such as Greece and Israel have policies in place that specifically restrict the placement of cell towers near "sensitive areas" defined generally as schools and/or homes and hospitals and provide for online access to real-time radiation levels. Greece further restricts exposure to a stronger limit within 300 m of sensitive areas. Chile's "Antenna Law"[258] has established mitigation measures in areas with dense infrastructure and prohibits towers near "sensitive areas" defined as institutions serving children, the elderly, and the medically compromised. Again, monitoring and enforcement are not reliably determined in many instances.

At the local level, numerous municipalities in the U.S.[259] and other countries[260] have policies to restrict cell towers on school property and many communities have removed wireless antennas from school properties. For example, the Supreme Court of India upheld a decision by the High Court of the State of Rajasthan to remove installations on school properties and playgrounds.[261]

Several countries focus their RFR monitoring and oversight on children's areas. Brazilian Law nr 11,934 includes regulations[262] defining a critical area as the 50-meters-radius around hospitals, clinics, schools, day care centers, and facilities for the elderly. The RFR levels must be assessed within 60 days after the issuance of a license and then regularly re-evaluated. Like France, Brazil hosts an online map[263] with the country's RFR measurements. Greece's National Observatory of Electromagnetic Fields[264] has 500 sensors providing RFR level monitoring for schools and other sensitive areas. Further measures that are commonly implemented internationally are listed in Table 3.

Regulatory gaps in the U.S

At the federal level in the U.S., policy changes are needed to address numerous regulatory gaps regarding

TABLE 3. International policy to Increase transparency, ensure compliance and reduce cell phone and RF radiation.

Policy	Country examples
Public RFR exposure limits are more stringent than ICNIRP/ FCC limits	Italy, India, Israel, Croatia, Ukraine, Greece, China, Russia, Canada, Switzerland, Belgium, Bosnia Herzegovina, Grand Duchy of Luxembourg, Belarus, Georgia, Serbia, Slovenia, Montenegro, Bulgaria, Turkey, Liechtenstein, Tajikistan, Kazakhstan, Uzbekistan, Kyrgyzstan, Moldova, Kuwait, Republic of Moldova, Iraq
RFR monitoring program for cell tower/base station emission compliance and/or environmental RFR exposures.	France, Greece, Turkey, Spain, Romania, Serbia, India, Israel, French Polynesia, Croatia, Bulgaria, Tunisia, Malta, Brazil, Bahrain, Monaco, Bhutan, Senegal, United Kingdom, Australia, Spain, Austria, India, Israel, Gibraltar, Brussels Belgium, Switzerland, Norway, Lithuania.
Straightforward official government advice that the public and/ or children "should" minimize cell phone RF exposure.	United Kingdom, Russia, Switzerland, Finland, Ireland, Germany, Belgium, Greece, Israel, Turkey, Singapore, France, Denmark, India, Austria, Cyprus, Canada, Italy, French Polynesia - Maryland U.S. for Wi-Fi in Schools (CEHPAC), Korea, Sri Lanka, Croatia, Krakow Poland, European Parliament Resolution 1815
Ban on mobile phone advertising to children	France, Belgium, French Polynesia, Russia
Ban on sale of phones designed for young children	Belgium, France, French Polynesia
SAR labeling on device, packaging or by retailer at point of sale	France, Israel, India, Belgium, Russia, Korea
SAR levels for cell phone models are publicly posted on easily accessible government website	France, Korea, Austria, Senegal, Germany,
Market surveillance program for cell phone SAR compliance	France, Canada
Public awareness program, robust website and/or educational campaign to educate the public on how to minimize RFR exposures from cell phones	France, French Polynesia, Israel, Cyprus, Israel

all aspects of control, monitoring, measuring and remediating wireless radiation.

First, no federal agencies with health or environmental expertise have reviewed the totality of the science to ensure U.S. regulations are adequate. In 2021 the U.S. Circuit Court of Appeals for the District of Columbia issued a landmark ruling in the case of Environmental Health Trust et al. vs. the FCC[55] that challenged the FCC's decision not to update the human exposure limits for RFR emissions from cell phones, Wi-Fi, and cell tower networks. The Court found that the FCC did not provide evidence of properly examining scientific evidence on the record and had ignored studies indicating low level non-thermal exposures could cause harm, especially for children. The Court then ordered the FCC to provide a reasoned explanation regarding these issues:

- the impacts of wireless radiation on children;
- the health implications of long-term exposure to RF radiation;
- the ubiquity of wireless devices and the technological developments since the FCC last updated its guidelines;
- the cell phone radiation emission test methods that use heat measurements and allow a space between the phone and body; and
- the impacts of wireless radiation on the environment.

Another critical regulatory gap is that when considering cell tower network emissions, there is no U.S. agency with health or environmental expertise engaged in any funded activities regarding health effects.

Unlike other countries that are gathering data via countrywide monitoring programs, the U.S. has no active federal field measurement program for assessment, compliance, or enforcement regarding cell tower and base station antenna RF emissions. The last federal agency report on RFR measurements was compiled in 1986 by the EPA.[265] When companies apply to build a cell tower in the U.S. near a school or homes, there are no requirements for real world RFR measurements before and after the antenna facilities are built, nor any requirement for annual measurements. The computer simulations provided by the company do not always provide estimated RFR levels for all of the areas that will be impacted by the cell antenna installation, such as inside an apartment that shares a wall with a building mounted antenna, or inside the room of a school or home in direct line of sight of the main beam of an antenna. Such close

proximity installations can result in increased RF exposure[35,266,267] and are associated with various EMF-related symptoms.[208,210]

Although several nations post online maps with the location of cell towers and wireless facilities alongside RFR measurements, U.S. federal agencies neither collect, nor provide this information to the public. For example, small cell wireless facilities (such as those on poles less than 50 feet tall such as street lamps) generally do not need to be registered with the FCC.

International marketing, compliance and transparency measures

Some countries have enacted a variety of regulations designed to minimize children's exposure, ensure compliance with cell phone regulations, and ensure that the public has access to RFR information as shown in Table 3. For example, since 2010 France has prohibited the sale of cell phones designed for children under 6 years, and banned advertising cell phones to children under 14 years. In 2015, their cell phone labeling requirements were strengthened. Advertising must clearly recommend how to reduce exposure to the head or companies can be fined. In 2019, a joint order of the French Health and Finance Agencies[268] ordered that the cell phone consumer information should include several specific ways to reduce RF exposure to the brain, minimizing frequency and duration of use. In addition, the cell phone information includes "Keep radio equipment away from the belly of pregnant women," and "away from the lower abdomen of adolescents."[269]

2020 regulations[270] now mandate that computers, tablets and other handheld wireless electronics (as well as refurbished products) held close to the body were subject to the same labeling regulations as cell phones. In 2022, the French General Directorate for Competition, Consumer Affairs and Fraud Prevention found numerous violations[271] of their labeling requirements for wireless devices and issued over 200 warnings.

In 2014, Belgium implemented two Royal Decrees[272] that prohibited the sale and advertising of cell phones designed for children under 7 years old.[273]

Premarket cell phone and wireless device RFR testing

Some countries such as France and Canada perform independent SAR measurements of cell phone models to ensure regulatory compliance. Both countries have found that some phone models exceed their regulatory limits, even when tested at the manufacturer's stated separation distance, i.e. 5 or 10 or 15 mm from the head or body.

So far, over 35 non-compliant phone models have been either withdrawn from the French market or had software updates to decrease the RFR. The French National Frequency Agency, ANFR, posts their independent SAR test measurements for hundreds of cell phones online.[274] The U.S. does not have an oversight program for cell phone RFR emission compliance.

Furthermore, all cell phones and Wi-Fi devices such as routers, speakers, and gaming consoles have fine print instructions in their manuals stating that the user should maintain a specified minimum distance between their body and the phone or device in order to ensure compliance with regulatory safety limits.

Schools and child care settings

France, Israel, and regions in Belgium have removed Wi-Fi from kindergarten classrooms and restricted exposures in elementary classrooms. See Table 4. For example, French law (2015)[275] stipulates that Wi-Fi be off as the default setting, so that it is only turned on if needed for a particular classroom activity. The Parliamentary Assembly of the Council of Europe (PACE) Resolution 1815[276] (2011) recommends that "for children in general, and particularly in schools and classrooms, give preference to wired Internet connections, and strictly regulate the use of mobile phones by school children on school premises."

TABLE 4. International examples of policy measures to reduce RFR exposures in schools and child care settings.

Recommendations to prefer wired over Wi-Fi in kindergartens and schools	France, Israel, Germany, French Polynesia, Salzburg Austria, Maryland U.S.
Wi-Fi banned in child care settings and kindergarten	France, Israel, Ghent Belgium, French Polynesia, Cyprus
Wi-Fi off or minimized in elementary	France, Israel, Cyprus, Various municipal school districts worldwide

In the U.S., there are no specific school-focused or workplace-based federal regulations for RFR exposures. The Maryland State Children's Environmental Health and Protection Advisory Council report on Wi-Fi in school[277] recommends the reduction of RFR exposures in schools "as much as feasibly practical." Clegg et al.[278] outlines how to minimize RFR in buildings and includes the Collaborative for High Performance Schools[279] criteria to reduce RFR and ELF EMF in classrooms. (See a summary of recommendations below.)

Recommendations by Maryland Expert Advisors to the Governor and the Collaborative For High Performance Schools include:

- Install and use wired local area network (LAN) for internet access instead of Wi-Fi and connect classroom tech with cables whenever possible and always when building/remodeling.
- Ensure devices (tablets and laptops) are always used on a desk, not lap.
- Laptops, tablets and notebooks should have an Ethernet port and a physical switch to disable all wireless radios at once.
- Cell phones should be powered off and stored away during the school day. Wireless wearables should be turned to airplane mode.
- Prohibit use of DECT and cordless phones.
- Corded telephones should be installed in every classroom and there should be a way that students can contact parents and make calls during the day for planning purposes.
- Schools should integrate education on why and how to reduce RFR exposure into elementary, middle and high school class curriculum.
- Cell towers and wireless facilities should not be built on or adjacent/near to school property.
- Measure ELF and RFR levels in classrooms and sports areas yearly and when new technology is added to classrooms.

Healthcare settings

Sources of non-ionizing EMF exposure inside hospitals and healthcare facilities come from both the wireless networks (RFR) as well as electrical medical equipment (ELF-EMF).

EMF levels in neonatal units have been the subject of research due to the elevated exposure to an especially vulnerable patient group. Measurements of ELF inside incubators can range from 2 to 100 mG, depending on the distance from the top of the mattress to the electrical equipment.[280] After documenting higher levels of low frequency EMF levels inside closed incubators as compared to the ambient levels in the room, Penn State Medical Center researchers moderated the exposure through a grounding technique and found the mitigation improved infant's vagal tone, a marker of vulnerability to stress, and the risk of developing necrotizing enterocolitis.[281]

RFR in neonatal intensive care units primarily originates from staff and families' use of cell phones and wireless devices. A prudent avoidance strategy is recommended because these newborns are particularly vulnerable.[282]

In 2017, in Israel measurements of magnetic field EMF were taken for incubators in neonatal units at the request of the Ministry of Health and the Ministry of Environmental Protection[283] and they found a range from 0.05 to 5 μT. The Israel Ministry of Environmental Protection identified manufacturer approved efficient shielding methods to mitigate exposure in incubators and recommends reducing the duration of exposure as much as possible and prioritizing the use of low EMF incubators.

In Cyprus, the National Committee on Environment and Children's Health, under the auspices of the Ministry of Health, worked with the Archbishop Makarios III Hospital to pilot an RFR reduction program[284] in the pediatric intensive therapy unit and neonatal units. They removed the Wi-Fi access points, installed wired LAN networks and launched a multimedia educational program for families. RFR levels were measured before and after the mitigation and the measures resulted in a significant reduction in ambient exposure in the units.

The Agaplesion Diakonie Hospital in Hamburg, Germany has designed two "environmental" rooms for people with multiple chemical sensitivities and/or environmental allergies including sensitivity to electromagnetic fields. In addition to using low VOC emission building materials and fragrance free cleaning, several measures have been taken to reduce exposure to non-ionizing electromagnetic fields including the installation of power circuit breakers and prohibition of the use of cell phones.[285]

Recommendations for healthcare settings to minimize exposures, to support positive health outcomes as well as to accommodate patients with sensitivities:[13,83,197,199,215,275,281]

- Decrease RFR exposures in pediatric healthcare settings including waiting rooms, treatment areas, hospital rooms, and administrative workspaces by prioritizing wired connections and setting routers to their lowest operating settings;
- Ensure facilities have spaces with adequate EMF mitigation for treatment of sensitive patients;
- Educate patients, families, and staff;
- Utilize medical devices, equipment and technology designed without wireless features, or configured such that wireless connections are not essential and can be turned off when not in use; and
- Work with companies on research and design of safer technologies.

Conclusion: next steps for clinicians to better protect the young from impacts of RFR

Modern telecommunications have been embraced for their innumerable benefits to society, but we have been slower to acknowledge the need to avoid and reduce harms to youngsters or to the natural world on which our lives depend.[286] Fortunately, alternatives to employing wireless devices can provide safer, faster and more efficient technical performance for many modern applications. There are many distinct physical, psychological and sociological grounds for moderating children's screen time to promote healthy development. The principle of ALARA—as low as reasonably achievable—ought to be adopted as a strategy for RFR health and safety protection.

While such measures are being implemented in clinicians' offices, clinics and the like, there is a critical need for an independently funded training, research and monitoring program to identify major data gaps in the field which are substantial, to set relative priorities for research and training, and to conduct long term studies of the physical and psychological impacts of rapidly changing technological milieu, including ways to mitigate impacts through modifications in hardware and software.

The medical community has a critical role to play in the prevention and treatment of EMF associated illness. Steps that doctors and other healthcare professionals can take include:

- Federal level: Advocate with the AAP and other health professionals for a reassessment of RFR exposure limits and the development of standards that adequately address biological impacts, children's vulnerabilities and current use patterns.
- State level: Engage membership with educational and training activities as well as resolutions to support federal initiatives.
- Support policies that reduce EMF exposure for children in home, child care, school, health care, and recreational settings.
- Support the continued development of clinical guidelines for prevention, treatment and diagnosis of EMF related illness.

References

1. McInerny T.K.. Letter from President of the American Academy of Pediatrics, Thomas K. McInerny, MD, FAAP to the FCC. August 2013.
2. CDC. ALARA - As Low as Reasonably Achievable. Centers for Disease Control and Prevention; 2022 https://www.cdc.gov/nceh/radiation/alara.htmlPublished May 18Accessed January 24, 2023.
3. Council on Communications and Media, Hill D, Ameenuddin N, et al. Media and young minds. *Pediatrics* 2016;138 (5):e20162591. https://doi.org/10.1542/peds.2016-2591.
4. AACAP. Screen Time and Children. American Academy of Child & Adolescent Psychiatry; 2020 https://www.aacap.org/AACAP/Families_and_Youth/Facts_for_Families/FFF-Guide/Children-And-Watching-TV-054. Accessed January 24, 2023Published February.
5. Mcclain C.. How parents' views of their kids' screen time, social media use changed during COVID-19. *Pew Res Cent*. https://www.pewresearch.org/fact-tank/2022/04/28/how-parents-views-of-their-kids-screen-time-social-media-use-changed-during-covid-19/. Accessed January 10, 2023.
6. American Psychiatric Association, Sherer J. Internet Gaming. https://www.psychiatry.org:443/patients-families/internet-gaming. Published January 2023. Accessed January 24, 2023.
7. Belpomme D, Hardell L, Belyaev I, Burgio E, Carpenter DO. Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environ Pollut* 2018;242:643–58. https://doi.org/10.1016/j.envpol.2018.07.019.
8. Belyaev I, Blackman C, Chamberlin K, et al. Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. *Environ Health* 2022;21(1):92. https://doi.org/10.1186/s12940-022-00900-9.
9. English K, Lau C, Jagals P. The unique vulnerabilities of children to environmental hazards. In: Xia Y, ed. *Early-Life Environmental Exposure and Disease: Facts and Perspectives*, Singapore: Springer, 2020. pp. 103–12. https://doi.org/10.1007/978-981-15-3797-4_6.

10. International Commission on Non-ionizing Radiation Protection (ICNIRP). ICNIRP. https://www.icnirp.org/en/about-icnirp/aim-status-history/index.html.
11. IEEE - The world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. https://www.ieee.org/. Accessed January 25, 2023.
12. Who We Are. *Int Comm Biol Eff Electromagn Fields*. https://icbe-emf.org/who-we-are/. Accessed January 25, 2023.
13. McCredden JE, Cook N, Weller S, Leach V. Wireless technology is an environmental stressor requiring new understanding and approaches in health care. *Front Public Health* 2022;10 https://www.frontiersin.org/articles/10.3389/fpubh.2022.986315. Accessed January 25, 2023.
14. Oceania Radiofrequencyscientific Advisory Association (ORSAA). Oceania radiofrequency scientific advisory association (ORSAA). https://www.orsaa.org/. Accessed January 25, 2023.
15. Panagopoulos DJ, ed. *Electromagnetic Fields of Wireless Communications: Biological and Heal*, 1st ed.., Boca Raton: CRC Press, 2022 https://www.taylorfrancis.com/books/edit/10.1201/9781003201052/electromagnetic-fields-wireless-communications-biological-health-effects-dimitris-panagopoulos. Accessed January 25, 2023.
16. Lin JC. Carcinogenesis from chronic exposure to radio-frequency radiation. *Front Public Health* 2022;10 https://www.frontiersin.org/articles/10.3389/fpubh.2022.1042478. Accessed January 10, 2023.
17. Hampshire DP. A derivation of Maxwell's equations using the Heaviside notation. *Philos Transact A Math Phys Eng Sci* 2018;376(2134):20170447. https://doi.org/10.1098/rsta.2017.0447.
18. Maxwell J.C. VIII. A dynamical theory of the electromagnetic field. *Philos Trans R Soc Lond* 1865;155:459–512. https://doi.org/10.1098/rstl.1865.0008.
19. Bryant JH. Heinrich Hertz's experiments and experimental apparatus: his discovery of radio waves and his delineation of their properties. In: Baird D, Hughes RIG, Nordmann A, (eds). Heinrich Hertz: Classical Physicist, Modern Philosopher. *Boston Studies in the Philosophy of Science*, Dordrecht: Springer Netherlands, 1998. pp. 39–58. https://doi.org/10.1007/978-94-015-8855-3_4.
20. Hertz H. Ueber sehr schnelle electrische Schwingungen. *Ann Phys* 1887;267(7):421–48. https://doi.org/10.1002/andp.18872670707.
21. texte A des inscriptions et belles lettres (France) A du. Le Journal des Sçavans. Gallica; 1676 https://gallica.bnf.fr/ark:/12148/bpt6k56527vPublishedAccessed January 31, 2023.
22. Hellemans A. The Timetables of Science. Simon and Schuster; 1988 http://archive.org/details/timetablesofscie00hell_0. Accessed January 21, 2023.
23. Mullenders LHF. Solar UV damage to cellular DNA: from mechanisms to biological effects. *Photochem Photobiol Sci Off J Eur Photochem Assoc Eur Soc Photobiol* 2018;17(12):1842–52. https://doi.org/10.1039/c8pp00182k.
24. Kemper AR, Newman TB, Slaughter JL, et al. Clinical practice guideline revision: management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics* 2022;150(3):e2022058859. https://doi.org/10.1542/peds.2022-058859.
25. Wahl S, Engelhardt M, Schaupp P, Lappe C, Ivanov IV. The inner clock—Blue light sets the human rhythm. *J Biophotonics* 2019;12(12):e201900102. https://doi.org/10.1002/jbio.201900102.
26. Hugh A. The Continuous Wave. Princeton, USA: Princeton Legacy Library; 2016 https://press.princeton.edu/books/hardcover/9780691639680/the-continuous-wave. Accessed January 21, 2023.
27. ECSTUFF4U for Electronics Engineer. https://www.ecstuff4u.com/. Accessed January 24, 2023.
28. Carter C. How the Camillagate Tapes were Revealed to the Rest of the World. Mirror; 2017 http://www.mirror.co.uk/news/uk-news/how-camillagate-tapes-exposed-secret-10958350Published August 9Accessed January 23, 2023.
29. Levitt BB, Lai HC, Manville AM. Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. *Front Public Health* 2022;10 https://www.frontiersin.org/articles/10.3389/fpubh.2022.1000840. Accessed January 23, 2023.
30. Harris A, Cooper M. Mobile phones: impacts, challenges, and predictions. *Hum Behav Emerg Technol* 2019;1(1):15–7. https://doi.org/10.1002/hbe2.112.
31. Bandara P, Carpenter DO. Planetary electromagnetic pollution: it is time to assess its impact. *Lancet Planet Health* 2018;2(12):e512–4. https://doi.org/10.1016/S2542-5196(18)30221-3.
32. López-Pérez D, De Domenico A, Piovesan N, et al. A Survey on 5G radio access network energy efficiency: massive MIMO, lean carrier design, sleep modes, and machine learning. *IEEE Commun Surv Tutor* 2022;24(1):653–97. https://doi.org/10.1109/COMST.2022.3142532.
33. El-Hajj AM, Naous T. Radiation analysis in a gradual 5G network deployment strategy. In: *2020 IEEE 3rd 5G World Forum (5GWF)*; 2020. p. 448–53. https://doi.org/10.1109/5GWF49715.2020.9221314.
34. Bonato M, Dossi L, Fiocchi S, et al. Computational assessment of RF exposure levels due to 5G mobile phones. In: *2022 Microwave Mediterranean Symposium (MMS)*; 2022. p. 1–4. https://doi.org/10.1109/MMS55062.2022.9825603.
35. Koppel T, Ahonen M, Carlberg M, Hedendahl LK, Hardell L. Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. *Oncol Lett* 2019;18(5):5383–91. https://doi.org/10.3892/ol.2019.10899.
36. Patrício S, Correia LM, Gomes M. Influence of active antennas on EMF restrictions in 5G base stations deployment. In: *2022 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting (AP-S/URSI)*; 2022. p. 1280–1. https://doi.org/10.1109/AP-S/USNC-URSI47032.2022.9886131.
37. Mazloum T, Aerts S, Joseph W, Wiart J. RF-EMF exposure induced by mobile phones operating in LTE small cells in two different urban cities. *Ann Telecommun* 2019;74(1):35–42. https://doi.org/10.1007/s12243-018-0680-1.
38. IEEE standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields, 0 Hz

to 300 GHz. In: *IEEE Std C951-2019 Revis IEEE Std C951-2005 Inc IEEE Std C951-2019Cor 1-2019*; October 2019. p. 1–312. https://doi.org/10.1109/IEEESTD.2019.8859679.
39. Beard BB, Kainz W. Review and standardization of cell phone exposure calculations using the SAM phantom and anatomically correct head models. *Biomed Eng OnLine* 2004;3(1):34. https://doi.org/10.1186/1475-925X-3-34.
40. Lee AK, Hong SE, Choi HD. Is the SAM phantom conservative for SAR evaluation of all phone designs? *ETRI J* 2019;41(3):337–47. https://doi.org/10.4218/etrij.2018-0231.
41. Gordon C., Churchill T., Clauser C., et al. Anthropometric Survey of U.S. Army Personnel: Summary Statistics, Interim Report for 1988. January 1989.
42. Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB, Davis DL. Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children. *Electromagn Biol Med* 2012;31(1):34–51. https://doi.org/10.3109/15368378.2011.622827.
43. Christ A, Gosselin MC, Christopoulou M, Kühn S, Kuster N. Age-dependent tissue-specific exposure of cell phone users. *Phys Med Biol* 2010;55(7):1767–83. https://doi.org/10.1088/0031-9155/55/7/001.
44. Mumford WW. Some Technical Aspects of Microwave Radiation Hazards. *Proc IRE* 1961;49(2):427–47. https://doi.org/10.1109/JRPROC.1961.287804.
45. Steneck NH, Cook HJ, Vander AJ, Kane GL. The origins of U.S. safety standards for microwave radiation. *Science* 1980;208(4449):1230–7. https://doi.org/10.1126/science.6990492.
46. Shore M. Review of the Ten-Milliwattt per Square Centimeter Microwave Standard. A Decade of Progress. Harrisburg Pennsylvania: U.S. Department of Health, Education, and Welfare; 1978. p. 32–9.
47. *47 CFR § 1.1310 - Radiofrequency radiation exposure limits.*; 2020. https://www.law.cornell.edu/cfr/text/47/1.1310. Accessed January 24, 2023.
48. Repacholi MH. A history of the international commission on non-ionizing radiation protection. *Health Phys* 2017;113(4):282–300. https://doi.org/10.1097/HP.0000000000000699.
49. Melnick R. Regarding ICNIRP'S evaluation of the national toxicology program's carcinogenicity studies on radiofrequency electromagnetic fields. *Health Phys* 2020;118(6):678–82. https://doi.org/10.1097/HP.0000000000001268.
50. Buchner K., Rivasi M.. The International Commission on Non-Ionizing Radiation Protection: Conflicts of Interest, Corporate Capture and the Push for 5G. *This Rep Was Comm Coord Publ Two Memb Eur Parliam –Michè Rivasi Eur Écologie Klaus Buchner Ökol-Demokr Part Financ GreensEfAgroup Eur Parliam*. June 2020:98. https://klaus-buchner.eu/wp-content/uploads/2020/06/ICNIRP-report-FINAL-19-JUNE-2020.pdf.
51. Hardell L, Carlberg M. [Comment] Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncol Lett* 2020;20(4):1.. https://doi.org/10.3892/ol.2020.11876:-1.
52. Carpenter DO, Sage C. Setting prudent public health policy for electromagnetic field exposures. *Rev Environ Health* 2008;23(2):91–118. https://doi.org/10.1515/REVEH.2008.23.2.91.
53. FCC Maintains Current RF Exposure Safety Standards. Federal Communications Commission. https://www.fcc.gov/document/fcc-maintains-current-rf-exposure-safety-standards. Published December 4, 2019. Accessed April 11, 2020.
54. Human Exposure to Radiofrequency Electromagnetic Fields and Reassessment of FCC Radiofrequency Exposure Limits and Policies. Federal Register. https://www.federalregister.gov/documents/2020/04/01/2020-02745/human-exposure-to-radiofrequency-electromagnetic-fields-and-reassessment-of-fcc-radiofrequency. Published April 1, 2020. Accessed January 23, 2023.
55. *No. 20-1025 ENVIRONMENTAL HEALTH TRUST, ET AL., PETITIONERS v. FEDERAL COMMUNICATIONS COMMISSION AND UNITED STATES OF AMERICA, RESPONDENTS Consolidated with 20-1138.*(United States Court of Appeals for the District of Columbia Circuit 2012). https://www.cadc.uscourts.gov/internet/opinions.nsf/FB976465BF00F8BD85258730004EFDF7/$file/20-1025-1910111.pdf.
56. The International EMF Project. https://www.who.int/initiatives/the-international-emf-project. Accessed January 24, 2023.
57. World Health Organization. The International EMF Project. Participating Countries & Entities. https://www.who.int/initiatives/the-international-emf-project/participating-countries-entities. Accessed February 1, 2023.
58. World Health Organization. Electromagnetic Fields and Public Health. https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/non-ionizing/emf/radiofrequency-fields. Accessed January 24, 2023.
59. Mercer D. The WHO EMF Project: legitimating the imaginary of global harmonization of EMF safety standards. *Engag Sci Technol Soc* 2016;2:88–105. https://doi.org/10.17351/ests2016.41.
60. Hardell L. World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). *Int J Oncol* 2017;51(2):405–13. https://doi.org/10.3892/ijo.2017.4046.
61. IARC. Press Release N° 208 IARC classifies Radiofrequency Electromagnetic Fields as possibly carcinogenic to humans. 2011. https://www.iarc.who.int/wp-content/uploads/2018/07/pr208_E.pdf.
62. Lai H, Levitt BB. The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines. *Electromagn Biol Med* 2022;41(2):230–55. https://doi.org/10.1080/15368378.2022.2065683.
63. Barnes F, Freeman JER. Some thoughts on the possible health effects of electric and magnetic fields and exposure guidelines. *Front Public Health* 2022;10 https://www.frontiersin.org/articles/10.3389/fpubh.2022.994758. Accessed January 25, 2023.
64. González-Gutiérrez MD, López-Garrido Á, Cortés-Pérez I, Obrero-Gaitán E, León-Morillas F, Ibáñez-Vera AJ. Effects of non-invasive radiofrequency diathermy in pelvic floor disorders: a systematic review. *Medicina (Mex)* 2022;58(3):437. https://doi.org/10.3390/medicina58030437.
65. Halliday D, Resnick R, Walker J. *Fundamentals of Physics, Volume 2*. 12th edition Wiley; 2021.
66. Yoshimura T, Mineki S, Ohuchi S. Microwave-assisted enzymatic reactions. Microwaves in Catalysis. John Wiley &

Sons, Ltd; 2015. p. 213–38. https://doi.org/10.1002/9783527688111.ch11.
67. Lai H. Exposure to static and extremely-low frequency electromagnetic fields and cellular free radicals. *Electromagn Biol Med* 2019;38(4):231–48. https://doi.org/10.1080/15368378.2019.1656645.
68. Desai NR, Kesari KK, Agarwal A. Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. *Reprod Biol Endocrinol RBE* 2009;7:114. https://doi.org/10.1186/1477-7827-7-114.
69. Luo J, Li H, Deziel NC, et al. Genetic susceptibility may modify the association between cell phone use and thyroid cancer: a population-based case-control study in Connecticut. *Environ Res* 2020;182:109013. https://doi.org/10.1016/j.envres.2019.109013.
70. Pall ML. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* 2013;17(8):958–65. https://doi.org/10.1111/jcmm.12088.
71. Smith-Roe SL, Wyde ME, Stout MD, et al. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen* 2020;61(2):276–90. https://doi.org/10.1002/em.22343.
72. Panagopoulos DJ, Karabarbounis A, Yakymenko I, Chrousos GP. Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review). *Int J Oncol* 2021;59(5):1–16. https://doi.org/10.3892/ijo.2021.5272.
73. Panagopoulos DJ, Messini N, Karabarbounis A, Philippetis AL, Margaritis LH. A mechanism for action of oscillating electric fields on cells. *Biochem Biophys Res Commun* 2000;272(3):634–40. https://doi.org/10.1006/bbrc.2000.2746.
74. Zhou L, Zhang Z, Huang Z, Nice E, Zou B, Huang C. Revisiting cancer hallmarks: insights from the interplay between oxidative stress and non-coding RNAs. *Mol Biomed* 2020;1:4. https://doi.org/10.1186/s43556-020-00004-1.
75. Emerit J, Edeas M, Bricaire F. Neurodegenerative diseases and oxidative stress. *Biomed Pharmacother Biomedecine Pharmacother* 2004;58(1):39–46. https://doi.org/10.1016/j.biopha.2003.11.004.
76. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O, Kyrylenko S. Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. *Electromagn Biol Med* 2016;35(2):186–202. https://doi.org/10.3109/15368378.2015.1043557.
77. Schuermann D, Mevissen M. Manmade electromagnetic fields and oxidative stress—biological effects and consequences for health. *Int J Mol Sci* 2021;22(7):3772. https://doi.org/10.3390/ijms22073772.
78. Miller AB, Sears ME, Morgan LL, et al. Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. *Front Public Health* 2019;7 https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223. Accessed January 10, 2023.
79. Moon JH. Health effects of electromagnetic fields on children. *Clin Exp Pediatr* 2020;63(11):422–8. https://doi.org/10.3345/cep.2019.01494.
80. Redmayne M, Johansson O. Radiofrequency exposure in young and old: different sensitivities in light of age-relevant natural differences. *Rev Environ Health* 2015;30(4):323–35. https://doi.org/10.1515/reveh-2015-0030.
81. Sage C, Burgio E. Electromagnetic fields, pulsed radiofrequency radiation, and epigenetics: how wireless technologies may affect childhood development. *Child Dev* 2018;89(1):129–36. https://doi.org/10.1111/cdev.12824.
82. Fernández C, de Salles AA, Sears ME, Morris RD, Davis DL. Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality. *Environ Res* 2018;167:694–9. https://doi.org/10.1016/j.envres.2018.05.013.
83. Peyman A. Dielectric properties of tissues; variation with age and their relevance in exposure of children to electromagnetic fields; state of knowledge. *Prog Biophys Mol Biol* 2011;107(3):434–8. https://doi.org/10.1016/j.pbiomolbio.2011.08.007.
84. Hussein M, Awwad F, Jithin D, El Hasasna H, Athamneh K, Iratni R. Breast cancer cells exhibits specific dielectric signature in vitro using the open-ended coaxial probe technique from 200 MHz to 13.6 GHz. *Sci Rep* 2019;9(1):4681. https://doi.org/10.1038/s41598-019-41124-1.
85. Jimenez H, Blackman C, Lesser G, et al. Use of non-ionizing electromagnetic fields for the treatment of cancer. *Front Biosci Landmark Ed* 2018;23(2):284–97. https://doi.org/10.2741/4591.
86. Júlvez J, Paus T, Bellinger D, et al. Environment and brain development: challenges in the global context. *Neuroepidemiology* 2016;46(2):79–82. https://doi.org/10.1159/000442256.
87. Redmayne M, Johansson O. Could myelin damage from radiofrequency electromagnetic field exposure help explain the functional impairment electrohypersensitivity? A review of the evidence. *J Toxicol Environ Health Part B* 2014;17(5):247–58. https://doi.org/10.1080/10937404.2014.923356.
88. Markovà E, Malmgren LOG, Belyaev IY. Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: possible mechanistic link to cancer risk. *Environ Health Perspect* 2010;118(3):394–9. https://doi.org/10.1289/ehp.0900781.
89. Yahyazadeh A, Deniz ÖG, Kaplan AA, Altun G, Yurt KK, Davis D. The genomic effects of cell phone exposure on the reproductive system. *Environ Res* 2018;167:684–93. https://doi.org/10.1016/j.envres.2018.05.017.
90. Gye MC, Park CJ. Effect of electromagnetic field exposure on the reproductive system. *Clin Exp Reprod Med* 2012;39(1):1–9. https://doi.org/10.5653/cerm.2012.39.1.1.
91. Jangid P, Rai U, Sharma RS, Singh R. The role of non-ionizing electromagnetic radiation on female fertility: a review. *Int J Environ Health Res* 2022;0(0):1–16. https://doi.org/10.1080/09603123.2022.2030676.
92. Maluin SM, Osman K, Jaffar FHF, Ibrahim SF. Effect of radiation emitted by wireless devices on male reproductive hormones: a systematic review. *Front Physiol* 2021;12 https://www.frontiersin.org/articles/10.3389/fphys.2021.732420. Accessed January 10, 2023.
93. Agarwal A, Desai NR, Makker K, et al. Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular

phones on human ejaculated semen: an in vitro pilot study. *Fertil Steril* 2009;92(4):1318–25. https://doi.org/10.1016/j.fertnstert.2008.08.022.
94. Negi P, Singh R. Association between reproductive health and nonionizing radiation exposure. *Electromagn Biol Med* 2021;40(1):92–102. https://doi.org/10.1080/15368378.2021.1874973.
95. Adams JA, Galloway TS, Mondal D, Esteves SC, Mathews F. Effect of mobile telephones on sperm quality: a systematic review and meta-analysis. *Environ Int* 2014;70:106–12. https://doi.org/10.1016/j.envint.2014.04.015.
96. Kim S, Han D, Ryu J, Kim K, Kim YH. Effects of mobile phone usage on sperm quality – No time-dependent relationship on usage: A systematic review and updated meta-analysis. *Environ Res* 2021;202:111784. https://doi.org/10.1016/j.envres.2021.111784.
97. Yu G, Bai Z, Song C, et al. Current progress on the effect of mobile phone radiation on sperm quality: An updated systematic review and meta-analysis of human and animal studies. *Environ Pollut* 2021;282:116952. https://doi.org/10.1016/j.envpol.2021.116952.
98. Yadav H, Rai U, Singh R. Radiofrequency radiation: A possible threat to male fertility. *Reprod Toxicol* 2021;100:90–100. https://doi.org/10.1016/j.reprotox.2021.01.007.
99. Kesari KK, Agarwal A, Henkel R. Radiations and male fertility. *Reprod Biol Endocrinol RBE* 2018;16(1):118. https://doi.org/10.1186/s12958-018-0431-1.
100. Krzastek SC, Farhi J, Gray M, Smith RP. Impact of environmental toxin exposure on male fertility potential. *Transl Androl Urol* 2020;9(6):2797–813. https://doi.org/10.21037/tau-20-685.
101. Houston BJ, Nixon B, King BV, Iuliis GND, Aitken RJ. The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction* 2016;152(6):R263–76. https://doi.org/10.1530/REP-16-0126.
102. Santini SJ, Cordone V, Falone S, et al. Role of mitochondria in the oxidative stress induced by electromagnetic fields: focus on reproductive systems. *Oxid Med Cell Longev* 2018;2018:e5076271. https://doi.org/10.1155/2018/5076271.
103. Alchalabi ASH, Rahim H, Aklilu E, et al. Histopathological changes associated with oxidative stress induced by electromagnetic waves in rats' ovarian and uterine tissues. *Asian Pac J Reprod* 2016;5(4):301–10. https://doi.org/10.1016/j.apjr.2016.06.008.
104. Bozok S, Karaagac E, Sener D, Akakin D, Tumkaya L. The effects of long-term prenatal exposure to 900, 1800, and 2100 MHz electromagnetic field radiation on myocardial tissue of rats. *Toxicol Ind Health* 2023;39(1):1–9. https://doi.org/10.1177/07482337221139586.
105. Cirillo PM, La Merrill MA, Krigbaum NY, Cohn BA. Grandmaternal perinatal serum DDT in relation to granddaughter early menarche and adult obesity: three generations in the child health and development studies cohort. *Cancer Epidemiol Biomarkers Prev* 2021;30(8):1480–8. https://doi.org/10.1158/1055-9965.EPI-20-1456.
106. Davis DL, Friedler G, Mattison D, Morris R. Male-mediated teratogenesis and other reproductive effects: Biologic and epidemiologic findings and a plea for clinical research. *Reprod Toxicol* 1992;6(4):289–92. https://doi.org/10.1016/0890-6238(92)90190-5.
107. Sepehrimanesh M, Kazemipour N, Saeb M, Nazifi S, Davis DL. Proteomic analysis of continuous 900-MHz radiofrequency electromagnetic field exposure in testicular tissue: a rat model of human cell phone exposure. *Environ Sci Pollut Res Int* 2017;24(15):13666–73. https://doi.org/10.1007/s11356-017-8882-z.
108. Haghani M, Pouladvand V, Mortazavi SMJ, Razavinasab M, Bayat M, Shabani M. Exposure to electromagnetic field during gestation adversely affects the electrophysiological properties of purkinje cells in rat offspring. *J Biomed Phys Eng* 2020;10(4):433–40. https://doi.org/10.31661/jbpe.v0i0.560.
109. Kaplan S, Deniz OG, Önger ME, et al. Electromagnetic field and brain development. *J Chem Neuroanat* 2016;75:52–61. https://doi.org/10.1016/j.jchemneu.2015.11.005.
110. Hu C, Zuo H, Li Y. Effects of radiofrequency electromagnetic radiation on neurotransmitters in the brain. *Front Public Health* 2021;9:691880. https://doi.org/10.3389/fpubh.2021.691880.
111. Odaci E, Bas O, Kaplan S. Effects of prenatal exposure to a 900 MHz electromagnetic field on the dentate gyrus of rats: a stereological and histopathological study. *Brain Res* 2008;1238:224–9. https://doi.org/10.1016/j.brainres.2008.08.013.
112. Şahin A, Aslan A, Baş O, et al. Deleterious impacts of a 900-MHz electromagnetic field on hippocampal pyramidal neurons of 8-week-old Sprague Dawley male rats. *Brain Res* 2015;1624:232–8. https://doi.org/10.1016/j.brainres.2015.07.042.
113. Bas O, Odaci E, Kaplan S, Acer N, Ucok K, Colakoglu S. 900 MHz electromagnetic field exposure affects qualitative and quantitative features of hippocampal pyramidal cells in the adult female rat. *Brain Res* 2009;1265:178–85. https://doi.org/10.1016/j.brainres.2009.02.011.
114. Li DK, Chen H, Ferber JR, Odouli R, Quesenberry C. Exposure to magnetic field non-ionizing radiation and the risk of miscarriage: a prospective cohort study. *Sci Rep* 2017;7(1):17541. https://doi.org/10.1038/s41598-017-16623-8.
115. Li DK, Ferber JR, Odouli R, Quesenberry CP. A prospective study of in-utero exposure to magnetic fields and the risk of childhood obesity. *Sci Rep* 2012;2(1):540. https://doi.org/10.1038/srep00540.
116. Li DK, Chen H, Odouli R. Maternal exposure to magnetic fields during pregnancy in relation to the risk of asthma in offspring. *Arch Pediatr Adolesc Med* 2011;165(10):945–50. https://doi.org/10.1001/archpediatrics.2011.135.
117. Li DK, Chen H, Ferber JR, Hirst AK, Odouli R. Association between maternal exposure to magnetic field nonionizing radiation during pregnancy and risk of attention-deficit/hyperactivity disorder in offspring in a longitudinal birth cohort. *JAMA Netw Open* 2020;3(3):e201417. https://doi.org/10.1001/jamanetworkopen.2020.1417.
118. Su XJ, Yuan W, Tan H, et al. Correlation between exposure to magnetic fields and embryonic development in the first trimester. *PLOS ONE* 2014;9(6):e101050. https://doi.org/10.1371/journal.pone.0101050.
119. Myruski S, Gulyayeva O, Birk S, Pérez-Edgar K, Buss KA, Ta D-T. Digital disruption? Maternal mobile device use is

related to infant social-emotional functioning. *Dev Sci* 2018;21(4):e12610. https://doi.org/10.1111/desc.12610.
120. Divan HA, Kheifets L, Obel C, Olsen J. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiol Camb Mass* 2008;19(4):523–9. https://doi.org/10.1097/EDE.0b013e318175dd47.
121. Divan HA, Kheifets L, Obel C, Olsen J. Cell phone use and behavioural problems in young children. *J Epidemiol Community Health* 2012;66(6):524–9. https://doi.org/10.1136/jech.2010.115402.
122. Papadopoulou E, Haugen M, Schjølberg S, et al. Maternal cell phone use in early pregnancy and child's language, communication and motor skills at 3 and 5 years: the Norwegian mother and child cohort study (MoBa). *BMC Public Health* 2017;17:685. https://doi.org/10.1186/s12889-017-4672-2.
123. Foerster M., Thielens A., Joseph W., Eeftens M., Röösli M.. A prospective cohort study of adolescents' memory performance and individual brain dose of microwave radiation from wireless communication. *Environ Health Perspect*. 126 (7):077007. doi:10.1289/EHP2427
124. Schoeni A, Roser K, Röösli M. Memory performance, wireless communication and exposure to radiofrequency electromagnetic fields: A prospective cohort study in adolescents. *Environ Int* 2015;85:343–51. https://doi.org/10.1016/j.envint.2015.09.025.
125. Fragopoulou AF, Miltiadous P, Stamatakis A, Stylianopoulou F, Koussoulakos SL, Margaritis LH. Whole body exposure with GSM 900 MHz affects spatial memory in mice. *Pathophysiology* 2010;17(3):179–87. https://doi.org/10.1016/j.pathophys.2009.11.002.
126. Hao D, Yang L, Chen S, et al. Effects of long-term electromagnetic field exposure on spatial learning and memory in rats. *Neurol Sci* 2013;34(2):157–64. https://doi.org/10.1007/s10072-012-0970-8.
127. Li Y, Shi C, Lu G, Xu Q, Liu S. Effects of electromagnetic radiation on spatial memory and synapses in rat hippocampal CA1. *Neural Regen Res* 2012;7(16):1248–55. https://doi.org/10.3969/j.issn.1673-5374.2012.16.007.
128. Narayanan SN, Kumar RS, Karun KM, Nayak SB, Bhat PG. Possible cause for altered spatial cognition of prepubescent rats exposed to chronic radiofrequency electromagnetic radiation. *Metab Brain Dis* 2015;30(5):1193–206. https://doi.org/10.1007/s11011-015-9689-6.
129. Narayanan SN, Kumar RS, Potu BK, Nayak S, Mailankot M. Spatial memory performance of Wistar rats exposed to mobile phone. *Clin Sao Paulo Braz* 2009;64(3):231–4. https://doi.org/10.1590/s1807-59322009000300014.
130. Ntzouni MP, Skouroliakou A, Kostomitsopoulos N, Margaritis LH. Transient and cumulative memory impairments induced by GSM 1.8 GHz cell phone signal in a mouse model. *Electromagn Biol Med* 2013;32(1):95–120. https://doi.org/10.3109/15368378.2012.709207.
131. Ntzouni MP, Stamatakis A, Stylianopoulou F, Margaritis LH. Short-term memory in mice is affected by mobile phone radiation. *Pathophysiology* 2011;18(3):193–9. https://doi.org/10.1016/j.pathophys.2010.11.001.
132. Tang J, Zhang Y, Yang L, et al. Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. *Brain Res* 2015;1601:92–101. https://doi.org/10.1016/j.brainres.2015.01.019.
133. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Abegaonkar MP. Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. *Indian J Exp Biol* 2012;50(12):889–96.
134. Azimzadeh M, Jelodar G. Prenatal and early postnatal exposure to radiofrequency waves (900 MHz) adversely affects passive avoidance learning and memory. *Toxicol Ind Health* 2020;36 (12):1024–30. https://doi.org/10.1177/0748233720973143.
135. Shahin S, Banerjee S, Swarup V, Singh SP, Chaturvedi CM. From the cover: 2.45-GHz microwave radiation impairs hippocampal learning and spatial memory: involvement of local stress mechanism-induced suppression of iGluR/ERK/CREB signaling. *Toxicol Sci* 2018;161(2):349–74. https://doi.org/10.1093/toxsci/kfx221.
136. Othman H, Ammari M, Rtibi K, Bensaid N, Sakly M, Abdelmelek H. Postnatal development and behavior effects of in-utero exposure of rats to radiofrequency waves emitted from conventional WiFi devices. *Environ Toxicol Pharmacol* 2017;52:239–47. https://doi.org/10.1016/j.etap.2017.04.016.
137. Panagopoulos DJ, Johansson O, Carlo GL. Real versus simulated mobile phone exposures in experimental studies. *BioMed Res Int* 2015;2015:e607053. https://doi.org/10.1155/2015/607053.
138. Leach V, Weller S, Redmayne M. A novel database of bioeffects from non-ionizing radiation. *Rev Environ Health* 2018;33(3):273–80. https://doi.org/10.1515/reveh-2018-0017.
139. Aldad TS, Gan G, Gao XB, Taylor HS. Fetal radiofrequency radiation exposure from 800-1900 Mhz-rated cellular telephones affects neurodevelopment and behavior in mice. *Sci Rep* 2012;2:312. https://doi.org/10.1038/srep00312.
140. Broom KA, Findlay R, Addison DS, Goiceanu C, Sienkiewicz Z. Early-life exposure to pulsed LTE radiofrequency fields causes persistent changes in activity and behavior in C57BL/6 J mice. *Bioelectromagnetics* 2019;40(7):498–511. https://doi.org/10.1002/bem.22217.
141. Fragopoulou AF, Samara A, Antonelou MH, et al. Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. *Electromagn Biol Med* 2012;31(4):250–74. https://doi.org/10.3109/15368378.2011.631068.
142. Fragopoulou AF, Polyzos A, Papadopoulou MD, et al. Hippocampal lipidome and transcriptome profile alterations triggered by acute exposure of mice to GSM 1800 MHz mobile phone radiation: An exploratory study. *Brain Behav* 2018;8 (6):e01001. https://doi.org/10.1002/brb3.1001.
143. IARC. *Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields*. https://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Non-ionizing-Radiation-Part-1-Static-And-Extremely-Low-frequency-ELF-Electric-And-Magnetic-Fields-2002. Accessed January 10, 2023.
144. Carpenter DO. Extremely low frequency electromagnetic fields and cancer: How source of funding affects results.

Environ Res 2019;178:108688. https://doi.org/10.1016/j.envres.2019.108688.
145. Seomun G, Lee J, Park J. Exposure to extremely low-frequency magnetic fields and childhood cancer: A systematic review and meta-analysis. *PLOS ONE* 2021;16(5):e0251628. https://doi.org/10.1371/journal.pone.0251628.
146. Falcioni L, Bua L, Tibaldi E, et al. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environ Res* 2018;165:496–503. https://doi.org/10.1016/j.envres.2018.01.037.
147. National Toxicology Program NI of ESciences. Toxicology and carcinogenesis studies in B6C3F1/n mice exposed to whole-body radio frequency radiation at a frequency (1,900 mHz) and modulations (GSM and CDMA) used by cell phones. *NTP Tech Rep* 2018;596:260.
148. National Toxicology Program NI of EHS. Toxicology and carcinogenesis studies in Hsd: Sprague Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. *NTP Tech Rep* 2018;595:384 https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr595_508.pdf. Accessed November 15, 2018.
149. Coureau G, Bouvier G, Lebailly P, et al. Mobile phone use and brain tumours in the CERENAT case-control study. *Occup Environ Med* 2014;71(7):514–22. https://doi.org/10.1136/oemed-2013-101754.
150. Turner MC, Sadetzki S, Langer CE, et al. Investigation of bias related to differences between case and control interview dates in five INTERPHONE countries. *Ann Epidemiol* 2016;26(12):827–32. https://doi.org/10.1016/j.annepidem.2016.09.013:e2.
151. Momoli F, Siemiatycki J, McBride ML, et al. Probabilistic multiple-bias modeling applied to the canadian data from the interphone study of mobile phone use and risk of glioma, meningioma, acoustic neuroma, and parotid gland tumors. *Am J Epidemiol* 2017;186(7):885–93. https://doi.org/10.1093/aje/kwx157.
152. Lerchl A, Klose M, Grote K, et al. Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. *Biochem Biophys Res Commun* 2015;459(4):585–90. https://doi.org/10.1016/j.bbrc.2015.02.151.
153. Choi YJ, Moskowitz JM, Myung SK, Lee YR, Hong YC. Cellular phone use and risk of tumors: systematic review and meta-analysis. *Int J Environ Res Public Health* 2020;17(21):8079. https://doi.org/10.3390/ijerph17218079.
154. Uche UI, Naidenko OV. Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach. *Environ Health* 2021;20(1):84. https://doi.org/10.1186/s12940-021-00768-1.
155. The INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case−control study. *Int J Epidemiol* 2010;39(3):675–94. https://doi.org/10.1093/ije/dyq079.
156. Hardell L, Moskowitz JM. A critical analysis of the MOBI-Kids study of wireless phone use in childhood and adolescence and brain tumor risk. *Rev Environ Health* May 2022. https://doi.org/10.1515/reveh-2022-0040.
157. Repacholi MH, Lerchl A, Röösli M, et al. Systematic review of wireless phone use and brain cancer and other head tumors. *Bioelectromagnetics* 2012;33(3):187–206. https://doi.org/10.1002/bem.20716.
158. Birnbaum LS, Taylor HS, Baldwin H, Ben-Ishai P, Davis D. RE: cellular telephone use and the risk of brain tumors: update of the UK million women study. *JNCI J Natl Cancer Inst* 2022;114(11):1551–2. https://doi.org/10.1093/jnci/djac110.
159. Moskowitz JM. RE: cellular telephone use and the risk of brain tumors: update of the UK million women study. *JNCI J Natl Cancer Inst* 2022;114(11):1549–50. https://doi.org/10.1093/jnci/djac109.
160. Carlberg M, Hedendahl L, Ahonen M, Koppel T, Hardell L. Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data. *BMC Cancer* 2016;16(1):426. https://doi.org/10.1186/s12885-016-2429-4.
161. West JG, Kapoor NS, Liao SY, Chen JW, Bailey L, Nagourney RA. Multifocal breast cancer in young women with prolonged contact between their breasts and their cellular phones. *Case Rep Med* 2013;2013:e354682. https://doi.org/10.1155/2013/354682.
162. Shih YW, Hung CS, Huang CC, et al. The association between smartphone use and breast cancer risk among taiwanese women: a case-control study. *Cancer Manag Res* 2020;12:10799–807. https://doi.org/10.2147/CMAR.S267415.
163. Carlberg M, Hardell L. Evaluation of mobile phone and cordless phone use and glioma risk using the bradford hill viewpoints from 1965 on association or causation. *BioMed Res Int* 2017;2017:e9218486. https://doi.org/10.1155/2017/9218486.
164. Peleg M, Berry EM, Deitch M, Nativ O, Richter E. On radar and radio exposure and cancer in the military setting. *Environ Res* 2023;216:114610. https://doi.org/10.1016/j.envres.2022.114610.
165. Miller AB, Morgan LL, Udasin I, Davis DL. Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environ Res* 2018;167:673–83. https://doi.org/10.1016/j.envres.2018.06.043.
166. Melnick RL. Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. *Environ Res* 2019;168:1–6. https://doi.org/10.1016/j.envres.2018.09.010.
167. Directorate-General for Parliamentary Research Services (European Parliament), Belpoggi F. Health Impact of 5G: Current State of Knowledge of 5G Related Carcinogenic and Reproductive/Developmental Hazards as They Emerge from Epidemiological Studies and in Vivo Experimental Studies. LU: Publications Office of the European Union; 2021 https://data.europa.eu/doi/10.2861/657478. Accessed September 21, 2022.
168. White MC, Weir HK, Soman AV, Peipins LA, Thompson TD. Risk of clear-cell adenocarcinoma of the vagina and

cervix among US women with potential exposure to diethylstilbestrol in utero. *Cancer Causes Control CCC* 2022;33 (8):1121–4. https://doi.org/10.1007/s10552-022-01598-3.
169. Ugai T, Sasamoto N, Lee HY, et al. Is early-onset cancer an emerging global epidemic? Current evidence and future implications. *Nat Rev Clin Oncol* 2022;19(10):656–73. https://doi.org/10.1038/s41571-022-00672-8.
170. Loomans-Kropp HA, Umar A. Increasing incidence of colorectal cancer in young adults. *J Cancer Epidemiol* 2019;2019: e9841295. https://doi.org/10.1155/2019/9841295.
171. Rising colon and rectal cancer rates could be due to cell phone radiation. *Environ Health Trust* September 2020 https://ehtrust.org/rising-colon-and-rectal-cancer-rates-could-be-due-to-cell-phone-radiation/. Accessed January 10, 2023.
172. Mokarram P, Sheikhi M, Mortazavi SMJ, Saeb S, Shokrpour N. Effect of exposure to 900 MHz GSM mobile phone radiofrequency radiation on estrogen receptor methylation status in colon cells of male sprague dawley rats. *J Biomed Phys Eng* 2017;7(1):79–86.
173. Alkayyali T, Ochuba O, Srivastava K, et al. An exploration of the effects of radiofrequency radiation emitted by mobile phones and extremely low frequency radiation on thyroid hormones and thyroid gland histopathology. *Cureus* 2021;13 (8). https://doi.org/10.7759/cureus.17329.
174. Cantürk Tan F, Yalçin B, Yay AH, Tan B, Yeğin K, Daşdağ S. Effects of pre and postnatal 2450 MHz continuous wave (CW) radiofrequency radiation on thymus: four generation exposure. *Electromagn Biol Med* 2022;41(3):315–24. https://doi.org/10.1080/15368378.2022.2079673.
175. La Merrill MA, Vandenberg LN, Smith MT, et al. Consensus on the key characteristics of endocrine-disrupting chemicals as a basis for hazard identification. *Nat Rev Endocrinol* 2020;16(1):45–57. https://doi.org/10.1038/s41574-019-0273-8.
176. Soffritti M, Giuliani L. The carcinogenic potential of nonionizing radiations: the cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation. *Basic Clin Pharmacol Toxicol* 2019;125(Suppl 3):58–69. https://doi.org/10.1111/bcpt.13215.
177. Tan S, Wang H, Xu X, et al. Acute effects of 2.856 GHz and 1.5 GHz microwaves on spatial memory abilities and CREB-related pathways. *Sci Rep* 2021;11(1):12348. https://doi.org/10.1038/s41598-021-91622-4.
178. Yao C, Wang H, Sun L, et al. The biological effects of compound microwave exposure with 2.8 GHz and 9.3 GHz on immune system: transcriptomic and proteomic analysis. *Cells* 2022;11(23):3849. https://doi.org/10.3390/cells11233849.
179. Parent J, Sanders W, Forehand R. Youth screen time and behavioral health problems: the role of sleep duration and disturbances. *J Dev Behav Pediatr JDBP* 2016;37(4):277–84. https://doi.org/10.1097/DBP.0000000000000272.
180. Royant-Parola S, Londe V, Tréhout S, Hartley S. [The use of social media modifies teenagers' sleep-related behavior]. *L'Encephale* 2018;44(4):321–8. https://doi.org/10.1016/j.encep.2017.03.009.
181. Hale L, Kirschen GW, LeBourgeois MK, et al. Youth screen media habits and sleep: sleep-friendly screen behavior recommendations for clinicians, educators, and parents. *Child Adolesc Psychiatr Clin N Am* 2018;27(2):229–45. https://doi.org/10.1016/j.chc.2017.11.014.
182. Guerrero MD, Barnes JD, Chaput JP, Tremblay MS. Screen time and problem behaviors in children: exploring the mediating role of sleep duration. *Int J Behav Nutr Phys Act* 2019;16(1):105. https://doi.org/10.1186/s12966-019-0862-x.
183. Stiglic N, Viner RM. Effects of screentime on the health and well-being of children and adolescents: a systematic review of reviews. *BMJ Open* 2019;9(1):e023191. https://doi.org/10.1136/bmjopen-2018-023191.
184. Council on Communications and Media, Hill D, Ameenuddin N, et al. Media use in school-aged children and adolescents. *Pediatrics* 2016;138(5):e20162592. https://doi.org/10.1542/peds.2016-2592.
185. Nagata JM, Chu J, Zamora G, et al. Screen time and obsessive-compulsive disorder among children 9−10 years old: a prospective cohort study. *J Adolesc Health* December 2022. https://doi.org/10.1016/j.jadohealth.2022.10.023.
186. van den Heuvel M, Ma J, Borkhoff CM, et al. Mobile media device use is associated with expressive language delay in 18-month-old children. *J Dev Behav Pediatr* 2019;40(2):99–104. https://doi.org/10.1097/DBP.0000000000000630.
187. Lissak G. Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environ Res* 2018;164:149–57. https://doi.org/10.1016/j.envres.2018.01.015.
188. Axelsson EL, Purcell K, Asis A, et al. Preschoolers' engagement with screen content and associations with sleep and cognitive development. *Acta Psychol (Amst)* 2022;230:103762. https://doi.org/10.1016/j.actpsy.2022.103762.
189. American Psychiatric Association. DSM-5 Task Force. Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). 5th ed Arlington, VA: American Psychiatric Association; 2013.
190. Perrin A.. 5 facts about Americans and video games. *Pew Res Cent*. https://www.pewresearch.org/fact-tank/2018/09/17/5-facts-about-americans-and-video-games/. Accessed January 25, 2023.
191. Nagata JM, Chu J, Ganson KT, et al. Contemporary screen time modalities and disruptive behavior disorders in children: a prospective cohort study. *J Child Psychol Psychiatry* 2023;64(1):125–35. https://doi.org/10.1111/jcpp.13673.
192. Dunkley V.L.. *Reset Your Child's Brain: A Four-Week Plan to End Melt-Downs, Raise Grades, and Boost Social Skills by Reversing the Effects of Electronic Screen Time*. https://www.publishersweekly.com/9781608682843. Accessed January 25, 2023.
193. Pedersen J, Rasmussen MGB, Sørensen SO, et al. Effects of limiting recreational screen media use on physical activity and sleep in families with children: a cluster randomized clinical trial. *JAMA Pediatr* 2022;176(8):741–9. https://doi.org/10.1001/jamapediatrics.2022.1519.
194. Camerini AL, Albanese E, Marciano L. The impact of screen time and green time on mental health in children and adolescents during the COVID-19 pandemic. *Comput Hum Behav Rep* 2022;7:100204. https://doi.org/10.1016/j.chbr.2022.100204.
195. Li M, Lanca C, Tan CS, et al. Association of time outdoors and patterns of light exposure with myopia in children. *Br J*

Ophthalmol 2023;107(1):133–9. https://doi.org/10.1136/bjophthalmol-2021-318918.
196. Philipp D, Vogel M, Brandt M, et al. The relationship between myopia and near work, time outdoors and socioeconomic status in children and adolescents. *BMC Public Health* 2022;22(1):2058. https://doi.org/10.1186/s12889-022-14377-1.
197. MacRoy-Higgins M, Kolker C. Time to Talk: What You Need to Know About Your Child's Speech and Language Development. First edition New York: AMACOM; 2017.
198. McDaniel BT, Radesky JS. Technoference: parent distraction with technology and associations with child behavior problems. *Child Dev* 2018;89(1):100–9. https://doi.org/10.1111/cdev.12822.
199. Davis D, Sears ME, Miller AB, Bray R. Microwave/radiofrequency radiation and human health: clinical management in the digital age. In: Cohen A, vom Saal FS, Weil A, (eds). *Integrative Environmental Medicine*, Oxford University Press, 2017. p. 0. https://doi.org/10.1093/med/9780190490911.003.0010.
200. Belyaev I, Dean A, Eger H, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Rev Environ Health* 2016;31(3):363–97. https://doi.org/10.1515/reveh-2016-0011.
201. Bray R.. Clinical Practice Guidelines in the Diagnosis and Management of Electromagnetic Field Hypersensitivity (EHS). October 2020.
202. Austrian Medical Association. Guideline of the Austrian Medical Association (w) for the diagnosis and treatment of EMFrelated health problems and illnesses (EMF syndrome). March 2012 https://ehtrust.org/wp-content/uploads/The-Austrian-Medical-Association-Guidelines-for-Diagnosis-and-Treatment-of-EMF-related-Health-Problems.pdf.
203. EMF – Medical Conference 2021. https://emfconference2021.com/. Accessed January 25, 2023.
204. Stein Y, Udasin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) – Review of mechanisms. *Environ Res* 2020;186:109445. https://doi.org/10.1016/j.envres.2020.109445.
205. Farashi S, Bashirian S, Khazaei S, Khazaei M, Farhadinasab A. Mobile phone electromagnetic radiation and the risk of headache: a systematic review and meta-analysis. *Int Arch Occup Environ Health* 2022;95(7):1587–601. https://doi.org/10.1007/s00420-022-01835-x.
206. Redmayne M, Smith E, Abramson MJ. The relationship between adolescents' well-being and their wireless phone use: a cross-sectional study. *Environ Health Glob Access Sci Source* 2013;12:90. https://doi.org/10.1186/1476-069X-12-90.
207. Chongchitpaisan W, Wiwatanadate P, Tanprawate S, Narkpongphan A, Siripon N. Trigger of a migraine headache among Thai adolescents smartphone users: a time series study. *Environ Anal Health Toxicol* 2021;36(1):e2021006. https://doi.org/10.5620/eaht.2021006.
208. Balmori A. Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. *Environ Res* 2022;214:113851. https://doi.org/10.1016/j.envres.2022.113851.
209. Dieudonné M. Does electromagnetic hypersensitivity originate from nocebo responses? Indications from a qualitative study. *Bioelectromagnetics* 2016;37(1):14–24. https://doi.org/10.1002/bem.21937.
210. Hardell L, Nilsson M. Case Report: the microwave syndrome after installation of 5G emphasizes the need for protection from radiofrequency radiation. *Ann Case Rep* January 2023 https://www.gavinpublishers.com/article/view/case-report-the-microwave-syndrome-after-installation-of-5g-emphasizes-the-need-for-protection-from-radiofrequency-radiation. Accessed January 25, 2023.
211. US Access Board. IEQ Indoor Environmental Quality Project. https://www.access-board.gov/research/building/indoor-environmental-quality/. Accessed January 25, 2023.
212. Electrical Sensitivity. https://askjan.org/disabilities/Electrical-Sensitivity.cfm#otherinfo. Accessed January 25, 2023.
213. Job Accommodation Network. Accommodation and Compliance Series: Employees with Electrical Sensitivity. 2022. https://askjan.org/publications/Disability-Downloads.cfm?pubid=226622. Accessed January 25, 2023.
214. Physicians' Health Initiative for Radiation and Environment. Press Release: Education Health Care Plan (EHCP) awarded (July 2022) for UK child on the basis of Electromagnetic Hypersensitivity (EHS). August 2022. https://phiremedical.org/wp-content/uploads/2022/10/phire-2022-press-release-hm-courts-and-tribunals-service-ehcp-for-uk-child-with-ehs.pdf.
215. *McDonald and Comcare*.(Administrative Appeals Tribunal of Australia 2013). http://www8.austlii.edu.au/cgi-bin/viewdoc/au/cases/cth/aat/2013/105.html. Accessed January 26, 2023.
216. Wilkie C., Baker D.. Accommodation for environmental sensitivities: legal perspective.
217. Sears M.E., Eng M.. The medical perspective on environmental sensitivities. 2007.
218. Canadian Human Rights Commission. Policy on Environmental Sensitivities. In:; 2019. https://www.chrc-ccdp.gc.ca/en/resources/publications/policy-environmental-sensitivities. Accessed January 26, 2023.
219. Kostoff RN, Lau CGY. Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature. In: Geddes CD, ed. *Microwave Effects on DNA and Proteins*, Cham: Springer International Publishing, 2017. pp. 97–157. https://doi.org/10.1007/978-3-319-50289-2_4.
220. Sueiro-Benavides RA, Leiro-Vidal JM, Salas-Sánchez AÁ, Rodríguez-González JA, Ares-Pena FJ, López-Martín ME. Radiofrequency at 2.45 GHz increases toxicity, pro-inflammatory and pre-apoptotic activity caused by black carbon in the RAW 264.7 macrophage cell line. *Sci Total Environ* 2021;765:142681. https://doi.org/10.1016/j.scitotenv.2020.142681.
221. Ledoigt G, Sta C, Goujon E, Souguir D, Ferjani EE. Synergistic health effects between chemical pollutants and electromagnetic fields. *Rev Environ Health* 2015;30(4):305–9. https://doi.org/10.1515/reveh-2015-0028.
222. Leszczynski D, Joenväärä S, Reivinen J, Kuokka R. Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related

effects. *Differentiation* 2002;70(2):120–9. https://doi.org/10.1046/j.1432-0436.2002.700207.x.
223. Salford LG, Brun AE, Eberhardt JL, Malmgren L, Persson BRR. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Perspect* 2003;111(7):881–3. https://doi.org/10.1289/ehp.6039.
224. Sirav B, Seyhan N. Effects of radiofrequency radiation exposure on blood-brain barrier permeability in male and female rats. *Electromagn Biol Med* 2011;30(4):253–60. https://doi.org/10.3109/15368378.2011.600167.
225. Sırav B, Seyhan N. Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood−brain barrier in male & female rats. *J Chem Neuroanat* 2016;75:123–7. https://doi.org/10.1016/j.jchemneu.2015.12.010.
226. Byun YH, Ha M, Kwon HJ, et al. Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study. *PLOS ONE* 2013;8(3):e59742. https://doi.org/10.1371/journal.pone.0059742.
227. Choi KH, Ha M, Ha EH, et al. Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure. *Environ Res* 2017;156:810–7. https://doi.org/10.1016/j.envres.2017.04.029.
228. Braun KVN, Christensen D, Doernberg N, et al. Trends in the prevalence of autism spectrum disorder, cerebral palsy, hearing loss, intellectual disability, and vision impairment, metropolitan Atlanta, 1991−2010. *PLOS ONE* 2015;10(4):e0124120. https://doi.org/10.1371/journal.pone.0124120.
229. Dutheil F, Comptour A, Morlon R, et al. Autism spectrum disorder and air pollution: a systematic review and meta-analysis. *Environ Pollut Barking Essex 1987* 2021;278:116856. https://doi.org/10.1016/j.envpol.2021.116856.
230. Ahuja YR, Sharma S, Bahadur B. Autism: an epigenomic side-effect of excessive exposure to electromagnetic fields. *Int J Med Med Sci* 2013;5(4):171–7. https://doi.org/10.5897/IJMMS12.135.
231. Thornton IM. Out of time: a possible link between mirror neurons, autism and electromagnetic radiation. *Med Hypotheses* 2006;67(2):378–82. https://doi.org/10.1016/j.mehy.2006.01.032.
232. Herbert MR, Sage C. Autism and EMF? Plausibility of a pathophysiological link − Part I. *Pathophysiology* 2013;20(3):191–209. https://doi.org/10.1016/j.pathophys.2013.08.001.
233. Herbert MR, Sage C. Autism and EMF? Plausibility of a pathophysiological link part II. *Pathophysiology* 2013;20(3):211–34. https://doi.org/10.1016/j.pathophys.2013.08.002.
234. National Council on Radiation Protection and Measurements. Report No. 086 − Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields (1986). Bethesda, MD: NCRP; 1986.| https://ncrponline.org/shop/reports/report-no-086-biological-effects-and-exposure-criteria-for-radiofrequency-electromagnetic-fields-1986/. Accessed January 26, 2023.
235. Institute of Electrical and Electronics Engineers. Section 1.1310 - Radiofrequency radiation exposure limits. *Code Fed Regul* 2011;1 https://www.govinfo.gov/content/pkg/CFR-2011-title47-vol1/xml/CFR-2011-title47-vol1-sec1-1310.xml. Accessed February 1, 2023.
236. National Institute for Public Health and the Environment (RIVM). Comparison of International Policies on Electromagnetic Fields. 201820.
237. Parliamentary Assembly. The Potential Dangers of Electromagnetic Fields and Their Effect on the Environment. https://assembly.coe.int/nw/xml/XRef/Xref-XML2HTML-en.asp?fileid=17994&Accessed January 26, 2023.
238. Redmayne M. International policy and advisory response regarding children's exposure to radio frequency electromagnetic fields (RF-EMF). *Electromagn Biol Med* 2016;35(2):176–85. https://doi.org/10.3109/15368378.2015.1038832.
239. Sivani S, Sudarsanam D. Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on biosystem and ecosystem − a review. *Biol Med* 2012.
240. Ministry of Environment and Forest, Government of India. *Report on Possible Impacts of Communication Towers on Wildlife Including Birds and Bees*.; 2010. https://www.ee.iitb.ac.in/∼mwave/Report%20on%20Possible%20Impacts%20of%20Communication%20Towers.pdf.
241. Hennies K, Neitzke HP, Voigt H. Mobile Telecommunications and Health Review of the Current Scientific Research in View Of Precautionary Health Protection. ECOLOG-Institut; April 2000. p. 86 https://ehtrust.org/wp-content/uploads/T-mobile-RF-Radiation-Ecolog-2000-Report-.pdf.
242. Belyaev I. Dependence of non-thermal biological effects of microwaves on physical and biological variables: Implications for reproducibility and safety standards. *Eur J Oncol Libr* 2010;5:187–218.
243. Mohammed B, Jin J, Abbosh AM, Bialkowski KS, Manoufali M, Crozier S. Evaluation of children's exposure to electromagnetic fields of mobile phones using age-specific head models with age-dependent dielectric properties. *IEEE Access* 2017;5:27345–53. https://doi.org/10.1109/ACCESS.2017.2767074.
244. Beard BB, Kainz W, Onishi T, et al. Comparisons of computed mobile phone induced SAR in the SAM phantom to that in anatomically correct models of the human head. *IEEE Trans Electromagn Compat* 2006;48(2):397–407. https://doi.org/10.1109/TEMC.2006.873870.
245. McInerny T.K.. Letter from President of the American Academy of Pediatrics, Thomas K. McInerny, MD, FAAP to the Honorable Dennis Kucinich, Representative. December 2012. https://ehtrust.org/wp-content/uploads/2015/12/aap_-support_letter_cell_phone_right_to_know_act.pdf.
246. Cell Phone Right to Know Act (2012 - H.R. 6358). GovTrack.us. https://www.govtrack.us/congress/bills/112/hr6358. Accessed January 27, 2023.
247. Environmental Health Trust | Information About Cell Phone, Wi-Fi, 5G, and Bluetooth Radiation Science Facts on Health Effects. Environmental Health Trust. https://ehtrust.org/. Accessed January 27, 2023.
248. Common Position on 5G Deployment of the Cyprus Medical Association and the Cyprus National Committee of Environment and Children's Health (19/09/2019) | Paidi.com.cy.

https://paidi.com.cy/common-position-on-5g-deployment-of-the-cyprus-medical-association-and-the-cyprus-national-committee-of-environment-and-childrens-health/?lang=en. Accessed January 10, 2023.
249. Steiner E, Aufdereggen B, Semadeni C. Vorsorgeprinzip beim Mobilfunk konsequent anwenden. *Schweiz Ärztezt* 2020;101 (46):1534–6. https://doi.org/10.4414/saez.2020.19274.
250. Inquinamento radioattivo. *ISDE Ital*. https://www.isde.it/cosa-facciamo/aree-tematiche/inquinamento/inquinamento-radioattivo/. Accessed January 10, 2023.
251. Gravalos T.. Η *ανάγκη να ληφθούν μέτρα, για την προστασία από την ηλεκτρομαγνητική ακτινοβολία, τονίστηκε στο πλαίσιο ημερίδας που διοργάνωσε* ο ΙΣΑ, *υπό την αιγίδα της* ΚΕΔΕ. Ιατρικός Σύλλογος Αθηνών. https://www.isathens.gr/syndikal/6743-imerida-ilektromagnitiki-aktinovolia.html. Published April 2, 2017. Accessed January 27, 2023.
252. American Academy of Pediatrics. Cell Phone Radiation & Children's Health: What Parents Need to Know. HealthyChildren.org. https://www.healthychildren.org/English/safety-prevention/all-around/Pages/Cell-Phone-Radiation-Childrens-Health.aspx. Accessed January 10, 2023.
253. California Department of Public Health, Division of Environmental and Occupational Disease Control. How to Reduce Exposure to Radiofrequency Energy from Cell Phones. https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CDPH%20Document%20Library/Cell-Phone-Guidance.pdf.
254. Wall S, Wang ZM, Kendig T, Dobraca D, Lipsett M. Real-world cell phone radiofrequency electromagnetic field exposures. *Environ Res* 2019;171:581–92. https://doi.org/10.1016/j.envres.2018.09.015.
255. Children's Environmental Health and Protection Advisory Council. Maryland.gov Guidelines to Reduce Electromagnetic Field Radiation. https://health.maryland.gov/phpa/OEHFP/EH/Shared%20Documents/CEHPAC/CEHPAC_EMF%20Guidelines%20to%20Reduce%20Exposure_12.20.2022.pdf. Accessed January 10, 2023.
256. Madjar HM. Human radio frequency exposure limits: An update of reference levels in Europe, USA, Canada, China, Japan and Korea. In: *2016 International Symposium on Electromagnetic Compatibility - EMC EUROPE*; 2016. p. 467–73. https://doi.org/10.1109/EMCEurope.2016.7739164.
257. ANFR. Wave Observatory. https://www.anfr.fr/maitriser/information-du-public/observatoire-des-ondes. Accessed January 27, 2023.
258. Silva A. New communications antenna law in Chile. *Commun Law Newsl Int Bar Assoc Leg Pract Div* 2013;20(1) https://www.carey.cl/download/newsalert/Communications%20Law%20(April%202013).pdf.
259. Local cell tower laws that protect communities. *Environ Health Trust* November 2022: https://ehtrust.org/local-cell-tower-laws-that-protect-communities/Accessed January 27, 2023.
260. Database of Worldwide Policies on Cell Phones, Wireless and Health. Environ Health Trust. https://ehtrust.org/policy/international-policy-actions-on-wireless/. Accessed January 27, 2023.
261. Sharma A. Rajasthan HC Orders Relocation of Mobile Towers from Schools, Hospitals. The Economic Times; 2012 https://economictimes.indiatimes.com/industry/telecom/rajasthan-hc-orders-relocation-of-mobile-towers-from-schools-hospitals/articleshow/17397645.cms?intenttarget=noPublished November 28Accessed January 10, 2023.
262. Linhares A., da Silva M.. *INTERNATIONAL EMF PROJECT ADVISORY COMMITTEE (IAC) MEETING Anatel Report on EMF Activities in Brazil*. Brazil; 2018:2. https://cdn.who.int/media/docs/default-source/radiation/radiation/emf-international-project-country-reports/amro-region/brazil_2019.pdf?sfvrsn=2b0e7f97_5&download=true.
263. National Telecommunications Agency Brazil. Electromagnetic Field Exposure Map. Anatel Gov Brazil. https://informacoes.anatel.gov.br/paineis/espectro-e-orbita/mapa-de-exposicao-a-campos-eletromagneticos. Accessed January 27, 2023.
264. Observatory. https://paratiritirioemf.eeae.gr/en/?rCH=2. Accessed January 10, 2023.
265. U.S. Environmental Protection Agency, Hankin NN. Radiofrequency Radiation Environment Environmental Exposure Levels And Rf Radiation Emitting Sources. July 1986 https://nepis.epa.gov/Exe/ZyNET.exe/2000ECTQ.txt?ZyActionD=ZyDocument&Client=EPA&Index=1981%20Thru%201985&Docs=&Query= &Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField =&IntQFieldOp=0& ExtQFieldOp=0&XmlQuery=&File=D%3A% 5CZYFILES%5CINDEX %20DATA%5C 81THRU85%5CTXT %5C00000003 %5C2000ECTQ.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page &MaximumPages=1&ZyEntry=1.
266. Hardell L, Carlberg M, Hedendahl LK. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: a case report. *Oncol Lett* 2018;15(5):7871–83. https://doi.org/10.3892/ol.2018.8285.
267. Koppel T, Ahonen M, Carlberg M, Hardell L. Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. *Environ Res* 2022;208:112627. https://doi.org/10.1016/j.envres.2021.112627.
268. *Order of 15 November 2019 relating to the display of the specific absorption rate of radio equipment and consumer information*. Vol NOR: SSAP1834792A.; 2019. https://www.legifrance.gouv.fr/loda/id/JORFTEXT000039385174#JORFARTI000039385179. Accessed November 16, 2022.
269. *Order of 15 November 2019 Relating to the Display of the Specific Absorption Rate of Radio Equipment and Consumer Information*.
270. ANFR. SAR Regulation Guide on 1st July 2020. 2020. https://www.anfr.fr/fileadmin/mediatheque/documents/expace/2020-guide-R%C3%A9glementation-DAS-EN.pdf.
271. Directorate of Legal and Administrative Information (Prime Minister). Ondes électromagnétiques : plus de vigilance sur

l'information aux consommateurs. *Electromagn Waves More Vigil Consum Inf* November 2022: https://www.service-public.fr/particuliers/actualites/A16183Accessed January 27, 2023.
272. Bolksgezondheid F.O., Van De Voedselketen En Leefmilieu V.. New rules for selling mobile phones Practical guide for sellers and distributors. https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/19096044/Guide%20mobile%20phone%20v5.pdf.
273. Lukovnikova DrM. Implementation of the council recommendations in Belgium introduction of new rules for mobile phone sales. In: *Presented at the: Workshop on Electromagnetic Fields and Health Effects: from Science to Policy and Public Awareness*, Athens, Greece; 2014.March 28 https://ec.europa.eu/health/scientific_committees/emerging/docs/ev_20140328_co06_en.pdf.
274. ANFR-The results of SAR measurements. https://www.anfr.fr/maitriser/equipements-radioelectriques/le-debit-dabsorption-specifique-das/les-resultats-des-mesures-de-das. Accessed January 27, 2023.
275. *Adopted Text N° 468 "Little Law."* https://www.assemblee-nationale.fr/14/ta/ta0468.asp. Accessed January 26, 2023.
276. Parliamentary Assembly. PACE website. https://assembly.coe.int/nw/xml/XRef/Xref-XML2HTML-en.asp?fileid=17994&. Accessed January 10, 2023.
277. Friday SEHTP, March 03, Permalink 2017 at 11:43 AM CST-. First State in the Nation: Maryland State Advisory Council Recommends Reducing School Wireless to Protect Children. SBWire. http://www.sbwire.com/press-releases/first-state-in-the-nation-maryland-state-advisory-council-recommends-reducing-school-wireless-to-protect-children-777904.htm. Published March 3, 2017. Accessed January 10, 2023.
278. Clegg FM, Sears M, Friesen M, et al. Building science and radiofrequency radiation: what makes smart and healthy buildings. *Build Environ* 2020;176:106324. https://doi.org/10.1016/j.buildenv.2019.106324.
279. Collaborative for High Performance Schools. 2014 US-CHPS Criteria New Construction and Renovation Low-EMF Best Practices. 2014. https://ehtrust.org/wp-content/uploads/2015/12/US-CHPS_Criteria_2014_Low-EMF-Criteria102314.pdf.
280. Bellieni CV, Nardi V, Buonocore G, Di Fabio S, Pinto I, Verrotti A. Electromagnetic fields in neonatal incubators: the reasons for an alert. *J Matern Fetal Neonatal Med* 2017;32(4):695–9. https://doi.org/10.1080/14767058.2017.1390559.
281. Passi R, Doheny KK, Gordin Y, Hinssen H, Palmer C. Electrical grounding improves vagal tone in preterm infants. *Neonatology* 2017;112(2):187–92. https://doi.org/10.1159/000475744.
282. Calvente I, Vázquez-Pérez A, Fernández MF, Núñez MI, Múñoz-Hoyos A. Radiofrequency exposure in the neonatal medium care unit. *Environ Res* 2017;152:66–72. https://doi.org/10.1016/j.envres.2016.09.019.
283. Sadetzki S, Ghelberg S, Kandel, S. *National Activity Report – ISRAEL 2016*. Israel; 2016:4. https://cdn.who.int/media/docs/default-source/radiation/emf-international-project-country-reports/euro-region/israel-2017.pdf?sfvrsn=27e550b4_3.
284. Campaign at Archbishop Makarios Hospital 2019 – EMF/RF | Paidi.com.cy. https://paidi.com.cy/campaign-at-archbishop-makarios-hospital-2019-emf-rf/?lang=en. Accessed January 10, 2023.
285. Environmental Medicine Matters » Hamburg hospital offers rooms for patients with MCS and environmental illness. http://www.csn-deutschland.de/blog/en/hamburg-hospital-offers-rooms-for-patients-with-mcs-and-environmental-illness/. Accessed February 1, 2023.
286. Levitt BB, Lai HC, Manville AM. Low-level EMF effects on wildlife and plants: what research tells us about an ecosystem approach. *Front Public Health* 2022;10 https://www.frontiersin.org/articles/10.3389/fpubh.2022.1000840. Accessed December 9, 2022.

Supplemental Materials For Wireless Technologies, Non-ionizing Electromagnetic Fields and Children: Reducing Health Risks

I. Recommendations to reduce RF radiation
   1. Medical Organizations
   2. Public Health Organizations and Entities
   3. Schools and Buildings
   4. New Hampshire State Report on 5G Health and Environment
   5. Scientific Appeals

II. Examples of Fine Print Warnings

III. Resources on Reducing Exposure To Share

Recommendations to reduce RF radiation

1. Medical Organizations

American Academy of Pediatrics (AAP)
AAP Cell phone safety tips for families (2016) ● Prefer texting to voice calls ● Use cell phones in speaker mode or hands-free to distance the cell phone away from the head. ● Make only short or essential calls on cell phones. ● Avoid carrying your phone against the body like in a pocket, sock, or bra. ● Do not talk on the phone or text while driving. ● If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure. ● Minimize use in areas of low signal (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off. ● Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases. ● Remember that cell phones are not toys or teething items.
American Academy of Pediatrics Letters ● AAP Letter to the FCC Chairman calling for the FCC to open up a review of RF guidelines (7/12/2012) ● AAP Letter to US Representative Dennis Kucinich in Support of the Cell Phone Right to Know Act 12/12/2012 ● AAP to FCC Commissioner Mignon Clyburn and FDA Commissioner Margaret Hamburg calling for a review of RF guidelines 8/29/2013

Santa Clara California Medical Association
Santa Clara California Medical Association Bulletin Articles on EMF • Wireless Silent Spring • Wi-Fi in School: Are We Playing it Safe With Our Kids • Shallow Minds: How the Internet and Wi–Fi in Schools Can Affect Learning • A 5G Wireless Future: Will it Give Us a Smart Future • Autism Rising Environmental Factors Part 1. • Autism Rising Environmental Factors Part 2 • Saving Your Landline May Save Your Life • What's the Diagnosis Doctor? Electromagnetic Sensitivity
California Medical Association
In 2014, the California Medical Association passed two resolutions regarding wireless standards: 1. To "support efforts to reevaluate microwave safety exposure levels associated with wireless communication devices, including consideration of adverse non-thermal biologic and health effects from non-ionizing electromagnetic radiation used in wireless communications"; and 2. To "support efforts to implement new safety exposure limits for wireless devices to levels that do not cause human or environmental harm based on scientific research."
Massachusetts Medical Association
In 2021, the Massachusetts Medical Association passed a policy statement in support of "continuing research, including quality epidemiologic studies, by appropriate agencies and entities to produce evidence-based data on the effect(s) of radio frequency radiation on human health. If indicated, study findings should be used to revise and update public health standards for safe limits of human exposure to radio frequency radiation."
Austrian Medical Chamber, Cyprus Committee on Environment and Children's Health
The 16 Practical Rules to Reduce Cell Phone and Wireless Radiation
Athens Medical Association
16 Recommendations to reduce human exposure to wireless radiation (2017)

TIPS TO REDUCE YOUR WIRELESS RADIATION EXPOSURE

WHERE & WHEN

Keep a distance. Avoid holding your cell phone or cordless phone near your head or body during phone calls. Don't carry your cell phone in your pocket, in your bra, or close to your body when it is powered on. Especially keep the phone away from your head and reproductive organs. Use speakerphone, text, or wired headset. Avoid talking longer than necessary.

Wait for a good signal. When the signal is poor, your wireless devices emit more radiation so avoid use when surrounded by metal such as in an elevator, or while travelling in automobiles, buses, trains or aircraft.

Reduce secondhand exposure. Reduce the time you spend in locations where many people are using cell phones in close proximity to each another, especially on public transit.

Turn off wireless devices at bedtime. Turn off your cell phone, Wi-Fi router, and other wireless devices at bedtime and at other times when not in use.

WHO & HOW

Minimize children's use & exposure to wireless radiation. Children's health risks are greater so limit their use of cell phones and other wireless devices. Turn off Wi-Fi and cellular on devices used by kids. Teach children to use wireless technology safely.

Pregnancy & fertility. If you are pregnant or planning for a baby be especially careful as wireless radiation exposure is linked to reproductive health effects and also to sperm damage. Do not use a wireless tablet or laptop in your lap.

Use airplane mode. Turn off cell phones and other wireless devices when not in use or switch to Airplane Mode. Turn off Wi-Fi and Bluetooth when not in use.

Use wired connections. Use a wired, land line phone whenever possible. Forward cell phone calls to your land line and check on them when you get home. Use wired Internet connections.

TAKE ACTION

Electromagnetic hypersensitivity. If you think you are developing allergic symptoms from wireless radiation exposure, keep a log of your exposures and your symptoms. Then reduce your exposures for two weeks, and see if your symptoms are reduced. Discuss the results with your healthcare provider.

Governmental action is essential. Send the *International EMF Scientist Appeal* (**EMFscientist.org**) to your elected representatives. Ask them to adopt policies to make wireless technology safer. Encourage them to fund education and research through a modest fee on mobile device subscriptions (e.g. a nickel a month). Work with others to get schools to remove Wi-Fi and provide students with Internet access via wired networks.

Joel M. Moskowitz, Ph.D., Director
Center for Family and Community Health
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety
Website: http://www.saferemr.com
Facebook: http://www.facebook.com/SaferEMR
News Releases: http://pressroom.prlog.org/jmm716/
Twitter: @berkeleyprc



Maryland Children's Environmental Health and Protection Advisory Council

Guidelines to Reduce Electromagnetic Field Radiation

December 2022

Introduction

The Maryland Children's Environmental Health and Protection Advisory Council (CEHPAC) identifies environmental health issues that impact children and seeks to protect them from exposure to environmental hazards. Under Md. Code Ann., Health-General §13–1506, CEHPAC is directed to:
(4) Gather and disseminate information to the public, including the research and medical communities, community–based organizations, schools, and State agencies, on how to reduce, treat, and eliminate children's exposures to environmental hazards to further the public's understanding of the environmental hazards that may potentially affect children; and

(5) Recommend uniform guidelines for State agencies to follow to help reduce and eliminate children's exposure to environmental hazards, especially in areas reasonably accessible to children…

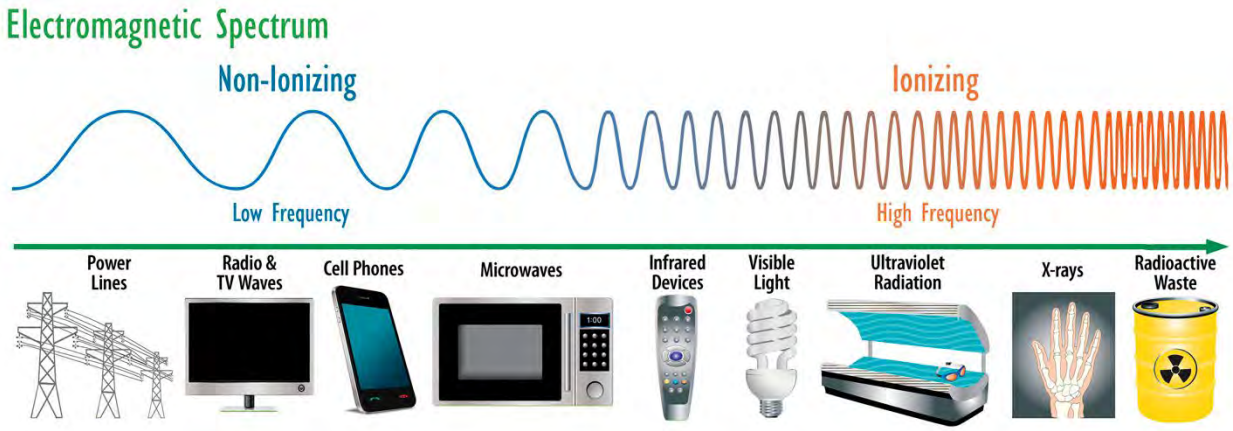


Figure 1. Source: National Institute of Environmental Health Sciences

In 2016, CEHPAC adopted a report on WiFi Radiation in Schools in Maryland to examine questions related to potential health outcomes linked to exposures associated with WiFi technology. This report expands on that work by compiling information on how families can reduce their daily exposure to non-ionizing electromagnetic fields. If you are interested in a more detailed analysis and policy recommendations please see the 2016 WiFi Radiation in Schools in Maryland Final Report.

What are electromagnetic fields?

"Electromagnetic fields are a combination of invisible electric and magnetic fields of force. They are generated by natural phenomena like the Earth's magnetic field but also by human activities, mainly through the use of electricity. Mobile phones, power lines and computer screens are examples of equipment that generates electromagnetic fields." - European Commission's Directorate General for Health & Food Safety

How do wireless devices work?

Cell phones and wireless devices use a type of non-ionizing electromagnetic field called radiofrequency radiation to transmit information.

"Radiofrequency (RF) energy is a type of electromagnetic radiation. It is used to transmit signals carrying information in the form of radio waves. Radio waves are broadcast using a transmitter. When the radio waves reach a receiver, the signal is converted back into the information that was originally sent by the transmitter. When you talk on a cell phone, your cell phone acts as a transmitter and your voice is carried on radio waves to the person you are calling. Their phone acts as the receiver and converts the signal back into your voice. In addition to cell phones, other wireless devices such as radios, Wifi routers, satellites, radars and pacemakers can send or receive RF energy waves." - US EPA's RadTown

Are there health concerns about exposure to RF energy from cell phones and wireless technologies?

For a more detailed analysis, please see the 2016 WiFi Radiation in Schools in Maryland Final Report, which examined the current evidence linking radiofrequency radiation to health outcomes, including cancer. While the science is still evolving, there are broad concerns about exposure to RF radiation.

According to the California Department of Public Health, "…some laboratory experiments and human health studies have suggested the possibility that long-term, high use of cell phones may be linked to certain types of cancer and other health effects, including:

- brain cancer and tumors of the acoustic nerve (needed for hearing and maintaining balance) and salivary glands,
- lower sperm counts and inactive or less mobile sperm,
- headaches, and
- effects on learning and memory, hearing, behavior, and sleep"

There are no definitive studies establishing a causal link in humans, and scientists disagree about whether cell phones cause these health problems and how great the risks might be.

Children may be at greater risk than adults from exposure to RF energy. Their bodies and brains are still developing and are more vulnerable to exposures that could cause harm. Because their skulls are thinner and their heads are smaller than those of adults, children have a relatively greater risk of exposure to the RF energy of cell phones. Children also will accumulate many more years of cell phone and wireless exposure than adults. Animal research has also shown the potential for health effects of RF radiation to a developing fetus.

In 2011, the International Agency for Research on Cancer (IARC) classified wireless radiofrequency radiation as a Class 2B possible carcinogen based on research that found long term cell phone use associated with a form of brain cancer.

The 2016 WiFi Radiation in Schools in Maryland Final Report recommended "…limiting exposures as much as feasibly practical, without negatively impacting education." The Department of Connecticut Department of Health takes this a step further and states, "It is wise to reduce children's exposure."

Sources of Children's Exposure to Wireless Radiofrequency Radiation

Common sources of radiofrequency radiation exposure to children include:

- Cell phones
- Cordless phones and their base station
- Tablets, laptops, and computers
- WiFi routers and hotspots
- Wireless video game consoles/handsets
- Wireless Baby monitors
- Signal boosters
- Wireless headphones, printers, speakers, keyboard, mouse
- Wearable wireless tech including "smart" watches and fitness wristbands
- Wireless "smart" appliances
- Wireless utility meters
- WiFi or Bluetooth toys

The Basics of Reducing RF Exposure

Increase Your Distance

The closer you are to a cell phone or wireless device, the higher the exposure to your brain and body. The further away you are, the lower the radiation your body absorbs. Notice how close children are to you when you are using a cell phone or wireless device, and minimize their exposure. For example, do not rest a cell phone on your baby or hold a transmitting device near their bodies.

Minimize Time on Wireless

A child's daily exposure adds up over time. Every time you reduce your child's exposure, even in small ways, you can decrease the overall cumulative exposure to mitigate risk.

Choose Safer Technology Solutions

As consumers, parents and caregivers have safer options when it comes to connecting to the internet or choosing which electronics to purchase. Once you are aware of this issue, you can make low RF radiation choices and choose corded connections whenever possible. Take a look at what you have in your home and swap wireless devices with corded connections if possible. For example, use a corded keyboard or earbuds with a wire.

Recommendations to Reduce Cell Phone and Wireless Device Radiation Exposure

Cell phones, wireless devices, and WiFi routers emit RF radiation all the time, even when you are not using them. Even in standby mode, your phone emits RF radiation because it is constantly searching for service or new messages. If you do not need your cell phone, simply turn it off or put it in airplane mode. This applies to all other wireless devices, including laptops, tablets, video gaming consoles and smart speakers. Additional recommendations are provided below as general guidelines.

Around the Home[1]

- Replace cordless phones with corded home phones.
- Unplug cordless phones when not in use (if you have at least one corded telephone in the house, you can always be reached, even if the cordless phone is off at night).
- Remove electronics from the bedroom and especially around your bed and the crib.
- Avoid sleeping with electric blankets and heating pads; if you use an electric blanket to preheat your bed, unplug it before sleeping. If you only turn it off, the electromagnetic field will still be present.
- Do not stand close to a microwave oven when it is on or let your child press their face up to it watching the food cook.

Cell Phones

- Try to keep devices, especially cell phones, away from the head and body. Keeping them an arm's distance away significantly reduces exposure.[2]
- When you are talking on a cell phone, use the speakerphone to reduce exposure to your head.[2]
- Avoid carrying your phone against the body like in a pocket, sock, bra, or spandex pants. Cell phone manufacturers cannot guarantee that the amount of radiation you are absorbing will be at a safe level.[2]
- Make only short or essential calls on cell phones so that you minimize your daily exposure.[2]
- Use text messaging rather than voice calls when possible.[2]

Laptops and Computers

- Choose wired Internet (ethernet cable modems) at home instead of wireless systems, if possible.[3]
- Place WiFi routers as far away from children as possible.[3]
- Consider using a switch to shut down your wireless router when it is not in use.[3]

[1] These recommendations are based on a Fact Sheet by the Collaborative on Health & the Environment.
[2] These recommendations come from the American Academy of Pediatrics (AAP).
[3] Based on the California Department of Health review.

- Instead of laps, place electronic devices, tablets, and laptops on desks and tables which can serve to increase the distance between the device and children's bodies.[3]

Turn Wireless Antennas Off

- Airplane mode is a setting that turns transmitting antennas off in wireless devices.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch to avoid unnecessary radiation exposure.[2]
- Teach children to turn off WiFi when not in use, especially if they are sleeping (also see bedroom suggestions below).[3]
- Newer phone models turn most of the wireless antennas off with Airplane mode, but Bluetooth or WiFi may stay on, so check that all antennas are set to off such as 4G, 5G, Bluetooth, WiFi hotspot, location.

Learn About When Your Cell Phone Goes to Highest Exposure

Reduce or avoid use of cell phones and wireless technologies when the devices are going to maximum power, which means the device will result in higher radiation exposures.[2,3]

- *You are in an area of low signal:* Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it emits. It is better to wait until you have a stronger signal before using your device.
- *You are traveling in a car or vehicle:* Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases. When vehicles are traveling, the device also increase power to switch connection to each cell tower the vehicle passes.
- *You are streaming video and large files:* The more streaming data, the higher the radiation exposure.

Helpful Tips

- If your tablet or laptop does not have an ethernet port you can get a special adapter that allows you use ethernet with thunderbolt or USB ports.
- Many cell phones can also be plugged into ethernet port with an adapter made for cell phones.
- Use wired peripherals and accessories (e.g. a wired mouse, wired speakers, and wired printers) rather than wireless.
- Wireless virtual assistants emit RF so choose wired tech whenever possible.
- Wireless gaming consoles emit RF even when not in use so keep these out of the bedroom and choose wired handsets.

In the Bedroom

- Cell phones should be powered off at night.[2]

- If your child or teen needs an alarm clock, get a battery powered alarm clock for the bedroom.[2]
- If they must use a cell phone for an alarm clock, teach them to turn the phone to airplane mode with wireless antennas off every night (the alarm will still work).[2]
- Do not charge a cell phone or wireless devices near your child's bed. Charging creates higher electromagnetic fields even if you are not using the device.
- Children should not sleep with their head near a wall that has the electric panel, electric meter, or appliance on the other side.

Read the Fine Print

Read the "fine print" from the manufacturer's instruction manual which may tell users to keep a distance between the phone and your head and body. These fine print warnings range from a few millimeters to almost an inch. The fine print warnings on other wireless devices such as WiFi routers, home cordless phone base stations, and baby monitors generally state devices should be at 20 cm, or about 8 inches. If people are closer than the manufacturer-stated separation distance, then they can be exposed to RF levels that violate the US government FCC limits for this type of radiation.

Beware Radiation Protection Devices

Do not rely on a "radiation shield" or other products claiming to block RF energy, electromagnetic fields, or radiation from cell phones. According to the U.S. Federal Trade Commission, products that interfere with the phone's signal may force it to work harder and emit more RF energy to stay connected, possibly increasing your exposure. There are no standard protocols for testing and comparing devices to ensure they work. It is best to use wired corded electronics to reduce RF radiation rather than rely on an untested product.[3]

If You are Pregnant

Findings on prenatal impacts have led doctors to sign onto an EPA-recognized educational campaign called The BabySafe Project*urging pregnant women to reduce wireless exposure to minimize risks to their babies' brain development. They recommend many of the same things listed above, including:

- Keep your cell phone away from your body. Never carry it in a pocket or bra.
- Do not sleep with your phone. Switch your phone to airplane mode whenever you are not using it.
- Keep your wireless laptop or tablet away from your body. Never rest your wireless device on your tummy.
- Use a corded landline if at all possible, rather your cell phone or cordless phone.
- Don't sit anywhere close to your router or smart meter. Turn off routers at night.
- Whenever possible, connect to the internet using wired (ethernet) connections.

*The BabySafe Project is a joint initiative of Environmental Health Trust and Grassroots Environmental Education.

Scientific Appeals

Scientists have organized numerous appeals highlighting the existence of non thermal biological effects and the need for new policies to reduce exposure.

The International Scientists Appeal to U.N. to Protect Humans and Wildlife from Electromagnetic Fields and Wireless Technology" was started in 2015. As of November 2022, 257 scientists from 44 nations and 15 supporting scientists from 11 nations have signed this appeal requesting: which has nine collective requests:

1. Children and pregnant women be protected;
2. Guidelines and regulatory standards be strengthened;
3. Manufacturers be encouraged to develop safer technology;
4. Utilities responsible for the generation, transmission, distribution, and monitoring of electricity maintain adequate power quality and ensure proper electrical wiring to minimize harmful ground current;
5. The public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies;
6. Medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity;
7. Governments fund training and research on electromagnetic fields and health that is independent of industry and mandate industry cooperation with researchers;
8. Media disclose experts' financial relationships with industry when citing their opinions regarding health and safety aspects of EMF-emitting technologies; and
9. Safe zones (radiation-free areas) be established.

There have been many appeals over the years such as the Reykjavik Iceland Appeal on Wireless in School (2017), the Scientist 5G Appeal to the EU(2017) , the Nicosia Declaration (2017), the International Society of Doctors for Environment 5G Appeal (2018) and the 2020 Consensus Statement of UK and International Medical and Scientific Experts and Practitioners on Health Effects of Non-Ionising Radiation.

How to Reduce Exposure to Radiofrequency Energy from Cell Phones



The use of cell phones has increased dramatically in recent years, including among children and young adults. These phones put out radio frequency (RF) energy.

Some scientists and public health officials believe RF energy may affect human health. This guidance document describes RF energy, lists some of the potential health concerns, and provides guidance on how people can reduce their exposure.

Why are people concerned about exposure to RF energy from cell phones?

Although the science is still evolving, some laboratory experiments and human health studies have suggested the possibility that long-term, high use of cell phones may be linked to certain types of cancer and other health effects, including:

- brain cancer and tumors of the acoustic nerve (needed for hearing and maintaining balance) and salivary glands
- lower sperm counts and inactive or less mobile sperm
- headaches and effects on learning and memory, hearing, behavior, and sleep

These studies do not establish the link definitely, however, and scientists disagree about whether cell phones cause these health problems and how great the risks might be. This document is intended to provide guidance for those people who want to reduce their own and their families' exposures to RF energy from cell phones, despite this uncertainty.

What is RF energy?

Cell phones work by sending and receiving signals to and from cell phone towers. These signals are a form of electromagnetic radiation called radiofrequency (RF) energy. Other sources of RF energy include cell phone towers, TV and radio transmitters, smart meters, and microwave ovens. When a phone sends signals to a tower, the RF energy goes from the phone's antenna out in all directions, including into the head and body of the person using the phone. Cell phones also emit RF energy when using Wi-Fi and/or Bluetooth, but at lower levels.

RF energy is not as powerful or as damaging to cells or DNA as some other kinds of electromagnetic radiation, such as X-rays or UV rays from the sun. Some scientific studies have, however, suggested that there may be increased health risks from exposure to RF energy.

How can you reduce your exposure?

Keep your phone away from your body. Keeping your phone just a few feet away from you can make a big difference.

- ***When you talk on your cell phone, avoid holding it to your head—use the speakerphone or a headset instead.*** Wireless (Bluetooth) and wired headsets emit much less RF energy than cell phones.
- ***Send text messages instead of talking on the phone.***
- ***If you are streaming or if you are downloading or sending large files, try to keep the phone away from your head and body.***
- ***Carry your cell phone in a backpack, briefcase, or purse; NOT in a pocket, bra or belt holster.*** Because your phone's antenna tries to stay connected with a cell tower whenever it's on, it emits some RF energy even when you are not using it. It does not emit RF energy when it's in airplane mode. (Airplane mode turns off cellular, Wi-Fi, and Bluetooth.)

Reduce or avoid using your cell phone when it is sending out high levels of RF energy. This happens mainly when:

- ***You see only one or two bars displayed.*** Cell phones put out more RF energy to connect with cell towers when the signal is weak. If you must use your phone when the signal is weak, try to follow the other guidance on this page.
- ***You are in a fast-moving car, bus, or train.*** Your phone puts out more RF energy to maintain connections to avoid dropping calls as it switches connections from one cell tower to the next unless it is in airplane mode.
- ***You are streaming audio or video, or downloading or sending large files.*** To watch movies or listen to playlists on your phone, download them first, then switch to airplane mode while you watch or listen.



What about children?

Children may be more at risk for harm from exposure to RF energy because:

- RF energy can reach a larger area of a child's brain than an adult's brain.
- A child's brain and body grow and develop through the teen years. During this time, the body may be more easily affected by RF energy and the effect may be more harmful and longer lasting.
- A child who uses a cell phone will have many more years of exposure to RF energy in his or her lifetime than someone who started using a cell phone as an adult.

There is not a lot of research about the effects of cell phone RF energy on children or teenagers, but a few studies have shown that there may be hearing loss or ringing in the ears, headaches, and decreased general well-being.

Don't sleep with your phone in your bed or near your head. Unless the phone is off or in airplane mode, keep it at least a few feet away from your bed.

Take off the headset when you're not on a call. Headsets release small amounts of RF energy even when you are not using your phone.

NEW HAMPSHIRE STATE COMMISSION

2020 REPORT: 5G HEALTH AND ENVIRONMENT

In 2020, the New Hampshire State Commission issued a Final Report with 15 recommendations to "to protect people, wildlife, and the environment from harmful levels of radiation" after a year-long investigation with numerous meetings and expert testimony.


State of New Hampshire

MEMORANDUM

"A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured."

Recommendations To Update RF Exposure Regulations With New Science

- A resolution to US Congress to require the FCC to commission an independent health study and review of safety limits.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.

Recommendations To Address Impacts to Wildlife And Environment

- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects, and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.

Recommendations To Reduce Public Exposure

- Require setbacks for new wireless antennas from residences, businesses, and schools.
- Cell phones and wireless devices should be equipped with updated software that stops cell phones from radiating when positioned against the body.
- Establish RF-radiation free zones in commercial and public buildings
- New Hampshire health agencies should educate the public on minimizing RF exposure with public service announcements on radio, television, print.

Recommendations To Utilize Safer Alternatives

- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.

Recommendations To Increase Transparency

- State should measure RFR and post maps with RF measurements..
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer RF measurement education for home inspectors.
- Warning signs posted in commercial and public buildings.

Collaborative for High Performance Schools	Low EMF Best Practices Summary • Evaluate for common wiring errors, correct them and ensure compliance with National and state electrical codes. • Measure magnetic field levels to ensure compliance with 1 mG in new construction and 2 mG in existing. • Ensure devices (tablets laptops) are used on a desk. Operation on the lap or body is prohibited. • Workstation equipment must be at least 2 feet away • Computers and devices are TCO-certified or lab tested to meet TCO Criteria "Mandate A.4.2" for EMF emissions. • Laptops or notebooks must have an Ethernet port and a physical switch to disable all wireless radios at once and an adaptor with a 3-pin plug. • Install and use wired local area network (LAN) for internet access instead of Wi-Fi. • Prohibit use of DECT and cordless phones (2.4 GHz and 5.8 GHz) unless they have been lab tested to demonstrate that they do not emit in standby mode.
Building science and radiofrequency radiation: What makes smart and healthy buildings Clegg et al. 2020	• Consider alternative approaches to wireless technology. Recommendations include: • Neighborhood infrastructure with cable access for high-speed, wired telephone and Internet; • Within buildings use cables, preferably shielded, in Local Area Networks (LAN) to provide wired access points for all networking and data transmission, including wired connections for modems, routers, Internet and media; lighting, heating, ventilation, air conditioning (HVAC), thermostats and humidistats; surveillance and security systems; fire detection and response (e.g., sprinklers); pool equipment such as pump and treatment controls, etc.; • Install easily accessible wired (not cordless) phones and prohibit installation and use of cordless phones; • Throughout the building, provide connections to hardwired CAT6 or CAT7 Ethernet cables, preferably shielded, to service devices such as computers, tablets and other devices. Use wired peripherals and accessories. Ensure that all wireless features are turned off or disabled; • Install wired RJ11 phone jacks for corded and landline telephones; and • Use analog, non-transmitting utility (water, electricity, gas) meter options, that do not transmit data wirelessly.

Examples of Fine Print Warnings for Cell Phones and Wi-Fi Devices

All cell phones and Wi-Fi devices like routers, speakers, and gaming consoles have fine print instructions in their manuals stating that the user should maintain a specified minimum distance between their body and the phone or device in order to ensure compliance with regulatory safety limits.

LG G8

"Body-worn Operation: This device was tested for typical use with the back of the device kept 0.39 inches (1.0 cm) from the body. To comply with FCC RF exposure requirements, a minimum separation distance of 0.39 inches (1.0 cm) must be maintained between the user's body and the back of the device."

Apple iPad IOS4

"To be sure that human exposure to RF energy does not exceed the FCC, IC, and European Union guidelines, always follow these instructions...Orient the device in portrait mode with the Home button at the bottom of the display, or in landscape mode with the cellular antenna away from your body or other objects."

Playstation 4 Pro

"This equipment should be installed and operated with at least 20 cm (8 inches) or more between the radiator and the person's body."

Amazon Echo Dot (4th Generation) Kids Edition

"…it is advised to use the Products in such a manner that minimizes the potential for human contact during normal operation…This Device should be installed and operated with at least 20 cm between the radiator and your body."

OC1A Owlet Baby Monitor Camera

"This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body."

Samsung Galaxy Z Fold 3 5G (2021)

"Body-worn SAR testing has been carried out at a separation distance of 1.5 cm. To meet RF exposure guidelines during body-worn operation, the device should be positioned at least this distance away from the body."

When cellphones are tested in body contact positions, (i.e closer than the instructions recommend), the way most children and teenagers use phones today, some cell phone models have been found to violate allowable levels up to 11 times the U.S. regulatory limits. However, most parents are unaware of these manufacturers' instructions.

Are You Pregnant?

Protect Your Baby from Wireless Radiation!



Recent studies from Yale University show that exposure to wireless radiation can have profound effects on brain development, including symptoms of Attention Deficit/ Hyperactivity Disorder (ADHD).

Now, doctors and researchers around the world are urging pregnant women to take simple steps to limit their exposure to wireless radiation.

For more information, including links to scientific studies and video interviews with medical doctors and public health experts, please visit our web site, **BabySafeProject.org**.

10 Tips for Reducing Your Exposure to Wireless Radiation

1. Avoid carrying your cell phone on your body (e.g. in a pocket or bra).
2. Avoid holding any wireless device against your body when in use.
3. Use your cell phone on speaker setting or with an “air tube” headset.
4. Avoid using your wireless device in cars, trains or elevators.
5. Avoid cordless phones, especially where you sleep.
6. Whenever possible, connect to the internet with wired cables.
7. When using Wi-Fi, connect only to download, then disconnect and disable Wi-Fi.
8. Avoid prolonged or direct exposure to Wi-Fi routers.
9. Unplug your home Wi-Fi router when not in use (e.g. at bedtime).
10. Sleep as far away from wireless utility meters (i.e. “smart” meters) as possible



The BabySafe Project

www.BabySafeProject.org

#KnowYourExposure

What’s Your Exposure? Take the Quiz!

Produced by Grassroots Environmental Education , a non-profit organization, in association with Environmental Health Trust © 2014 Grassroots Enviromental Educaiton, Inc.

Ways to REDUCE Cell Phone Radiation

Here are some examples of recommendations made by the American Academy of Pediatrics, the Vienna Medical Association, and the Cyprus Medical Association.

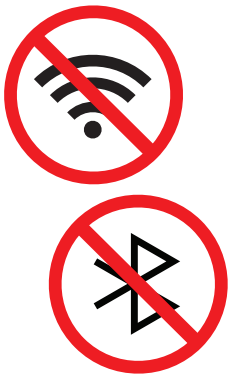


AIRPLANE MODE

Learn how to set your phone to Airplane Mode with antennas OFF. Airplane Mode turns off most of the wireless antennas.

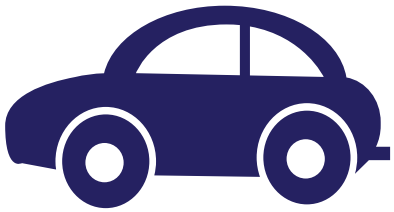
ANTENNAS OFF

Also be sure the Wi-Fi, Bluetooth, and Mobile Data antennas are OFF in the phone settings. Even with antennas off, you still can play music, take photos, and make videos.



AVOID MAKING CALLS IN CARS

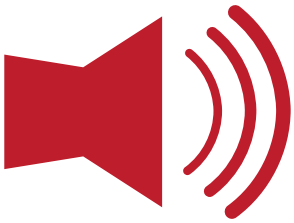
The cell phone works harder to get a signal through metal, so the radiation is stronger.



TEXT INSTEAD OF TALK

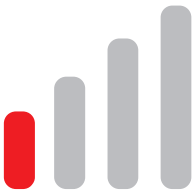
Remember to hold the phone away from your body. Pics and video increase radiation.





SPEAKERPHONE

Keep the phone away from your brain by using speakerphone.



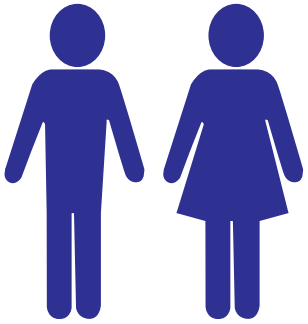
BEWARE THE LOW SIGNAL

The weaker your signal strength, the stronger the radiation from your phone.

DO NOT SLEEP WITH YOUR PHONE

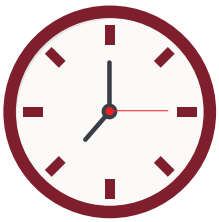
Use a battery-powered alarm clock, and power off the phone.





DISTANCE IS YOUR FRIEND

Phones should not be in your pocket, bra, or touching your body.



REDUCE TIME

Reduce the time you spend on cell phone and wireless overall. Choose safer tech.

Learn more at **www.ehtrust.org**

ENVIRONMENTAL HEALTH TRUST

BE SUPER-SMART
REDUCE WIRELESS

Simple steps to practice safe tech.



TURN IT OFF WHEN NOT IN USE.

Avoid unnecessary radiation by powering off wireless devices, network equipment, and hotspots when not in use, like at bedtime.



PRE-DOWNLOAD INSTEAD OF STREAMING.

Remember that when you wirelessly stream videos or music the radiation goes into your body. It is better to pre-download audio and video files and then watch or listen with wireless connections turned off.



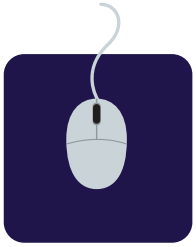
USE A PLUG-IN ETHERNET CORD.

It is super fast. Whenever possible connect your laptop, tablet, or computer with an ethernet cord (with Wi-Fi OFF, and Bluetooth OFF).

CORDED PHONE

Corded phones do not emit wireless radiation.





WIRED (NOT WI-FI & NOT BLUETOOTH)

Use a wired mouse, speakers, printer, game system, keyboard, tv, etc.



DISTANCE MATTERS.

Maximize the distance between people and wireless devices.

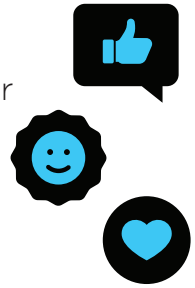
HEALTHY SLEEP

Remove electronics and wireless devices from around your bed. Do not sleep with your cell phone.



MINIMIZE FACETIME AND SOCIAL MEDIA ON CELL PHONES.

When you use facetime or post images, your phone emits more radiation. Instead, do social media or video sharing on a computer connected to the Internet by ethernet cord (with Wi-Fi turned off).



ENVIRONMENTAL HEALTH TRUST

Learn more at **www.ehtrust.org**



ENVIRONMENTAL HEALTH TRUST

Protect yourself.

#PracticeSafeTech

BE SMART. REDUCE WIRELESS RADIATION.

- Don't sleep with your cell phone or wireless device.
- Prefer phoning in speaker mode or hands-free.
- Avoid carrying a phone near your body– like in pants, pockets or bra.
- Text with phone away from your body.
- Use a corded landline and minimize wireless.
- Switch to airplane mode in cars, elevators, trains, buses, planes. Your device pumps out more radiation in metal surroundings.
- Turn Airplane mode on with Wi-Fi/Bluetooth OFF under settings to eliminate radiation.
- Use laptops, tablets, and all electronic tech away from your body – NOT on your lap.
- Connect to the internet with wired cables &Wi-Fi settings OFF.
- Go corded for mouse, headphones, keyboard, router, speakers, printer, gaming, tv, microphone etc.
- Streaming large files like video and music results in higher radiation exposure.
- 5G and 4G cell antennas will increase your daily dose of radiation. Not to mention, it will also impact the birds, bees and trees. Educate yourself on 5G.

RESEARCH SHOWS:
Cell phone/W-Fi radiation can damage the brain, sperm, your mood, and your sleep, in addition to increasing cancer and memory problems.

MUSIC & VIDEOS:
Instead of streaming, download first, switch to airplane mode then click play to avoid unnecessary radiation.

100% SAFETY = CORDED CONNECTIONS

GET INVOLVED:
Your elected officials need to hear from you. Ask for safe technology and updated radiation limits that protect the public. You have a right to know that cell phones & wireless devices emit radiation.

More at **EHTrust.org**

ENVIRONMENTAL HEALTH TRUST



ENVIRONMENTAL HEALTH TRUST

Protect Yourself.

CELL PHONES EXPOSE YOUR BODY TO RADIATION

Research links this microwave radiation to:

- Damaged sperm
- Reduced sperm count
- Erectile dysfunction
- Memory problems
- Cancer

5G and 4G cell antennas will increase your daily dose of radiation. Not to mention, it will also impact the birds, bees and trees. Educate yourself on 5G.

All cell phones and wireless devices have fine print warnings hidden deep in manuals advising the device not be in contact with the body.

More at **EHTrust.org**

ENVIRONMENTAL HEALTH TRUST

DOCTORS' RECOMMENDATIONS

1. PROTECT YOUR BODY

Do not carry cell phones in your pockets or bra. No laptops or tablets on your lap.

2. PROTECT YOUR BRAIN

Prefer a corded landline phone. Hold cell phones away from the head and body by using speakerphone.

3. PROTECT YOUR FERTILITY

No wireless devices near reproductive organs or near a pregnant woman's abdomen.

4. REDUCE WIRELESS

Turn off Wi-Fi and use cords to connect routers, phones, computers and other devices. Airplane Mode ON with Wi-Fi OFF turns off wireless.

5. DO NOT SLEEP WITH YOUR CELL PHONE

Cell phones and Wi-Fi devices are radiating even when not in use. Power off all devices at night, and keep them out of the bedroom.

ENVIRONMENTAL HEALTH TRUST

Protect the ones you love.



AMERICAN ACADEMY OF PEDIATRICS RECOMMENDS: REDUCE CELL PHONE AND WIRELESS RADIATION

- Do not hold the cell phone up to your head. Use speaker mode or hands free to limit radiation exposure to the brain.
- Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
- Make only short or essential calls on cell phones.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your signal, the harder your phone has to work and the more radiation it gives off.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder (and emits more radiation) to get a signal through metal.
- Remember that cell phones are not toys or teething items.

from AAP's HealthyChildren.org

Pre-download videos, programs & games onto tablet/phone/laptop so you can ensure Wi-Fi/Bluetooth/Cellular is off before handing device to child. Always keep digital devices OFF a child's lap.

RESEARCH SHOWS:
Cell phone/Wi-Fi radiation can damage the developing brain, sperm, and sleep. Research indicates increased cancer risk, headaches, hyperactivity, and memory problems from cell phone radiation.

All wireless devices emit the same type of radiation as cell phones.

AT HOME:
Easily reduce wireless radiation at home. Get a corded landline phone and forward cell phones to it.

100% SAFETY = CORDED ETHERNET CONNECTIONS
Use non-wireless corded connections for printers, mouse, computers, laptops, tablets, video game systems, e-readers, routers, keyboards, headphones, speakers, and other accessories – with all wireless functions off.

More at EHTrust.org

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More at EHTrust.org

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Wireless laptops expose your body to microwave radiation



Fernandez 2017

ENVIRONMENTAL HEALTH TRUST

HEALTHY TECH at HOME PROJECT

How To Minimize Wireless



Medical doctors and scientists recommend people reduce exposure to cell phone, Wi-Fi and wireless radiation. Scientific research has linked wireless to memory problems, cancer and harm to reproductive organs.

Use Speaker



Protect your brain and body by keeping the phone at a distance.

Minimize use and do not carry phones in pockets or use them near children.

Airplane Mode

Turn antennas OFF with airplane mode more often. Remember to check that Bluetooth, Wi-Fi, 5G and other antennas are also OFF.

Tip: Instead of Wi-Fi streaming, pre-download music and videos so that devices can be used on Airplane Mode.

Corded Home Phone

Choose a corded phone over a wireless one. Why? Because cordless & DECT phones emit nonstop wireless radiation.

Switch to Wired Tech

Connect computers, laptops and tablets to the internet with ethernet, not Wi-Fi. Adapters allow you to plug ethernet into USB or lightning ports

5G & Cell Towers

Talk to your elected officials. 5G and 4G "small" cells towers should not be built near homes and schools.

Raise awareness in your community.

Tablets OFF Laps

Tablets and laptops expose your body to non-ionizing radiation.

Always use devices on a table or desk.

Simple Steps

Each step you take to reduce wireless exposure to your child will make a huge difference. Look around your home and one by one swap out each Wi-Fi and Bluetooth device with safer, corded and ethernet connected tech.

Safe technology is the way forward.

Learn more at
healthytechhome.org

ENVIRONMENTAL HEALTH TRUST

HEALTHY TECH at HOME PROJECT

What Parents Need To Know About Safe Technology



Children are more vulnerable to wireless.

1. Children have thinner skulls. Research shows that children's developing brains, eyes, skull and bone marrow can absorb wireless radiation three to ten times more intensely than adults.

2. The World Health Organization's International Agency for the Research on Cancer classified wireless radio frequency radiation as a Class 2B, Possible Human Carcinogen in 2011. Cell phones are linked to increased brain and thyroid tumors. Risks are highest for those who first used a phone under the age of twenty.

3. A landmark study by the U.S. National Toxicology Program found "clear evidence" of cancer, heart damage and DNA damage in rats exposed to daily wireless.

4. A 2018 study found impacts to the memory of teenagers who used cell phones to the head after just one year. Numerous research studies links wireless exposure to hyperactivity, behavior problems, damaged sperm, and altered brain development.

5. Wireless radiation at very low levels has been shown to change brain activity. In 2011, NIH researchers found brain glucose metabolism increased from cell phone radiation.

6. A Yale Medicine study found increased hyperactivity and memory problems in mice after prenatal cell phone exposure. Now hundreds of doctors and scientists and educators recommend parents reduce their child's cell phone radiation exposure.

WORLDWIDE POLICY

Over 20 countries clearly recommend parents reduce their children's wireless cell phone radiation exposure.

France and Belgium have banned advertising and the sale of cell phones designed for young children.

Several countries have banned and/or restricted Wi-Fi from nursery schools, kindergartens and elementary.

IN FRANCE

Cell phones are labeled with safety information that says:

- Minimize children's use
- Use speakerphone to keep phone away from the brain.
- "Keep radio equipment away from the belly of pregnant women, and away from the lower abdomen of adolescents."



"For children the cancer risks may be greater than that for adults because of greater penetration and absorption of cell phone radiation in the brains of children and because the developing nervous system of children is more susceptible."

— Ron Melnick PhD,
Senior Toxicologist at National Institute of Environmental Health Sciences, Retired

But wireless is everywhere?

Simple steps like keeping cell phones and Wi-Fi devices away from your child's head and body will significantly reduce a child's exposure and could greatly reduce your child's risk of cancer and other disease.

Why is it legal?

Wireless was never premarket tested for children's safety. A scientific review of all the science has not been done by the FDA, CDC, FCC, NCI nor the EPA.

Is our government doing anything?

The FCC's cell phone and wireless radiation exposure limits are from 1996. They do not protect children from health effects from long term exposures. It will take years before federal regulations are updated.

NEW JERSEY EDUCATION ASSOCIATION

How to minimize health risks from electronics

- Keep devices away from the body and bedroom.
- Put devices on desks, not laps.
- Hard wire all devices that connect to the internet.
- Hard wire all fixed devices such as printers, projectors and boards.
- Use hard-wired phones instead of cell or cordless phones.
- Turn off Bluetooth devices when not using them.



Hardwired & Corded Connections

- Swap out Wi-Fi with ethernet for computers.
- Special ethernet adapters allow you to hardwire smaller devices such as tablets and smartphones.
- Instead of Bluetooth, use hardwired corded connections i.e mouse, keyboard and speakers.

Did You Know?

Cordless phones, Wi-Fi and Bluetooth "smart" speakers, virtual reality, video game consoles, baby monitors, watches and fitness monitors all emit wireless radiation, even when you are not using them.

Create A Sleep Sanctuary

An easy quick start is to power off wireless networks at night. Remove electronics and screens from the bedroom.

American Academy of Pediatrics Safety Tips For Families

- Use cell phones in speaker mode and distance the phone from your head.
- Avoid carrying your phone against the body like in a pocket, sock, or bra. Cell phone manufacturers can't guarantee that the amount of radiation you're absorbing will be at a safe level.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Keep an eye on your signal strength (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Cell phones are not toys or teething items.
- Make only short or essential calls on cell phones.

""The Council recommends limiting exposures... Wi-Fi can be turned off and wired local area network (LAN) can provide a reliable and secure form of networking ..without any microwave electromagnetic field exposure."

— Maryland State Children's Environmental Health and Protection Advisory Council Wi-Fi in Schools Report

Learn more
healthytechhome.org

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Health Matters

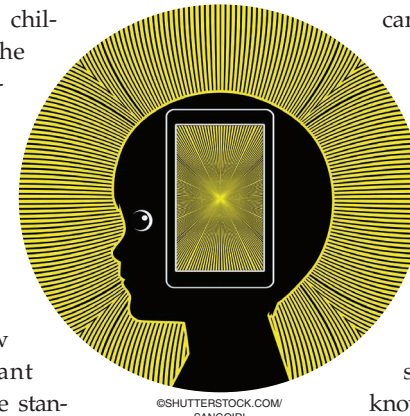
RF Health Safety Limits and Recommendations

■ **James C. Lin**

The rapid proliferation of cellular mobile telecommunication devices and systems is raising public health concerns about the biological effects and safety of RF radiation exposure. There is also concern about the efficacy of promulgated health safety limits, rules, and recommendations for the RF radiation used by these devices and systems. This article reviews and discusses the U.S. Federal Communications Commission (FCC) notices and rules, International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines, and International Committee on Electromagnetic Safety (ICES) standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields (EMFs). The recently revised RF exposure limits are adjusted only for heating with RF radiation. These limits are largely intended to restrict short-term heating by RF radiation that raises tissue temperatures. They are narrow in scope and are not applicable to long-term exposure at low levels. This review discusses the assumptions underlying the standards and the outdated exposure metrics employed, and concludes that the revised guidelines do not adequately protect children, workers, or the public from exposure to RF radiation or people with sensitivity to electromagnetic radiation from wireless devices and systems. Furthermore, the review discusses important animal data that the standards do not appear to take into account. Moreover, for millimeter-wave radiation from 5G mobile communications, there are no adequate human health effects studies in the published literature. The conclusions by scientific organizations, such as the International Agency for Research on Cancer (IARC), that diverge from these standards are also discussed. The review concludes that many of the recommended limits are debatable and require more scientific justification from the standpoint of safety and public health protection.

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Introduction

The biological effects from exposure to microwave and RF radiation have been a subject of scientific investigation since the mid-20th century [1], [2]. Initial studies have shown that exposure can cause both beneficial and adverse biological effects in humans via heating of tissues inside the body. The heating may or may not be detectable as temperature elevations available from simple temperature sensors. However, the knowledge was influential in setting 100 W/m^2 (10 mW/cm^2) of incident power density in 0.1 h as a safety guideline for human exposure to microwave and RF fields in 1966 [3]. Continued research led to a minor amendment to the limits in 1982 [4]. The efforts took place under the cosponsorship of the U.S. Department of the Navy and what is now known as the *IEEE*. However, the paucity of the then available scientific data was only able to provide the rudimentary basis for a less than rigorous or precise exposure limit. Thus, research interest in biological

effects and safe use of microwave and RF radiation continued, biomedical and bioengineering investigations expanded, and scientific knowledge and data steadily improved.

Aside from various observational investigations on biological responses, a salient aspect of the studies provided the approach for a quantitative estimation of the amount of deposited power density or absorbed energy inside the body to reliably induce biological responses by a given incident RF power density. Inauguration of the concept of specific absorption rate (SAR) and its frequency-dependent connection to incident power density formed the basis for the maximum permissible exposure level. It became a compelling rationale for reporting quantitative results from laboratory experiments and observational studies [5]. SAR can be used to relate the RF and microwave radiation to specific responses of the body; it facilitates understanding of biological phenomena and it is independent of mechanisms of interaction. It serves as an index for extrapolation of experimental results from cell-to-cell, cell-to-tissue, tissue-to-animal, animal-to-animal, and animal-to-human exposures. It is also useful in analyzing relationships among various observed biological responses in different experimental models and subjects.

Further advances contributed significantly to the refinement of the abovementioned exposure limit. For example, in its report on biological effects and exposure criteria for microwave and RF radiation [6], the U.S. National Council on Radiation Protection and Measurements (NCRP) recommended the exclusive use of SAR for quantification of RF and microwave distribution and absorption in biological materials or animal bodies under exposure. Also, SAR was used in the 1992 edition of exposure standards developed by the IEEE Standards Association, which was also recognized by the American National Standards Institute (ANSI) [7].

The rapid proliferation of cellular mobile communication devices and systems and public concerns about the biological effects and safety of microwave exposure caused the FCC to implement rules for permissible human exposure to RF and microwave radiation from cell phones and wireless base stations in 1996 [8]. The FCC rules are identical to those recommended by the NCRP (1.6 W/kg over 1 g of tissue mass) and are also essentially the same as ANSI/IEEE-1992 for the relevant frequencies. However, the FCC rules are enforceable by law. For example, at the wireless mobile communication frequencies between 800 and 2,200 MHz, the maximum permissible exposures for the general population are specified by [f (MHz)/1,500] mW/cm^2, as averaged over any 30-min period. For base stations operating at a frequency of 880 MHz, the FCC's RF exposure rules stipulate a maximum permissible level of 0.59 mW/cm^2 (5.9 W/m^2). For base-station antennas transmitting at 1,990 MHz, the FCC limit for the public is 1.27 mW/cm^2 (12.7 W/m^2).

Thus, research interest in biological effects and safe use of microwave and RF radiation continued, biomedical and bioengineering investigations expanded, and scientific knowledge and data steadily improved.

Subsequently, the newly formed ICNIRP published its recommended guidelines in 1998 [9]. For the most part, it follows the ANSI/IEEE-1992 and FCC-1996 recommendations, except it chose to set SAR values at 2 W/kg averaged over 10 g of tissue mass for local absorption, but without any clearly enunciated biophysical basis or scientific rationale.

In 2001, the name of the ICES was approved by the IEEE Standards Association in place of its prior entities, which developed the ANSI/IEEE-1992 standards [7].

In 2006, ICES published a revised exposure standard, which departs in major ways from the 1992 ANSI/IEEE edition (and its subsequent amendments). Specifically, it adopted ICNIRP's SAR value of 2 W/kg value as averaged over a 10 g of tissue mass for local absorption [10]. This apparently was done as a step toward global standards harmonization, not necessarily to reflect the current state-of-advances in knowledge for health safety protection.

Recently, both the ICNIRP and ICES published revisions of their recommendations for exposure limits [11], [12], [13]. These versions are clearly tied to heating effects associated with measurable tissue temperature changes. They are based primarily on biological data from short-term (6 or 30 min) exposures to RF and microwave radiation and do little to address the troubling question of the recommended limits for long-term, low-level exposures. The scenarios of a persistent lack of confidence in these RF exposure standards are recurring in many parts of the world about wireless and mobile telecommunication devices and installations [14], [15], [16], [17]. This article succinctly examines some of the issues and highlights the more significant aspects applicable to cell phone and wireless mobile telecommunication uses of RF and microwave radiation.

Assessing Recently Revised Limits for Health Safety Protection

A recent article challenged the health safety afforded by the current exposure limits to RF radiation and called for an independent evaluation of the scientific evidence [14]. It shows that the current exposure limits ignore hundreds of scientific studies that document adverse health effects at exposures below the threshold level claimed by these safety limits. It further

contends that the scientific evidence invalidates the health assumptions underlying the promulgated RF exposure limits. Specifically, for frequencies below 6 GHz, a SAR value of 4 W/kg, spatially and temporally averaged over the whole-body mass, was assumed as the effective threshold for adverse biological effects in humans. The level was predicated on disruption of operant-conditioned work schedules in a few trained rodents and primates. Also, it assumed that a heat-production rate of 4 W/kg was within the normal range of human thermoregulatory capacity. The ANSI/IEEE C95.1-1992 standards, and thus the FCC rules, ICES limits, and ICNIRP guidelines, are introduced to prevent only adverse thermal effects on the functioning of the human body. So, the SAR of 4 W/kg remains as the basis for the revised ICNIRP and ICES RF exposure limits.

The International Commission on the Biological Effects of Electromagnetic Fields article argued that the exposure limits, based on science from the 1980s, before cellular mobile phones were ubiquitous, do not adequately protect children, people with electromagnetic hypersensitivity, industrial workers, and the public from unsafe exposure to the RF radiation from cell phone and wireless devices and systems. Furthermore, while the revised ICNIRP safety guideline and ICES standard make recommendations to protect against adverse health effects from exposure to RF radiation, in fact, the guidelines and standards are based on controlling whole-body temperatures from increasing above 1 °C or local tissue temperatures to 5 °C for short-term exposures of 6 or 30 min (Table 1).

Contrary to persistent and recent concerns of inadequate health effect studies involving RF radiation with complex novel modulations and pulse sequences, especially about 5G, ICNIRP deleted its 1998 provision of pulse exposure limits from the revised 2020 guidelines. Consequently, there are no longer specific restrictions on pulse modulations of any kind in ICNIRP 2020. Note that time-averaged SAR over a 6-min period is inadequate to account for the unique characteristics of pulse modulations or to capture the effects of pulse-modulated exposures, including the microwave auditory effect that occurs without any measurable temperature rise and at low levels of SAR [18], [19]. It is well known that the outcomes of experimental studies are affected by differences in RF parameters and exposure conditions.

Furthermore, the question of applicability of the recommended limits for safe long-term exposure to low-level RF radiation (in contrast to exposures shorter than 6 or 30 min) remains open. The revised exposure limits do not provide any adjustments for possible effects due to long-term human exposures. There is a perceived lack of appreciation of scientific knowledge on chronic toxicology and carcinogenicity regarding RF exposures below the basic restrictions promulgated through existing exposure guidelines and standards [14], [15], [16], [17], [20].

The IARC, an intergovernmental agency of the World Health Organization, classifies exposure to RF radiation as a possible cancer-causing player in humans [21], [22]. The IARC's role is to conduct and coordinate research into the causes of cancer. It evaluated the accessible scientific investigations and decided that, while its database was imperfect and constrained, especially with respect to results from animal experiments in research laboratories, epidemiological observations in humans exhibited higher risks for the glioma-type of malignant brain cancer and of benign vestibular schwannoma of the vestibulocochlear nerve among heavy or long-term subscribers of cell or mobile phones are satisfactorily robust to underwrite a classification of RF radiation from cellular mobile phones as a carcinogenic actor for humans.

Significantly, the results from animal experiments that the IARC was lacking were later provided by the U.S. National Toxicology Program (NTP) report of two types of cancers in laboratory rats that were exposed, lifelong, to 2G and 3G cell phone RF radiation frequencies below 6 GHz [23], [24]. The study was the largest health effect

TABLE 1. Current guidelines or standards based on thermal effect for "safe" human exposure to RF radiation.

Frequency Range	Tissue Type	△T	Average Mass	Average Time	Health Effect Level	Factor*	Public Level	Factor*	Worker Level**
100 kHz–6 GHz	Local head-torso	2 °C	10 g	6 min	20 W/kg	10	2 W/kg	2	10 W/kg
	Local limbs	2 °C	10 g	6 min	40 W/kg	10	4 W/kg	2	20 W/kg
>6 GHz–300 GHz (5G)	Local head-torso	5 °C	4 cm^2	6 min	200 W/cm^2	10	20 W/cm^2	2	100 W/cm^2
30 GHz–300 GHz (5G)	Local limbs	5 °C	2 cm^2	6 min	400 W/cm^2	10	40 W/cm^2	2	200 W/cm^2
100 kHz–300 GHz	Body core	1 °C	WBA	30 min	4 W/kg	50	0.08 W/kg	10	0.4 W/kg

Compiled from [11] and [12]. WBA, whole-body average.
*Safety or reduction factor; **controlled or occupational exposure.

animal investigation performed by researchers at the NTP, arguably, the largest animal health study conducted of cell phone RF radiation. The findings included statistically significant and clear evidence that RF exposure caused the development of a rare form of malignant tumor (schwannoma) in the heart of male rats whose RF-induced body temperature increase did not exceed 1 °C at the highest SAR (6 W/kg). There was also a hint of some schwannoma risk among female rats. The NTP study also noted damage to the heart (cardiomyopathy) in both RF-exposed male and female rats compared to concurrent controls. In addition, based on statistical significance, the outcome of pathological examinations showed signs of RF-dependent carcinogenic activity in the brain of male rats, namely gliomas. However, the effects on females were deemed as presenting only equivocal evidence for malignant gliomas when compared to control rats.

In that same year, the Cesare Maltoni Cancer Research Center of the Ramazzini Institute in Bologna, Italy, reported the conclusions from its large laboratory study of cancer risks in rats exposed to 3G RF radiation. The research involved whole-body exposure of the same strain of rats as used by the NTP, either lifelong or prenatal until death, under far-field exposure conditions [25]. During the 19-h day for roughly two-year exposures, the calculated whole-body SARs were .001, .03, and 0.1 W/kg. A statistically significant elevation in the incidence of schwannomas in male rat hearts was noted for the 0.1-W/kg RF exposure. It is important to observe that the NTP and Ramazzini RF exposure investigations produced comparable outcomes for heart schwannomas and brain gliomas. Thus, two well-conducted large RF animal exposure investigations involving life-long exposures of the same strain of rats revealed consistent carcinogenicity outcomes.

The positions taken in the recent revisions of the health safety limits appear to view these animal studies as not applicable. The revisions ignored the independent variable for the experiments: the RF exposure. While the standards reference the animal studies, they opted to object with putative "chance differences" from experimental treatments or complications of thermally induced body-core temperature rises of up to 1 °C in rats at the highest RF exposure levels. In doing so, the standards overlook the error of proposing a 1 °C body-core temperature rise as a cause for cancer. Unfortunately, vague expressions, such as *substantial limitations*, do not specify why the standards' authors felt that "conclusions being drawn concerning RF EMFs and carcinogenesis" were not possible in formulating the recommended RF limits.

Regarding epidemiological studies of cell phone RF radiation and carcinogenicity, the revised recommendations argue that, while much research has been conducted, results on gliomas, meningiomas, parotid gland tumors, and vestibular schwannomas (acoustic neuromas) have not provided sufficient evidence of an increased cancer risk. Also, the revision states that, while there are reports of greater odds ratios, methodological differences and weaknesses—including recall and selection bias—thwarted the epidemiological results from being taken into consideration for the recommended exposure limits. Based on the published discussion accompanying the standards, it is hard not to suspect a tendency toward scepticism of positive results, along with an equal tendency toward less critical acceptance of negative findings.

Based on the published discussion accompanying the standards, it is hard not to suspect a tendency toward scepticism of positive results, along with an equal tendency toward less critical acceptance of negative findings.

Table 1 shows that for frequencies between 6 GHz and 300 GHz, including millimeter-waves deployed for 5G wireless mobile communications, the permissible local tissue temperature rise in the head, limbs, and torso of humans is 5 °C. This level of temperature rise could induce the tissue temperature to increase from a nominal value of 37 °C to a hyperthermic 42 °C. A hyperthermic tissue temperature of 42 °C is cytotoxic, with the potential for exponential cell death. Furthermore, it serves as the medical foundation for treatment of malignant tumors with hyperthermia therapy for cancer [26], [27], [28]. The recently revised exposure limits provide a reduction factor of 10 for ordinary people at 20–40 W/m^2 or a safety factor of 2 in RF workplaces at 100–200 W/m^2. Under these scenarios, the efficacy of these limits is marginal, and they may be irrelevant from the standpoint of health safety protection considering the measurement's uncertain and physiological variability.

Discussion and Conclusion

The newly revised RF exposure limits are devised largely for restricting short-term heating of RF radiation to raise tissue temperatures. These limits also exhibit a strong conviction that there is nothing but heat to worry about with RF radiation.

The IARC classified RF radiation from cell/mobile phones as a possible carcinogen in humans on the strength of the then-available epidemiological reports but with access to only partial data from experimental animals [21], [22]. The classification of RF radiation as possibly carcinogenic to humans

ranks third in the IARC categories of carcinogenic risk. The highest category is reserved for agents that are "carcinogenic." It is followed by "probably carcinogenic," "possibly carcinogenic," "not classifiable" as to its carcinogenicity, and finally, "probably not carcinogenic to humans."

The animal data the IARC sought were delivered by the NTP [25] and the Ramazzini Institute [26], which logically and scientifically supplement the IARC's earlier evaluation of human epidemiological studies that support the IARC's classification of RF radiation as a possible carcinogen. The latest animal data should help to upgrade the classification to the "probably carcinogenic" category, if not elevate it to a higher level. Nonetheless, the revisions evaded them by declaring that the findings do not provide credible evidence of adverse effects induced by chronic RF exposures.

Another perplexing issue pertains to the establishment of exposure limits based on scientific evidence rather than other assumptions. The problem arises from the harmonization of the IEEE's SAR limit value of 1.6 W/kg (over 1-g mass) to the ICNRIP's 2.0 W/kg (over 10-g mass) for short-term (<6 min) exposures below 6 GHz. The adoption of SAR as a dosimetry quantity and establishment of the value 1.6 W/kg over a 1-g mass have been examined with great scientific care and deliberation since the 1980s and were reaffirmed through several renditions of IEEE standards in the early 2000s. As mentioned above, the choice by the ICNIRP in 1998 to set the SAR at 2.0 W/kg was not accompanied by any enunciated biophysical basis or scientific rationale. Indeed, global harmonization of RF exposure limits for the public would be a worthy objective. However, it should not be approached on a basis of harmonization for harmonization's sake [29]. The process ought to aim toward improvement beyond the current state-of-affairs, through better precision in SAR specification and less uncertainty in exposure assessment.

It is interesting to note that in December 2019, the FCC reaffirmed its RF exposure limits [30]. The action was taken despite appeals from some to loosen the existing limits, and others to tighten them. Among campaigners embracing weaker limits were proposals from consultants for the wireless industry, CTIA–The Wireless Association, Mobile Manufacturers Forum, and the Telecommunications Industry Association. The same appeals also argued that the evidence for health effects suggests that 5G is akin to any other installed cell or mobile technology and systems. Claims were presented for lessening cell phone RF limits to SARs of 2.0 W/kg, averaged over 10 g of tissue instead of the FCC's limit of 1.6 W/kg over 1 g. Thus, the waxing question—if it is not for science—is the process in changing SAR limits from 1.6 to 2.0 W/kg an action on behest of others.

Aside from the numerical 25% increase of SAR from 1.6–2.0 W/kg, the expansion of averaging tissue mass from 1 to 10 g materially reduces 10-fold the precision of SAR determinations. Thus, harmonization could have a combined impact of raising the permissible IEEE exposure limit by a factor of 1,250%, with less safety protection. Of course, there is also the biological issue of vast differences in quantity and variety of cells in 1- or 10-g mass of living tissues.

Furthermore, research on correlation of SAR and induced tissue temperature elevation revealed a close dependence on size of averaging tissue mass and exposure duration [31]. The study investigated the influence of SAR and averaging mass on the correlation between RF energy and induced tissue temperature elevation for exposures involving anatomically realistic models of the human body. It found that SAR provides a better correlation with temperature for short exposures. The best correlation with temperature increase occurs for exposure durations between 1 and 2 min for SAR for most frequencies investigated (700 to 2,700 MHz). In this case, a mass of 1 g was found to be optimal for correlation of temperature elevation with SAR. For longer exposures, the correlation is reduced, and it favors larger averaging mass. At steady-state exposures (~30 min), correlation of temperature elevation with SAR is maximum for a mass of 9 g (~10 g) for the frequencies investigated. Thus, in a science-based exposure limit, the appropriate averaging mass for frequencies below 6 GHz should not be the same for short-term and longer exposure durations, even for heating-related exposure limits.

In conclusion, the revised RF exposure limits make allowances only to worry about heat with RF radiation. These limits are devised for restricting short-term heating by RF radiation and aim to prevent increased tissue temperatures. Thus, they are not applicable to long-term exposure at low levels. Instead of advances in science, they are predicated on assumptions using outdated exposure metrics, thus their ability to protect children, workers, and the public from exposure to the RF radiation or people with sensitivity to electromagnetic radiation from wireless devices and systems. Furthermore, the limits are based on outdated information and circumvent important animal data. These issues are even more relevant in the case of millimeter-wave radiation from 5G mobile communications for which there are no adequate health effects studies in the published literature. Finally, the guidelines do not adequately address conclusions from scientific organizations, such as the IARC. Thus, many of the recommended limits are questionable from the standpoint of scientific justification for the safety and public health protection.

References

[1] S. Michaelson and J. C. Lin, *Biological Effects and Health Implications of Radiofrequency Radiation*. New York, NY, USA: Plenum, 1987.

[2] H. P. Schwan, "Electrical properties of tissue and cell suspensions," *Adv. Biol. Med. Phys.*, vol. 5, pp. 147–209, 1957, doi: 10.1016/B978-1-4832-3111-2.50008-0.

(continued on page 77)

[11] Kuiper Systems LLC, "International Bureau," Federal Communications Commission, Washington, DC, USA, Rep. No. SAT-LOA-20190704-00057, 2020. Accessed: Jan. 14, 2022. [Online]. Available: https://licensing.fcc.gov/cgi-bin/ws.exe/prod/ib/forms/reports/swr031b.hts?q_set=V_SITE_ANTENNA_FREQ.file_numberC/File+Number/%3D/SATLOA2019070400057&prepare=&column=V_SITE_ANTENNA_FREQ.file_numberC/File+Number

[12] N. Pachler, I. del Portillo, E. F. Crawley, and B. G. Cameron, "An updated comparison of four low earth orbit satellite constellation systems to provide global broadband," in *Proc. IEEE Int. Conf. Commun. Workshops*, 2021, pp. 1–7, doi: 10.1109/ICCWorkshops50388.2021.9473799.

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[3] H. P. Schwan, "Early history of bioelectromagnetics," *Bioelectromagnetics*, vol. 13, no. 6, pp. 453–467, 1992, doi: 10.1002/bem.2250130604.

[4] *American National Standard for Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 kHz to 300 GHz*, ANSI Standard C95.1-1982, IEEE, New York, NY, USA, 1982.

[5] "Radiofrequency electromagnetic fields, properties, quantities and units, biophysical interactions, and measurements," Nat. Council Radiat. Protection Meas., Bethesda, MD, USA, NCRP Rep. No. 67, 1982.

[6] "Biological effects and exposure criteria for radiofrequency electromagnetic fields," Nat. Council Radiat. Protection Meas., Bethesda, MD, USA, NCRP Rep. No. 86, 1986.

[7] *Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, ANSI/IEEE C95.1, 1992.

[8] "Evaluating compliance with FCC specified guidelines for human exposure to radiofrequency radiation," Federal Commun. Commission, Office Eng. Technol., Washington, DC, USA, OET Bulletin 65, 1996.

[9] International Commission on Non-Ionizing Radiation Protection, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)," *Health Phys.*, vol. 74, no. 4, pp. 494–522, Apr. 1998.

[10] *IEEE Standard for Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, ICES, IEEE C95.1, 2006.

[11] International Commission on Non-Ionizing Radiation Protection, "Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)," *Health Phys.*, vol. 118, pp. 483–524, May 2020, doi: 10.1097/HP.0000000000001210.

[12] *IEEE Standards for Safety Levels With Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz, Revision of IEEE Std C95.1-2005/Incorporates*, ICES, IEEE Standard C95.1-2019/Cor 1-2019, 2019.

[13] W. H. Bailey et al., "Synopsis of IEEE Std C95.1™-2019 'IEEE standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields, 0 Hz to 300 GHz'," *IEEE Access*, vol. 7, pp. 171,346–171,356, Nov. 2019, doi: 10.1109/ACCESS.2019.2954823.

[14] International Commission on the Biological Effects of Electromagnetic Fields, "Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: Implications for 5G," *Environ. Health*, vol. 21, no. 1, p. 92, Oct. 2022, doi: 10.1186/s12940-022-00900-9.

[15] P. Elkind, "How the FCC shields cellphone companies from safety concerns," ProPublica, New York, NY, USA, Nov. 2022. [Online]. Available: https://bit.ly/ProPublicaFCC

[16] "How much is safe?" Investigate Europe, Berlin, Germany, 2019. Accessed: Mar. 25, 2022. [Online]. Available: https://www.investigate-europe.eu/en/2019/how-much-is-safe

[17] B. Koeppel, "Federal court instructs FCC to review electromagnetic radiation standards," Federal Commun. Commission, Washington Spectator, New York, NY, USA, 2022. Accessed: Mar. 9, 2022. [Online]. Available: https://washingtonspectator.org/fcc-electromagnetic-radiation

[18] J. C. Lin, "The microwave auditory effect," *IEEE J. Electromagn., RF, Microw. Med. Biol.*, vol. 6, no. 1, pp. 16–28, Mar. 2022, doi: 10.1109/JERM.2021.3062826.

[19] J. C. Lin, "Microwave auditory effects among U.S. Government personnel reporting directional audible and sensory phenomena in Havana," *IEEE Access*, vol. 10, pp. 44,577–44,582, Apr. 2022, doi: 10.1109/ACCESS.2022.3168656.

[20] N. R. Nyberg, J. E. McCredden, S. G. Weller, and L. Hardell, "The European Union prioritises economics over health in the rollout of radiofrequency technologies," *Rev. Environ. Health*, early access, Sep. 2022, doi: 10.1515/reveh-2022-0106.

[21] R. Baan et al., "IARC monograph working group. Carcinogenicity of radiofrequency electromagnetic fields," *Lancet Oncology*, vol. 12, no. 7, pp. 624–626, 2011, doi: 10.1016/S1470-2045(11)70147-4.

[22] IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, "Non-ionizing radiation, part 2: Radiofrequency electromagnetic fields," *IARC Monographs Eval. Carcinogenic Risks Hum.*, vol. 102, no. Pt 2, pp. 1–460, 2013.

[23] M. E. Wyde et al., "Effect of cell phone radiofrequency radiation on body temperature in rodents: Pilot studies of the National Toxicology Program's reverberation chamber exposure system," *Bioelectromagnetic*, vol. 39, no. 3, pp. 190–199, Apr. 2018, doi: 10.1002/bem.22116.

[24] "Technical report on the toxicology and carcinogenesis studies in HSD: Sprague–Dawley SD rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cellphones," NTP/NIEHS, Raleigh, NC, USA, NTP Tech. Rep. 595, 2018.

[25] L. Falcioni et al., "Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission," *Environ. Res.*, vol. 165, pp. 496–503, Aug. 2018, doi: 10.1016/j.envres.2018.01.037.

[26] D. J. Watmough and W. M. Ross, Eds. *Hyperthermia*. Glasgow, U.K.: Blackie, 1986.

[27] J. C. Lin, "Hyperthermia therapy," in *Encyclopedia of Electrical and Electronics Engineering*, vol. 9, J. G. Webster, Ed. New York, NY, USA: Wiley, 1999, pp. 450–460.

[28] "Hyperthermia to treat cancer," Nat. Inst. Health/Nat. Cancer Inst., U.S. Dept. Health Hum. Services, Washington, DC, USA, 2021. Accessed: Sep. 27, 2021. [Online]. Available: https://www.cancer.gov/about-cancer/treatment/types/hyperthermia#hyperthermia-treatment-research

[29] MMF, 2006. Accessed: Feb. 2006. [Online]. Available: http://mmfai.info/public/docs/eng/Viewpoint%20C95%2EI%20040ct05%2E.pdf

[30] "Resolution of notice of inquiry, second report and order, notice of proposed rulemaking, and memorandum opinion and order," Federal Commun. Commission, Washington, DC, USA, 2019. [Online]. Available: https://docs.fcc.gov/public/attachments/FCC-19-126A1.pdf

[31] M. Cavarnaro and J. C. Lin, "Importance of exposure duration and metrics on correlation between rf energy absorption and temperature increase in a human model," *IEEE Trans. Biomed. Eng.*, vol. 66, no. 8, pp. 2253–2258, Aug. 2019, doi: 10.1109/TBME.2018.2886475.

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TESTIMONY OF ANGELA SIEFER
Executive Director
NATIONAL DIGITAL INCLUSION ALLIANCE

Before the United States House of Representatives
Subcommittee on Communications and Technology
Committee on Energy and Commerce

On
"Empowering and Connecting Communities Through Digital Equity and Internet Adoption"

Washington DC
January 29, 2020

Chairman Doyle, thank you for the opportunity to be here today on behalf of the National Digital Inclusion Alliance and our affiliates including Pittsburgh's digital inclusion leader, Computer Reach.

Twenty some years ago, in Toledo, Ohio, I was a graduate student setting up computer labs, teaching people how to use Word to create a resume and organizing regional meetings of community technology centers. We thought of our work as "bridging the digital divide". Our focus was on access to computers and computer training. In 1996, we were not concerned with universal access to the internet. If we had just two computers in a lab connected to the internet, we congratulated ourselves for being cutting edge.

Today folks on the ground who are "bridging the digital divide" are facilitating access to home internet service, devices and digital literacy training. NDIA represents these heroes. They are nonprofit organizations, libraries, local governments, housing authorities and more. NDIA represents over 400 affiliated organizations in 41 states, the District of Columbia and the U.S. Virgin Islands.

NDIA's positions are based in our affiliates' on-the-ground experience and research. There are a few myths that I would like to address today.

Myth #1. A mis-statement that we hear repeated often is that the digital divide would be bridged if we filled the broadband infrastructure gaps in rural areas. According to the Census' latest American Community Survey, about fourteen million urban households (in major metro areas as well as smaller cities and towns) and 4 million rural households, still lacked broadband

subscriptions of any kind, including mobile data plans.[1] What did 60% of unconnected urban residents have in common with more than half of the unconnected rural households? They all had household incomes below $35,000. Households with incomes less than $35,000 make up 28% of all U.S. households but they account for 60% of those without any broadband internet service.[2]

We do need to address the lack of broadband infrastructure in rural areas. It is a serious problem. But, it is just one barrier to individuals and communities being able to fully participate in society today. The other common barriers, no matter where one lives, are the costs of internet service and devices, plus digital literacy skills. Simplistically equating "the digital divide" with just one of these barriers increases the division in our country.

Myth #2. The excitement around 5G has led to claims 5G will solve the digital divide. It will not. Current broadband technologies were not deployed to all neighborhoods (unless local governments mandated such) and there is no reason to think 5G will be any different. Additionally, 5G as a broadband service will require 5G capable devices. Low income households struggling to pay for internet service will certainly not rush out to purchase a 5G enabled device.

Myth #3. Well intentioned individuals have stated that if we could convince non-adopters of the value of the internet, they would subscribe. Anyone who has resisted using the internet realizes very quickly that the internet cannot be avoided when they try to apply for a job, register for classes or find out what their social security benefits will be. The greatest barrier to broadband adoption is not relevance. It is cost and digital literacy.

Residential internet service in the U.S. is expensive. On the low end, internet service generally runs $65-70 per month[3]. That's a lot of money. Unfortunately I cannot provide any detail as to the cost of internet service because that data does not exist. We need the FCC to begin collecting systematic data on the cost of home internet service and make it publicly available.

In the U.S., digital literacy training is under-valued and thus under-funded. One-third of manufacturing workers lack proficient digital skills. Half of all construction, transportation and

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[1] Of 18.1 million households with no broadband of any kind, 13.8 million were in what the Census calls urban areas, including six million in "principal cities" of metropolitan areas, other "urbanized" areas, and "urban clusters" in and around smaller cities and towns. Only about a fourth of U.S. households without broadband were in rural areas. (2018 American Community Survey 1-Year Estimates, Tables B28002, GCT2801 and S1101, United States)

[2] 2018 American Community Survey 1-Year Estimates, Table B28004 (United States). 38% of the households with no broadband at all had incomes below $20,000. Another 23% had incomes between $20,000 and $35,000.

[3] Refers to lowest monthly cost for non-promotional, standalone Internet service at any speed in most U.S. markets. Source: Ongoing NDIA research.

storage workers lack proficient digital skills.[4] There is no funding for digital literacy training.[5] It has been left up to local governments, libraries, and nonprofits to piece together resources to address the basic digital skills training that millions of Americans need to cross that digital divide. Piecing together funding is the wrong strategy for a strong workforce.

Now, let me share some good news. Digital inclusion solutions in the U.S. have been crafted from the ground up. NDIA's affiliates are providing guidance to low-income parents connecting to their children's teachers, teaching seniors how to use their electronic health records, helping veterans learn digital skills in order to acquire a job, and enabling disabled adults to participate more fully in their communities. We know that trust is an important factor. Technology can be quite intimidating. The most successful digital inclusion programs are rooted in the communities being served.

What is missing? Digital equity planning at the state level. And financial support for that planning plus the implementation. A good first start would be to pass the Digital Equity Act. We are also in need of increased awareness of the problem and the solutions.

So, thank you. This hearing is increasing awareness. You are increasing awareness.

[4] National Skills Coalition analysis of OECD Survey of Adult Skills 2012-14 data. Proficient digital skills defined as: At this level, tasks typically require the use of both generic and specific technology applications. For example, a person might be presented with a new type of online form, and need to navigate across multiple pages and applications to answer the test question. The task may have multiple steps, and may require the use of tools (such as the "sort" function) to solve the problem. The person may have to identify the goal themselves, and engage in higher-level reasoning to solve the problem.

[5] In 2018, combined expenditures for rural broadband infrastructure by USAC and USDA totalled more than $3.3 billion dollars.

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Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads

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ABSTRACT

In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter. The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading from the entire area was 31.6 V m^{-1} (2648 mW m^{-2}). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.

1. Introduction

Electromagnetic fields are known physical risk factors. When mobile phone base station antennas are installed, the immediate physical environment, including the public and the living spaces can be greatly affected by microwaves.

Measuring public exposure to radiofrequency fields is significant from public health perspective, but also for future epidemiological studies. Given the rapid development of mobile communication technologies, the radiofrequency landscape is continuously diversifying and intensifying: more frequencies are introduced to provide novel mobile phone and data services; more base station antennas are constantly installed to facilitate the increasing need for data amounts, pushed through the networks. Meanwhile, public exposure also increases.

In previous publications we have reported environmental exposure to radiofrequency (RF) electromagnetic (EMF) radiation at certain places in Stockholm in Sweden such as the Central Railway Station (Hardell et al., 2016), the Old Town (Hardell et al., 2017), with special attention to Järntorget in the Old Town (Hardell et al., 2019), and Stockholm city (Carlberg et al., 2019). Of special interest was to measure RF radiation in one Stockholm apartment with two groups of base station antennas nearby (Hardell et al., 2018). That apartment was further examined using a RF broadband analyzer and the results were compared with another Stockholm apartment with substantially much lower RF radiation but equally good wireless communication possibility (Koppel et al., 2019).

Earlier studies done in Europe show constant increase of public exposure, especially in urban environment. The increase is attributed to new mobile phone base stations installed, but also to the increased usage of corresponding mobile services. Sánchez-Montero et al. (2017) monitored urban exposure in Alcalá de Henares (Spain) for ten years and reported city mean field increase from 0.277 (203 μW m^{-2}) in 2006 to 0.395 V m^{-1} (414 μW m^{-2}) in 2015. Sánchez-Montero et al. (2017) admit that during the ten years of monitoring the number of mobile phone base

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station has doubled, but also conclude that the probability of being exposed to a high value of 14 V m^{-1} (519 mWm^{-2}) is less than 0.01% and the probability of being exposed by 28 V m^{-1} (2079 mWm^{-2}) is negligible (Sánchez-Montero et al., 2017).

It is expected, that wherever mobile phone base station antennas are installed, high exposure areas might be encountered. Although these highly exposed areas constitute a minor part of the urban environment, these should be carefully studied for the sake of the people who work and live there.

Urbinello et al. (2014) emphasized "A continuous monitoring is needed to identify high exposure areas and to anticipate critical development of RF-EMF exposure at public places", while they informed a steep RF radiation growth in public places within one year. The growth of RF radiation has been substantial in many countries, also in Sweden as exemplified in this study.

Sagar et al. (2018) conducted a literature review, looking at studies in between 2000 and 2013 of radiofrequency electromagnetic exposure in microenvironments in Europe. For outdoor microenvironments they report the mean total RF exposure to be 0.54 V m^{-1} for spot measurements. Typical exposure levels were around 0.5 V m^{-1} and rarely over 1 V m^{-1}. They report downlink contributing the most to the total RF exposure in outdoor microenvironments in all studies except one.

An updated review by Jalilian et al. (2019) on European microenvironments' studies from 2015 to 2018 found mean outdoor exposure ranging from 0.07 to 1.27 V m^{-1}. Mobile phone base stations' downlink signals were the most relevant contributor to total exposure. The review concluded a tendency for RF levels to increase with increasing urbanity. Also, the review found that all different types of studies reported mean exposure levels of less than 1 V m^{-1}; different types included spot measurement, fixed site monitoring, and personal measurement with volunteers.

The problem with most of the spot measurement studies is their inability to adequately represent spatial RF field distribution. This is due to two reasons: 1) the measurement sample is too small and does not account for highly exposed areas and/or 2) the spots where the measurements are collected do not coincide with the RF hotspots. RF hotspots occur usually around RF sources such as mobile phone base station antennas. Furthermore, RF hotspots depend on the radiation pattern of the antenna and the surrounding environment, hence the field distribution is uneven. It is not possible to visually identify RF hotspots around the antennas, this can only be done by detailed measurements or computer simulations.

For example, Aerts et al. conducted a detailed RF field mapping in Ghent, Belgium. They performed in total 650 broadband measurements in a city subarea of 1 km^2. The study found five hotspots, with max total electric field ranging from 1.3 to 3.1 V m^{-1} (Aerts et al., 2013). Their study showed, that significantly higher RF exposure levels are likely to occur than those reported by the majority of studies. In addition, they demonstrated that construction of a detailed RF heat map of the investigated area is important to characterize and outline the hotspot area.

1.1. The aim of the study

In this study we identified an area in Stockholm with an aggregation of base station antennas placed at low level, close to pedestrians' heads. The aim of this research is to point out highly exposed radiofrequency areas in the city environment and to analyze the sources and the reasons for the high exposure. We performed detailed measurements and constructed a detailed RF heat map. Such conclusions would help to better design the RF infrastructure sites with the aim of minimizing the public exposure. No ethical permission was needed since no test persons were involved.

2. Materials and methods

In this study spatial distribution of RF radiation sources was measured. The RF radiation sources were mobile phone base station antennas located at the Skeppsbron street, Stockholm, Sweden. This area is characterized by dense RF infrastructure as 15 mobile phone base station sectoral antennas from several operators are located on the same building complex, where the elevation from the street level is only few meters.

The site was selected by visually identifying radiofrequency sources, based on the dense packing of mobile phone base station antennas. Also the site is well suited for a scientific study, as it is positioned within the city center, whereas one side of the site is open to the sea where there are no RF sources nearby. The old town with old buildings is located on the other side of the street.

2.1. Study design

The measurements were conducted on a business day afternoon (January 14, 2019) with busy traffic which allows to assume higher network traffic. All measurements were done outdoor.

Field distribution was determined covering an area of 60 × 250 m, representing a street strip of old town buildings at one side and the sea (Strömmen) at the other side. The area is composed of the Skeppsbron street with busy traffic and pedestrians represented by a seaside promenade. Seaside promenade is filled with indoor and outdoor cafés, some operating throughout the year. Antennas are installed on top of those cafés. The promenade and the cafés are packed with hundreds of people on a holiday period – many of which at close range to the mobile phone base station antennas.

The area was covered by 3 × 11 quadrats, where each quadrat cell (quad) was measured with RF broadband analyzer by registering RF readings from one end of the quad to another by following North-South axis with a slow pace. For each quad, one moving measurement scan was done. Quads were drawn to both sides of the Skeppsbron street. Each quad measurement was done for about 1 min with average and maximum readings registered. The measurements were taken at the height from 1 to 1.8 m by moving the meter in circular movements along the quad. This allows covering the standing waves and detecting maximum radiation points.

RF broadband analyzer used was Narda NBM-520, with an E-field probe E0391 (Narda-Safety-Test-Solutions GmbH, Pfullingen, Germany). This meter of Narda NBM-series is capable of time and spatial averaging and determining the maximum level during the monitored period. Manufacturer's probe EF0391 is intended for base station measurements with a frequency range from 100 kHz to 3 GHz. This meter and the probe cover a large range of RF sources, including different telecommunications protocols: frequency modulation (FM) radio broadcasting; television (TV) broadcasting; TETRA emergency services (police, rescue, etc.); global system for mobile communications (GSM) second generation mobile communications; universal mobile telecommunications systems (UMTS) third generation mobile communications, 3G; long-term evolution (LTE) fourth generation mobile communications standard, 4G; digital European cordless telecommunications (DECT) cordless telephone systems standard; Wi-Fi wireless local area network protocol, 2.45 GHz; worldwide interoperability for microwave access (WIMAX) wireless communication standard for high speed voice, data and internet.

Later, the measurement readings were entered into vector mapping software 3DFIELD ver. 4.5.2.0 (by Vladimir Galouchko) and field distribution map created (in V m^{-1}). Field distribution map was based on quadrat measurement spatial averages by using kriging, which is a geostatistical calculation method.

Additionally to analyze the frequency composition the entire quadrat was in parallel also measured with an exposimeter EME Spy 200 b y Microwave Vision Group, Paris, France. The exposimeter measures 20 predefined frequency bands covering most public RF radiation emitting devices currently used in Sweden. The exposimeter covers frequencies from 88 to 5850 MHz. For FM, TV3, TETRA, TV4&5, Wi-Fi 2.4 GHz and

Wi-Fi 5 GHz the lower detection limit is 0.01 V m^{-1} (0.27 μW m^{-2}); for all other bands the lower detection limit is 0.005 V m^{-1} (0.066 μW m^{-2}). For all bands the upper detection limit is 6 V m^{-1} (95,544 μW m^{-2}; 9.5544 μW cm^{-2}). The sampling rate used in this study was every 4th second which is the fastest possible sampling rate for the given exposimeter when all bands are active. The exposimeter was held at some distance (about 0.4 m) from the body. The unit reports the exposure in a conservative manner since each reported value is the sampling outcome, where many samples are taken and statistically processed including minimum, mean, median and maximum values. The meters had valid calibration.

Based on Cellmapper.net mobile phone operators and their corresponding services, mobile bands and frequencies were determined (Table 1). A large number of base station sector antennas emit a multitude of downlink frequency spans (N = 14) covering 2G, 3G and 4G services. Service providers have their own allocated frequency spans, but some are shared.

2.2. Statistical methods

Broadband RF readings using Narda NBM-520 were collected in Volts per meter (V m^{-1}) based on quadrat measurements covering the entire area. Each quadrat produced a spatial average and maximum reading calculated on the space covered. Based on quadrat cells measurements, two samples were formed: one of spatial averages and the second of spatial maximums. For both samples minimum, quartiles, median and maximum were calculated containing all the spatial measurement values in the area, using MS Excel 2016.

Means in microWatts per square meter (μW m^{-2}) were calculated for all measured frequency bands for measurements using the exposimeter EME Spy 200. Values below the lower detection limit were treated as no (0) exposure. Total exposure was calculated as the sum of all measured frequency bands. Stata/SE 12.1 (Stata/SE 12.1 for Windows; StataCorp., College Station, TX, USA) was used for all calculations.

3. Results

The results display a greatly uneven distribution of the RF fields with hotspots. The close proximity to the RF sources creates highly elevated field levels in the immediate vicinity to the base station. Given the antennas elevation from the ground, people walking on the street are highly exposed when passing or hanging around the area.

Fig. 1 presents a boxplot of spatial RF distribution of the entire investigated area. Both spatial average and maximum readings of RF broadband analyzer are included in the graph. The fields emanated by the base station antennas overlapped at several locations, elevating the exposure to high levels. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading over the entire area was 31.6 V m^{-1} (2649 mW m^{-2}). These were far-field measurement results, the meter was not used in the near-field of antennas. The lowest spatial average quadrat was 1.4 V m^{-1} (5.2 mW m^{-2}) which is still relatively high, considering the levels reported by the review studies (Jalilian et al., 2019; Sagar et al., 2018) discussed in the Introduction chapter. This emphasizes that the entire microenvironment

Table 1
Mobile phone operators, their corresponding services and frequencies used at Skeppsbron, information from cellmapper.net.

Operator	Bands	Downlink frequency (MHz)
Telia	4G	806, 1815, 1832, 2660
	3G	2152, 2157
	2G	950
Telenor	4G	936, 1857, 2630, 2680
	3G	2112, 2122
Tele2	4G	936, 1857, 2630, 2680
	3G	2152, 2157, 2162

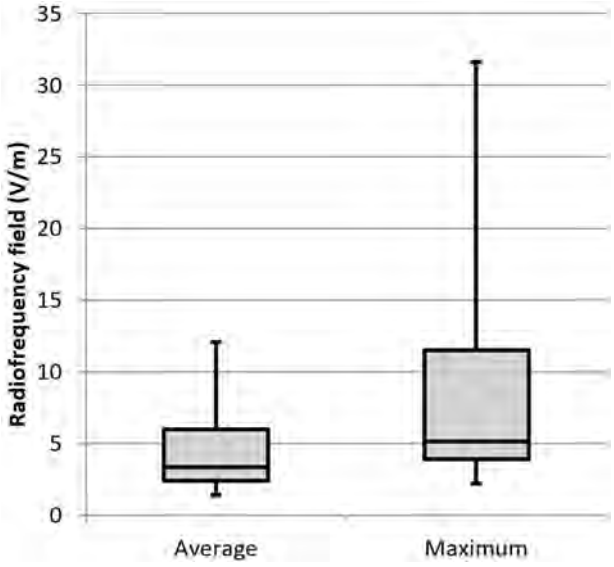


Fig. 1. Boxplot of spatial distribution of the radiofrequency field (V m^{-1}) at Skeppsbron street, based on quadrat measurements covering the entire area; sample is based on spatial averages and maximums of a quadrat cells; boxplot depicts (from bottom up) minimum, first quartile, median, third quartile and maximum of the sample containing all the spatial measurement values in the area.

in Skeppsbron street is covered with relatively high levels of radiofrequency radiation.

Fig. 2 displays a spatial distribution of the RF field at the Skeppsbron street. Exposure readings are based on spatial average of a given quadrat cell. High field levels are encountered close to the base station antennas, whereas the highest levels were not detected below the antenna, but at 26 m distance, directly on the line of the direction of sector antenna. The field decreases with increasing distance from the base station array, but is still significantly elevated at the entire 250 m length of the studied street area.

Highest field levels as registered across the street, may also refer to confounding action of building walls, as some building materials may reflect the incident waves, hence giving rise to resultant exposure level (Koppel et al., 2017a). Also the weather can play a role in microwave propagation as wet walls may increase building material microwave reflection properties (Koppel et al., 2017b).

Exposimeter measurements (mean of sample) showed that the majority of exposure was due to mobile phone downlink bands. Most dominant were 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. Also 800, 900 and 1800 MHz bands were clearly elevated in the frequency spectrum, which fits the 4G profile (Table 2). The exposimeter was unable to register the highest exposure levels as the upper detection limit was exceeded repeatedly. Therefore, FM, as well as 1800 MHz, 2100 MHz, and 2600 MHz downlinks were not properly evaluated by the exposimeter measurements. Meanwhile, broadband meter measurements were able to register also the highest levels.

Table 3 compares public exposure to radiofrequency fields in Stockholm, based on authors' studies – comparing this study at Skeppsbron street to previous measurements. Comparison is done based only on exposimeter (EME Spy 200) measurements, excluding broadband meter measurements. RF field comparison reveals that Skeppsbron street is one of the highest public exposure areas in Stockholm so far measured with the maximum field level exceeding upper detection limit of the exposimeter.

Figs. 3 and 4 are photographs of the street view with some of the mobile phone base station antennas pointed out. The antennas are placed quite low, near the street level, where microwaves irradiate



Fig. 2. Spatial distribution of the radiofrequency field (values in V m $^{-1}$) at Skeppsbron street, based on spatial average of a given quadrat cell; hotspots are displayed in darker red where pedestrians are exposed at close range or rays overlap from several mobile phone base station antennas; the investigated area measures about 250 m North to South; map by Lantmäteriet, Sweden. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 2
Exposimeter measurements of the radiofrequency field at Skeppsbron street, analysis of all data (μW m^{-2}) treating values at detection limit as 0. (Note: Exposimeter's highest detection limit (95,522.5 μW m^{-2} was constantly exceeded, therefore Max-values are likely to be much higher, as also confirmed by broadband measurements.) Total (n = 915).

Frequency band	Mean	Median	Min	Max
FM	1304.0	19.6	0.0	95,522.5
TV3	7.2	0.0	0.0	1601.4
TETRA I	0.0	0.0	0.0	1.0
TETRA II	0.0	0.0	0.0	4.7
TETRA III	2.3	0.0	0.0	403.4
TV4&5	17.4	0.6	0.0	2434.4
800 (DL)	751.3	164.5	0.7	12,978.6
800 (UL)	0.0	0.0	0.0	6.6
900 (UL)	0.0	0.0	0.0	8.6
900 (DL)	2545.3	926.5	0.4	35,473.9
1800 (UL)	71.0	8.3	0.0	3291.8
1800 (DL)	3466.6	714.5	3.6	95,522.5
DECT	367.6	0.0	0.0	36,548.9
2100 (UL)	0.1	0.0	0.0	45.5
2100 (DL)	6558.8	1237.4	1.7	95,522.5
WIFI 2G	0.4	0.0	0.0	61.3
2600 (UL)	689.5	154.1	0.0	17,275.1
2600 (DL)	11,338.3	3483.6	1.7	95,522.5
WIMax	0.2	0.0	0.0	58.9
WIFI 5G	0.4	0.0	0.0	93.8
Total	27,120.5	10,481.5	24.4	373,381.0

Table 3
Public exposure to radiofrequency field in Stockholm – this study compared authors' previous studies; exposimeter EME Spy 200 measurements; analysis of all data (μW m^{-2}) treating values at detection limit as 0.

Study	Total (n)	Mean	Median	Min	Max
Stockholm, Central Station (Hardell et al., 2016)	1669	3860.2	920.6	5.8	9206.3
Stockholm, Old Town (Hardell et al., 2017)	10,437	4292.7	534.0	0.0	173,301.8
Stockholm, City (Carlberg et al., 2019)	11,482	5494.2	3346.0	36.6	205,154.8
Stockholm, Järntorget, Old Town (Hardell et al., 2019)	792	21,354.9	12,655.3	381.7	178,928.2
Stockholm, Skeppsbron (current study)	915	27,120.5	10,481.5	24.4	373,381.0



Fig. 3. Street view on the Skeppsbron street with some of the mobile phone base station antennas pointed out with a circle; note the low placement of the antennas, where microwaves irradiate the pedestrian at close range.

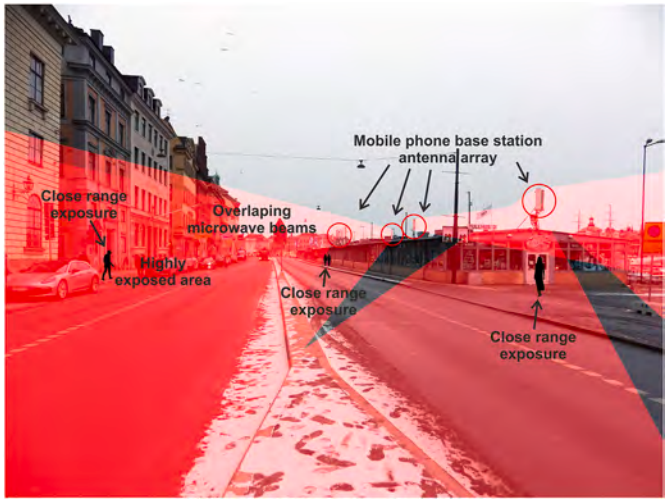


Fig. 4. Problem context of mobile phone base station antennas created high exposure at Skeppsbron street; altogether 15 antenna panels could be counted on that building, all positioned at low elevation close to the street level; the maximum RF exposure was at 31.6 V m^{-1}, registered at close range to the antennas.

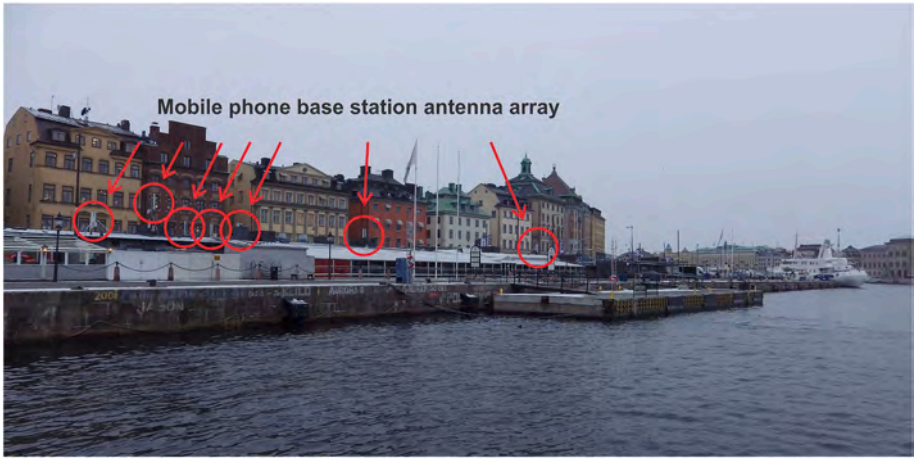


Fig. 5. The antennas are mostly facing the buildings, as the operators want to force the wave into the old town through the narrow streets. Considering the low placement of antennas and pushing all this power - creates very high exposure levels nearby.

pedestrians at close range. Fig. 5 depicts the context – very low placement of the antennas, most of which are targeting the buildings in order to push the microwave into the narrow streets and further into the old town.

4. Discussion

This study, and our previous ones, have recorded the exposure to RF radiation which will provide means for historic comparison for both public and occupational exposure. It is clear from our current study and the previous ones that the level of ambient RF radiation exposure is increasing, see Table 3. Public exposure in different places around the globe is shown in Table 4. Our average and peak RF measurement results are much higher than many of those measurements in that table, indicating a rather recent and rapid increase in radiofrequency radiation levels in city centers. To provide comparison, Bergqvist et al. (2001) measured 0,18 mW m^{-2} highest average levels in Stockholm city center in 2001 (Bergqvist et al., 2001). Swedish radiation protection authorities pointed out recently highest average levels like 720 mW m^{-2} at Järntorget (Esternberg, 2020) and 690 mW m^{-2} at Skeppsbron area (Umeå kommun 2019) in Stockholm. One possible reason for our high RF readings in 2019 was the upgrade of 4G (LTE) base stations with new antenna panels including more antenna elements for the forthcoming 5G (which started officially in Stockholm in 2020).With the development of mobile communications technologies and the widespread use of wireless services the exposure will continue to increase with substantially higher exposure levels and also ever increasing frequency bands, even though several research reports indicate health risks. These risks are relevant to those people working or living in the highly exposed places – in this study they are 1) people living in the apartments across the street from the antennas, 2) workers of the shops across the street and beneath the antennas.

This research identified an increased RF exposure risk area in the center of Stockholm city. Clearly we measured high RF radiation levels of the same magnitude at a square (Järntorget) in the old town (Hardell et al., 2019). These results may be compared with the Ramazzini Institute rat study on far field exposure to 1.8 GHz RF radiation of 0, 5, 25, 50 V m^{-1} with a whole-body exposure for 19 h/day similar to that from base stations (Falcioni et al., 2018). Increased incidence of glioma and heart tumours of the Scwannoma type were found, i.e. similar tumour types as found among people using wireless phones. A statistically significant increase in the incidence of malignant Schwannoma in the heart was found in male rats at the highest dose, 50 V m^{-1} corresponding to whole-body SAR of 0.1 W/kg. Increased non-significant incidence of heart Schwann cells hyperplasia was observed in exposed male and female rats at the highest dose. In irradiated female rats at the highest dose (50 V m^{-1}) the incidence of malignant glial tumours was increased, although not statistically significant. In the current study maximum exposure level of 31.6 V m^{-1} was measured. Thus, there is no reasonable safety limit comparing with the animal study.

Table 4
Public exposure to radiofrequency fields at different places.

Study	Investigated locations	Exposure (mean)
Joseph et al. (2010)	Europe, outdoor	372–569 μW m^{-2}
Bolte et al. (2011)	Netherlands, railway stations	304–354 μW m^{-2}
Bolte and Eikelboom (2012)	Netherlands, outdoor activities	208 μW m^{-2}
Rowley and Joyner (2012)	23 countries	730 μW m^{-2}
Urbinello et al. (2014)	Europe, Basel, Ghent, Brussels	271–892 μW m^{-2}
Verloock et al. (2014)	Belgium, public places	1020 μW m^{-2}
Estenberg and Augustsson (2014)	Stockholm city, Sweden	6700 μW m^{-2}
	Sweden, urban	1500 μW m^{-2}
	Sweden, rural	230 μW m^{-2}
Calvente et al. (2015)	Spain, Granada	799 μW m^{-2}
Gonzalez-Rubio et al. (2016)	Spain, Albecete	4,2–2102 μW m^{-2}
Choudhary and Vijay (2017)	India, Kota city residential	5452–77,840 μW m^{-2}
	industrial, commercial	2386–68,769 μW m^{-2}
	agricultural	2378–68,724 μW m^{-2}
	rural	1878–68,724 μW m^{-2}
Sánchez-Montero et al. (2017)	Spain, Alcalá de Henares	2006: 0.278 V m^{-1} (205 μW m^{-2})
		2010: 0.407 V m^{-1} (439 μW m^{-2})
		2015: 0.396 V m^{-1} (416 μW m^{-2})
Thielens et al. (2018)	Australia, Melbourne	0.05–0.89 V m^{-1} (6–2101 μW m^{-2})
Misek et al. (2018)	Ziina city, center	1.072 V m^{-1} (3048 μW m^{-2})
	residential	1.852 V m^{-1} (9097 μW m^{-2})
	rural	0.510 V m^{-1} (690 μW m^{-2})
	Visnove, rural	0.093 V m^{-1} (23 μW m^{-2})
Eeftens et al. (2018)	Europe, 5 countries	150–160 μW m^{-2}
Zeleke et al. (2018)	Australia, Melbourne	0.233 V m^{-1} (144 μW m^{-2})
Christopoulou and Karabetsos (2019)	Greece, urban	0.244 V m^{-1} (158 μW m^{-2})
	Greece, suburban	0.229 V m^{-1} (139 μW m^{-2})

Electromagnetic fields are a physical risk factor. However, current legislation does not require the mobile phone services operator to ask for approval from neighboring inhabitants, when installing RF sources. Nevertheless, when mobile phone base station antennas are installed, the immediate physical environment, including the neighborhood living environment is greatly altered by the microwaves.

Studies from recent decades have shown elevated health risk under long term exposure to such highly elevated radiofrequency fields.

A review by Khurana et al. (2010) found in 80% of the available studies neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations (Khurana et al., 2010). In another review exposure from base stations and other antenna arrays showed changes in immunological and reproductive systems as well as DNA double strand breaks, influence on calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells (Levitt and Lai, 2010).

When a GSM 900 MHz base station was installed in the village Rimbach in Germany it had an influence on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (Buchner and Eger, 2011). Influence on cortisol and thyroid hormones in people living near base stations was shown in other studies (Augner et al., 2010; Eskander et al., 2012).

Dode et al. (2011 compared base station (BS) clusters and cases of deaths by neoplasia in the Belo Horizonte municipality, Minas Gerais state, Brazil, from 1996 to 2006. In their study largest electric field was 12.4 V m^{-1} and the smallest was 0.4 V m^{-1}. They found cancer-related death rates be higher close to base stations. This finding confirmed earlier findings by Eger (Eger et al., 2004).

In a study from India, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. Genetic damage parameters of DNA migration length, damage frequency, and damage index were significantly ($p < 0.001$) elevated in the sample group compared to respective values in healthy controls (Gandhi et al., 2014).

The effect of RF radiation among 20 subjects living close to mobile phone base station compared with 20 subjects living with a distance of about 1 km was studied (Singh et al., 2016). The authors concluded that: "*It was unveiled that a majority of the subjects who were residing near the mobile base station complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties, and hypertension. A majority of the study subjects had significantly lesser stimulated salivary secretion ($p < 0.01$) as compared to the control subjects*."

Zothansiama et al. (2017) in India inspected DNA damage and antioxidant status in cultured human peripheral blood lymphocytes (HPBLs) of individuals residing in the vicinity of mobile phone base stations and compared it with healthy controls living further away. The analyses of data from the exposed group ($n = 40$), residing within a perimeter of 80 m of mobile base stations, showed statistically significantly ($p < 0.0001$) higher frequency of micronuclei when compared to the control group, residing 300 m away from the mobile base stations.

The Ramazzini Institute findings (Falcioni et al., 2018) are supported by the results in the USNTP study on rats and mice exposed to RF radiation (National Toxicology Program, 2018a, 2018b). A clear evidence of increased incidence of heart Schwannoma and some evidence for glioma and tumours in the adreanal medulla in male rats was found according to the expert panel, for further discussion see Hardell and Carlberg (2019).

4.1. Health risks associated with mobile phone radiation

RF radiation was in 2011 classified as a possible human carcinogen, Group 2B by the International Agency for Research on Cancer (IARC) at the WHO (Baan et al., 2011; IARC Working Group, 2013), After that the evidence on cancer risk has increased so that RF radiation may now be classified as a human carcinogen, Group 1 according to the IARC classification (Carlberg and Hardell, 2017).

By now there is concordance between tumours in human epidemiology (Belpomme et al., 2018; Miller et al., 2018) and animal studies (Falcioni et al., 2018; National Toxicology Program, 2018a, 2018b), that is glioma and Schwann cell tumours. These results are supported by mechanistic studies such as oxidative stress (Yakymenko et al., 2016) and DNA damage from RF radiation (Smith-Roe et al., 2020).

So far personal use of wireless phones, mobile and cordless phones (DECT), have yielded highest RF radiation exposure especially to children and to the brain (Gandhi et al., 2012). However, ambient exposure is of increasing concern and may now be of the same magnitude as for increasing cancer incidence in animal studies. This is exemplified in this study.

The BioInititative Report (2012) defines a target level of 30–60 μW m^{-2}, and for chronic exposure and sensitive people such as children one tenth of this, 3–6 μW m^{-2}, see Chapter 24 of the BioInitiative Report (Sage, and Carpenter, 2012).

Already in 2011 Yakymenko et al. stated that: *It is now becoming increasingly evident that assessment of biological effects of non-ionizing radiation based on physical (thermal) approach used in recommendations of current regulatory bodies, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines, requires urgent reevaluation* (Yakymenko et al., 2011).

This view is supported by 252 EMFscientists from 43 nations www.emfscientist.org:

> "Numerous recent scientific publications have shown that EMF [electromagnetic field] affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life."

5. Conclusions

This study has pointed out a highly exposed radiofrequency radiation area in the Stockholm city environment and identified the sources and reasons of high exposure. By positioning RF infrastructure to the proximity of the public the risk of health effects is increased since members of the public on the street, also inhabitants in nearby buildings are highly exposed. Mobile phone base station antennas are positioned at the height of second floor levels of adjacent buildings spreading microwaves across the street. Highly elevated exposure levels would likely be encountered in the premises next to the windows facing the mobile phone base station array.

The study concluded that Skeppsbron street mobile phone base station antennas are examples of a poor radiofrequency infrastructure design with mobile phone base station antennas positioned into close range to the general public which brings upon high exposure levels. Given the low placement of the antennas (height from the street floor), the highest exposure was often registered at pedestrian head level. Given that head is one of most vulnerable parts of the body, these placements by mobile telephony service providers put pedestrians into unnecessary risk. Position of these antennas, can pose a health risk to people at close range. This is especially critical for people at particular risk, including persons with medical implants, pregnant women or chronically ill persons.

Based on the latest scientific literature regarding RF exposure and adverse health effects, this study recommends repositioning such base station antennas to areas away from the nearby inhabitants, workers and the general public. Alternatively, very low power antennas may also be considered to reduce the exposure. Occupational exposure of people

working close to the antennas should also be considered – shop clerks, restaurant workers are likely to spend considerably longer time under high exposure, compared to the general public.

The following recommendations for radiofrequency infrastructure can be concluded from the current study.

1. Antennas should be positioned as far as possible from the general public, like locations at the high elevations or remote areas, where the antenna targeted area is not regularly/frequently visited by the members of the public.
2. Only low power output mobile phone base station antennas (<15W) should be used in the city environment.
3. To avoid hotspots, created by overlapping arrays, dense packing of many antennas at one site should be avoided.
4. Low power output antennas in the city environment should be positioned into locations where direct beam would not hit members of public closer than 50m.

The conclusions of this study will help to design safer mobile phone base station sites in the city environment, when the aim is to minimize public exposure.

Author contributions

T.K. and M.A. performed the measurements. Conception of the study, design and analyses of the material, writing of the article and approval of the final manuscript was made by all authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Aerts, S., Deschrijver, D., Verloock, L., Dhaene, T., Martens, L., Joseph, W., 2013. Assessment of outdoor radiofrequency electromagnetic field exposure through hotspot localization using kriging-based sequential sampling. Environ. Res. 126, 184–191. https://doi.org/10.1016/j.envres.2013.05.005 PMID:23759207.

Augner, C., Hacker, G.W., Oberfeld, G., Florian, M., Hitzl, W., Hutter, J., Pauser, G., 2010. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed. Environ. Sci. 23, 199–207. https://doi.org/10.1016/S0895-3988(10)60053-0 PMID:20708499.

Baan, R., Grosse, Y., Lauby-Secretan, B., El Ghissassi, F., Bouvard, V., Benbrahim-Tallaa, L., Guha, N., Islami, F., Galichet, L., Straif, K., 2011. WHO international agency for research on cancer monograph working group: carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol. 12, 624–626. https://doi.org/10.1016/S1470-2045(11)70147-4 PMID:21845765.

Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., Carpenter, D.O., 2018. Thermal and non-thermal health effects of low intensity non-ionizing radiation: an international perspective. Environ. Pollut. 242 (Pt A), 643–658. https://doi.org/10.1016/j.envpol.2018.07.019 PMID:30025338. https://www.sciencedirect.com/science/article/pii/S0269749118310157.

Bergqvist, U., Anger, G., Birke, E., Hamnerius, Y., Hillert, L., Larsson, L.E., Christer Törnevik, C., Zetterblad, J., 2001. Exponering för radiofrekventa fält och mobiltelefoni, SSI report [exposure to radiofrequency radiation and mobile phones. In: Swedish, English Summary], 2001:09 April 2001 ISSN 0282-4434. Report.

BioInitiative Working Group, 2012. BioInitiative Report: A Rationale for Biologically-Based Exposure Standards for Low-Intensity Electromagnetic Radiation. https://bioinitiative.org/table-of-contents/. (Accessed 27 October 2021).

Bolte, J.F.B., van der Zande, G., Kamer, J., 2011. Calibration and uncertainties in personal exposure measurements of radiofrequency electromagnetic fields. Bioelectromagnetics 32, 652–663 http://doi.wiley.com/10.1002/bem.20677. https://doi.org/10.1002/bem.20677 PMID:21544843.

Bolte, J.F.B., Eikelboom, T., 2012. Personal radiofrequency electromagnetic field measurements in The Netherlands: exposure level and variability for everyday activities, times of day and types of area. Environ. Int. 48, 133–142. https://doi.org/10.1016/j.envint.2012.07.006 PMID:22906414.

Buchner, K., Eger, H., 2011. Changes of clinically important Neurotransmitters under the influence of modulated RF fields—a long-term study under real-life conditions. Umwelt-Medizin-Gesellschaft 24, 44–57.

Calvente, I., Fernández, M.F., Pérez-Lobato, R., Dávila-Arias, C., Ocón, O., Ramos, R., Ríos-Arrabal, S., Villalba-Moreno, J., Olea, N., Núñez, M.I., 2015. Outdoor characterization of radio frequency electromagnetic fields in a Spanish birth cohort. Environ. Res. 138, 136–143. https://doi.org/10.1016/j.envres.2014.12.013 PMID:25707018.

Carlberg, M., Hardell, L., 2017. Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford hill viewpoints from 1965 on association or causation. BioMed Res. Int. 2017 9218486. https://doi.org/10.1155/2017/9218486 PMID:28401165.

Carlberg, M., Hedendahl, L., Koppel, T., Hardell, L., 2019. High ambient radiofrequency radiation in Stockholm city, Sweden. Oncol. Lett. 17, 1777–1783. PMID:30675237.

Choudhary, M.P., Vijay, S., 2017. Study on electromagnetic field radiation emission from mobile towers in kota city. Int. J. Innov .Res. Sci,. Engn Technoln 11, 21402–21409. https://doi.org/10.15680/IJIRSET.2017.0611061.

Christopoulou, M., Karabetsos, E., 2019. Evaluation of radiofrequency and extremely low-frequency field levels at children's playground sites in Greece from 2013 to 2018. Bioelectromagnetics 40, 602–605. https://doi.org/10.1002/bem.22220 PMID:31541484.

Dode, A.C., Leão, M.M., Tejo Fde, A., Gomes, A.C., Dode, D.C., Dode, M.C., Moreira, C. W., Condessa, V.A., Albinatti, C., Caiaffa, W.T., 2011. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. Sci. Total Environ. 409, 3649–3665. https://doi: 10.1016/j.scitotenv.2011.05.051.

Eeftens, M., Struchen, B., Birks, L.E., Cardis, E., Estarlich, M., Fernandez, M.F., Gajšek, P., Gallastegi, M., Huss, A., Kheifets, L., et al., 2018. Personal exposure to radio-frequency electromagnetic fields in Europe: is there a generation gap? Environ. Int. 121, 216–226. https://doi.org/10.1016/j.envint.2018.09.002 PMID:30216774.

Eger, H., Hagen, K.U., Lucas, B., Vogel, P., Voitet, H., 2004. Einfluss der räumlichen nähe von Mobilfunksendeanlagen Auf Die Krebsinzidenz. Umwelt-Medizin-Gesellschaft 17, 326–335 (In German, English summary).

Eskander, E.F., Estefan, S.F., Abd-Rabou, A.A., 2012. How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin. Biochem. 45, 157–161. https://doi.org/10.1016/j.clinbiochem.2011.11.006 PMID:22138021.

Estenberg, J., Auguststsson, T., 2014. Extensive frequency selective measurements of radiofrequency fields in outdoor environments performed with a novel mobile monitoring system. Bioelectromagnetics 35, 227–230. https://doi.org/10.1002/bem.21830 PMID:24375568.

Esternberg, 2020. Mätrapport. Radiovågsmätningar på Järntorget i Stockholm. [Measurement report. Radiofrequency radiation at Järntorget Stockholm, in Swedish]. Swedish Radiation Safety Authority. Document: SSM2019-10309-1, 2020. ssm_jarntorget-1.pdf (stralskyddsstiftelsen.se). (Accessed 27 October 2021).

Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Mandrioli, D., Manservigi, M., Manservisi, F., Manzoli, I., et al., 2018. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ. Res. 165, 496–503. https://doi.org/10.1016/j.envres.2018.01.037 PMID:29530389.

Gandhi, G., Morgan, L.L., de Salles, A.A., Han, Y.Y., Herberman, R.B., Davis, D., 2012. Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. Electromagn. Biol. Med. 31, 34–51. https://doi.org/10.3109/15368378.2011.622827.

Gandhi, G., Kaur, G., Nisar, U., 2014. A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station. Electromagn. Biol. Med. 9, 1–11. https://doi.org/10.3109/15368378.2014.933349.

Gonzalez-Rubio, J., Najera, A., Arribas, E., 2016. Comprehensive personal RF-EMF exposure map and its potential use in epidemiological studies. Environ. Res. 149, 105–112. https://doi.org/10.1016/j.envres.2016.05.010 PMID:27196609.

Hardell, L., Koppel, T., Carlberg, M., Ahonen, M., Hedendahl, L., 2016. Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields. Int. J. Oncol. 49, 1315–1324. https://doi.org/10.3892/ijo.2016.3657 PMID:27633090.

Hardell, L., Carlberg, M., Koppel, T., Hedendahl, L., 2017. High radiofrequency radiation at Stockholm old town: an exposimeter study including the royal castle, supreme court, three major squares and the Swedish parliament. Mol Clin. Onco.l 6, 462–476. https://doi.org/10.3892/mco.2017.1180 PMID:28413651.

Hardell, L., Carlberg, M., 2019. Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. Int. J. Oncol. 54, 111–127. PMID:30365129.

Hardell, L., Carlberg, M., Hedendahl, L.K., Koppel, T., Ahonen, M., 2019. Environmental radiofrequency radiation at the Järntorget square in Stockholm old town, Sweden in may, 2018 compared with results on brain and heart tumour risks in rats exposed to 1.8 GHz base station environmental emissions. World Acad. Sci. J. 1, 47–54. https://doi.org/10.3892/wasj.2018.5.

Hardell, L., Carlberg, M., Hedendahl, L.K., 2018. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: a case report. Oncol. Lett. 15, 7871–7883. https://doi.org/10.3892/ol.2018.8285 PMID:29725476.

IARC Working Group, 2013. IARC monographs on the evaluation of carcinogenic risks to humans. In: Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields, ume 102. International Agency for Research on Cancer, Lyon, France, 2013. http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf. (Accessed 27 October 2021).

Jalilian, H., Eeftens, M., Ziaei, M., Röösli, M., 2019. Public exposure to radiofrequency electromagnetic fields in everyday microenvironments: an updated systematic review for Europe. Environ. Res. 176, 108517. https://doi.org/10.1016/j.envres.2019.05.048 PMID:31202043.

Joseph, W., Frei, P., Röösli, M., Thuróczy, G., Gajsek, P., Trcek, T., Bolte, J., Vermeeren, G., Mohler, E., Juhász, P., et al., 2010. Comparison of personal radio

frequency electromagnetic field exposure in different urban areas across Europe. Environ. Res. 110, 658–663. https://doi.org/10.1016/j.envres.2010.06.009 PMID: 20638656.

Khurana, V.G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., Ahonen, M., 2010. Epidemiological evidence for a health risk from mobile phone base stations. Int. J. Occup. Environ. Health 16, 263–267. https://doi.org/10.1179/107735210799160192.

Koppel, T., Shishkin, A., Haldre, H., Toropovs, N., Vilcane, I., Tint, P., 2017a. Reflection and transmission properties of common construction materials at 2.4 GHz frequency. Energy Proc. 113, 158–165. https://doi.org/10.1016/j.egypro.2017.04.045.

Koppel, T., Vilcane, I., Mironov, V., Shiskin, A., Rubene, S., Tint, P., 2017b. Aerated concrete microwave reflection and transmission properties in a wet environment. In: Vide: Energy Procedia Environment. Technology. Resources, Rezekne, Latvia. Proceedings of the 11 International Scientific and Practical Conference, III, pp. 145–149. https://doi.org/10.17770/etr2017vol3.2619.

Koppel, T., Ahonen, M., Carlberg, M., Hedendahl, L.K., Hardell, L., 2019. Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. Oncol. Lett. 18, 5383–5391. https://doi.org/10.3892/ol.2019.10899 PMID:31612047.

Levitt, B., Lai, H., 2010. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ. Rev. 18 (NA), 369–395. https://doi.org/10.1139/a10-903.

Miller, A.B., Morgan, L.L., Udasin, I., Davis, D.L., 2018. Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). Environ. Res. 167, 673–683. https://doi.org/10.1016/j.envres.2018.06.043 PMID:30196934.

Misek, J., Laukova, T., Kohan, M., Veternik, M., Jakusova, V., Jakus, J., 2018. Measurement of low-level radiofrequency electromagnetic fields in the human environment. Acta Med. Martiniana 18, 27–33. https://doi.org/10.2478/acm-2018-0010.

National Toxicology Program, 2018a. NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 596. March 26-28, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf. (Accessed 27 October 2021).

National Toxicology Program, 2018b. NTP technical report on the toxicology and carcinogenesis studies in hsd:sprague Dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595. March 26-28, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf. (Accessed 27 October 2021).

Rowley, J.T., Joyner, K.H., 2012. Comparative international analysis of radiofrequency exposure surveys of mobile communication radio base stations. J. Expo. Sci. Environ. Epidemiol. 22, 304–315. https://doi.org/10.1038/jes.2012.13 PMID:22377680.

Sagar, S., Dongus, S., Schoeni, A., Roser, K., Eeftens, M., Struchen, B., Foerster, M., Meier, N., Adem, S., Röösli, M., 2018. Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: a systematic literature review. J. Expo. Sci. Environ. Epidemiol. 28, 147–160. https://doi.org/10.1038/jes.2017.13 PMID:28766560.

Sage, S., Carpenter, D., 2012. Key Scientific Evidence and Public Health Policy Recommendations (Supplement 2012). Prepared for the BioInitiative Working Group December 2012. https://www.bioinitiative.org/wp-content/uploads/pdfs/sec24_2012_Key_Scientific_Studies.pdf. (Accessed 27 October 2021).

Sánchez-Montero, R., Alén-Cordero, C., López-Espí, P.L., Rigelsford, J.M., Aguilera-Benavente, F., Alpuente-Hermosilla, J., 2017. Long term variations measurement of electromagnetic field exposures in Alcalá de Henares (Spain). Sci. Total Environ. 598, 657–668. https://doi.org/10.1016/j.scitotenv.2017.03.131 PMID:28454038.

Singh, K., Nagaraj, A., Yousuf, A., Ganta, S., Pareek, S., Vishnani, P., 2016. Effect of electromagnetic radiations from mobile phone base stations on general health and salivary function. J. Int. Soc. Prev. Community Dent. 6, 54–59. https://doi.org/10.4103/2231-0762.175413 PMID:27011934.

Smith-Roe, S.L., Wyde, M.E., Stout, M.D., Winters, J.W., Hobbs, C.A., Shepard, K.G., Green, A.S., Kissling, G.E., Shockley, K.R., Tice, R.R., et al., 2020. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ. Mol. Mutagen. 61, 276–290, 2020.

Thielens, A., Van den Bosschea, M., Brzozekc, C., Bhatt, C., Abramson, M., Benke, G., Martens, L., Joseph, W., 2018. Microenvironmental personal and head exposure measurements of radio-frequency electromagnetic fields in melbourne, Australia. In: Joint Annual Meeting of the Bioelectromagnetics Society and the European BioElectromagn Assoc (BioEM 2018), pp. 273–279.

Umeå Kommun, 2019. Informationsmöte Om 5G i Umeå Folkets Hus (Umeå municipality information meeting about 5G at umeå common house). Video recording. Monday 3 June. https://youtu.be/ihs13eFeBFg?t=2768. (Accessed 27 October 2021).

Urbinello, D., Joseph, W., Verloock, L., Martens, L., Röösli, M., 2014. Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities. Environ. Res. 134, 134–142. https://doi.org/10.1016/j.envres.2014.07.003 PMID:25127524.

Verloock, L., Joseph, W., Goeminne, F., Martens, L., Verlaek, M., Constandt, K., 2014. Assessment of radio frequency exposures in schools, homes, and public places in Belgium. Health Phys. 107, 503–513. https://doi.org/10.1097/HP.0000000000000149 PMID:25353235.

Yakymenko, I., Sidorik, E., Kyrylenko, S., Chekhun, V., 2011. Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems. Exp. Oncol. 33, 62–70. PMID: 21716201.

Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., Kyrylenko, S., 2016. Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn. Biol. Med. 35, 186–202. https://doi.org/10.3109/15368378.2015.1043557 PMID:26151230. http://www.tandfonline.com/doi/full/10.3109/15368378.2015.1043557.

Zeleke, B.M., Brzozek, C., Bhatt, C.R., Abramson, M.J., Croft, R.J., Freudenstein, F., Wiedemann, P., Benke, G., 2018. Personal exposure to radio frequency electromagnetic fields among Australian adults. Int J Environ Res Public Health 15, E2234. https://doi.org/10.3390/ijerph15102234 PMID:30321997.

Zothansiama, M.Z., Zosangzuali, M., Lalramdinpuii, M., Jagetia, G.C., 2017. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn. Biol. Med. 36, 295–305. https://doi.org/10.1080/15368378.2017.1350584 PMID:28777669.

COMMENT

Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest

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Abstract. The fifth generation, 5G, of radiofrequency (RF) radiation is about to be implemented globally without investigating the risks to human health and the environment. This has created debate among concerned individuals in numerous countries. In an appeal to the European Union (EU) in September 2017, currently endorsed by >390 scientists and medical doctors, a moratorium on 5G deployment was requested until proper scientific evaluation of potential negative consequences has been conducted. This request has not been acknowledged by the EU. The evaluation of RF radiation health risks from 5G technology is ignored in a report by a government expert group in Switzerland and a recent publication from The International Commission on Non-Ionizing Radiation Protection. Conflicts of interest and ties to the industry seem to have contributed to the biased reports. The lack of proper unbiased risk evaluation of the 5G technology places populations at risk. Furthermore, there seems to be a cartel of individuals monopolizing evaluation committees, thus reinforcing the no-risk paradigm. We believe that this activity should qualify as scientific misconduct.

Introduction

Most politicians and other decision-makers using guidelines for exposure to radiofrequency (RF) radiation seem to ignore the risks to human health and the environment. The fact that the International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) in May 2011 classified RF radiation in the frequency range of 30 kHz to 300 GHz to be a 'possible' human carcinogen, Group 2B (1,2), is being ignored. This has been recently exemplified in a hearing at the Tallinn Parliament in Estonia (3).

An important factor may be the influence on politicians by individuals and organizations with inborn conflicts of interests (COIs) and their own agenda in supporting the no-risk paradigm (4,5). The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has repeatedly ignored scientific evidence on adverse effects of RF radiation to humans and the environment. Their guidelines for exposure are based solely on the thermal (heating) paradigm and were first published in ICNIRP 1998 (6), updated in ICNIRP 2009 (7) and have now been newly published in ICNIRP 2020 (8), with no change of concept, only relying on thermal effects from RF radiation on humans. The large amount of peer-reviewed science on non-thermal effects has been ignored in all ICNIRP evaluations (9,10). Additionally, ICNIRP has successfully maintained their obsolete guidelines worldwide.

COIs can be detrimental, and it is necessary to be as unbiased as possible when assessing health risks. There are three points that should be emphasized. Firstly, the evidence regarding health risks from environmental factors may not be unambiguous, and therefore informed judgements must be made. Furthermore, there are gaps in knowledge that call for experienced evaluations, and no conclusion can be reached without value judgements. Secondly, paradigms are defended against the evidence and against external assessments by social networks in the scientific community. Thirdly, the stronger the impact of decisions about health risks on economic, military and political interests, the stronger will stakeholders try to influence these decision processes.

Since the IARC evaluation in 2011 (1,2), the evidence on human cancer risks from RF radiation has been strengthened based on human cancer epidemiology reports (9-11), animal carcinogenicity studies (12-14) and experimental findings on oxidative mechanisms (15) and genotoxicity (16). Therefore, the IARC Category should be upgraded from Group 2B to Group 1, a human carcinogen (17).

The deployment of the fifth generation, 5G, of RF radiation is a major concern in numerous countries, with groups of citizens trying to implement a moratorium until thorough research

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on adverse effects on human health and the environment has been performed. An appeal for a moratorium, currently signed by >390 international scientists and medical doctors, was sent to the European Union (EU) in September 2017 (18), currently with no EU response (19). Several regions have implemented a moratorium on the deployment of 5G motivated by the lack of studies on health effects, for instance Geneva (20).

In the present article, the current situation in Switzerland is discussed as an example (21). Additionally, the ICNIRP 2020 evaluation is discussed (8).

Evaluation of health risks in Switzerland

Several Swiss citizens have brought to our attention that Associate Professor Martin Röösli is the chair of two important government expert groups in Switzerland (directeur), despite possible COIs and a history of misrepresentation of science (22,23). These groups are Beratende Expertengruppe NIS (BERENIS; the Swiss advisory expert group on electromagnetic fields and non-ionizing radiation) (24), and the subgroup 3, the Mobile Communications and Radiation Working Group of the Department of the Environment, Transport, Energy and Communications/Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation, evaluating RF-radiation health risks from 5G technology (25,26).

The conclusions made in the recent Swiss government 5G report are biased and can be found here (27,28). This 5G report concluded that there is an absence of short-term health impacts and an absence or insufficient evidence of long-term effects [see Table 17 (Tableau 17) on page 69 in the French version (27) and Table 17 (Tabelle 17) on page 67 in the German version (28)].

Furthermore, it was reported that there is limited evidence for glioma, neurilemmoma (schwannoma) and co-carcinogenic effects, and insufficient evidence for effects on children from prenatal exposure or from their own mobile phone use. Regarding cognitive effects, fetal development and fertility (sperm quality), the judgement was that the evidence on harmful effects is insufficient. These evaluations were strikingly similar to those of the ICNIRP (see Appendix B in ICNIRP 2020; 8). Other important endpoints, such as effects on blood-brain barrier, cell proliferation, apoptosis (programmed cell death), oxidative stress (reactive oxygen species) and gene and protein expression, were not evaluated.

According to Le Courrier November 19, 2019, Martin Röösli presented the conclusion in an interview in the following way: '*Sur l'aspect sanitaire pur, «le groupe de travail constate que, jusqu'à présent, aucun effet sanitaire n'a été prouvé de manière cohérente en dessous des valeurs limites d'immissions fixées», résume Martin Röösli, professeur d'épidémiologie environnementale à l'Institut tropical et de santé publique suisse*' (29). [*Regarding the health issue, the working group concludes that, until now, no health effect has been consistently proven below the given exposure limits, summarizes Martin Röösli, professor in environmental epidemiology at the Swiss Tropical and Public Health Institute*].

This Swiss evaluation is scientifically inaccurate and is in opposition to the opinion of numerous scientists in this field (18). In addition, 252 electromagnetic field (EMF) scientists from 43 countries, all with published peer-reviewed research on the biologic and health effects of nonionizing electromagnetic fields (RF-EMF) have stated that:

'*Numerous recent scientific publications have shown that RF-EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life*' (30).

We are concerned that the Swiss 5G report may be influenced by ties to mobile phone companies (COIs) by one or several members of the evaluating group.

COIs

Funding from telecom companies is an obvious COI. Martin Röösli has been a member of the board of the telecom funded Swiss Research Foundation for Electricity and Mobile Communication (FSM) organization and he has received funding from the same organization (31-33).

It should be noted that the FSM is a foundation that serves formally as an intermediate between industry and researchers. According to their website, among the five founders of FSM who '*provided the initial capital of the Foundation*' four are telecommunications companies: Swisscom, Salt, Sunrise, 3G Mobile (liquidated in 2011). The fifth founder is ETH Zurich (technology and engineering university). There are only two sponsors, Swisscom (telecommunications) and Swissgrid (energy), who '*support the FSM with annual donations that allow for both the management of the Foundation and research funding*' (34).

The same situation applies to being a member of ICNIRP (Table I) (35). In 2008, the Ethical Council at Karolinska Institute in Stockholm stated that being a member of ICNIRP is a potential COI. Such membership should always be declared. This verdict was based on activities by Anders Ahlbom in Sweden, at that time a member of ICNIRP, but is a general statement (2008-09-09; Dnr, 3753-2008-609). In summary: '*It is required that all parties clearly declare ties and other circumstances that may influence statements, so that decision makers and the public may be able to make solid conclusions and interpretations. AA [Anders Ahlbom] should thus declare his tie to ICNIRP whenever he makes statements on behalf of authorities and in other circumstances*' (translated into English).

COIs with links to industry are of great importance; these links may be direct or indirect funding for research, payment of travel expenses, participation in conferences and meetings, presentation of research, etc. Such circumstances are not always declared as exemplified above. A detailed description was recently presented for ICNIRP members (22).

ICNIRP

ICNIRP is a non-governmental organization (NGO) based in Germany. Members are selected via an internal process, and the organization lacks transparency and does not represent the

Table I. Members of the WHO core group and additional experts of the Environmental Health Criteria Document 2014 (54), EU SCENIHR 2015 (52), the SSM 2015-2020 (93) and ICNIRP commission or the Scientific Expert Group 1992-2020 (94).

Members	WHO, 2014	SCENIHR, 2015	SSM, 2015-2020	ICNIRP, 1992-2020
Emilie van Deventer	X		X	X[a]
Simon Mann	X			X
Maria Feychting	X		(X)[b]	X
Gunnhild Oftedal	X			X
Eric van Rongen	X		X	X
Maria Rosaria Scarfi	X	X	X	X
Jukkka Juutilainen	X			X
Denis Zmirou	X			
Theodoros Samaras		X		
Norbert Leitgeb		X		
Anssi Auvinen		X		X
Heidi Danker Hopfe		X	X	
Kjell Hansson Mild		X		
Mats Olof Mattsson		X		X
Hannu Norppa		X		
James Rubin	X	X		
Joachim Schüz		X		
Zenon Sienkiewicz	X	X		X
Olga Zeni	X	X		
Anke Huss			X	X[c]
Clemens Dasenbrock			X	X
Lars Klaeboe			X	
Martin Röösli	X		X	X
Aslak Harbo Poulsen			X	

[a]WHO Observer in the main commission (95); [b]2002-2011; [c]2020-2024. The table is based on members of WHO, SCENIHR and SSM during the defined time period(s). No other individuals among those within WHO or SCENIHR were found in the list of SSM participants. A total of 15 additional experts in WHO were not members of SCENIHR, SSM or ICNIRP. SCENIHR, Scientific Committee on Emerging and Newly Identified Health Risks; SSM, Swedish Radiation Safety Authority; WHO, World Health Organization; EU, European Union; ICNIRP, International Commission on Non-Ionizing Radiation Protection.

opinion of the majority of the scientific community involved in research on health effects from RF radiation. Independent international EMF scientists in this research area have declared that: '*In 2009, the ICNIRP released a statement saying that it was reaffirming its 1998 guidelines, as in their opinion, the scientific literature published since that time has provided no evidence of any adverse effects below the basic restrictions and does not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields. ICNIRP continues to the present day to make these assertions, in spite of growing scientific evidence to the contrary. It is our opinion that, because the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, they are insufficient to protect public health*' (30).

ICNIRP only acknowledges thermal effects from RF radiation. Therefore, the large body of research on detrimental non-thermal effects is ignored. This was further discussed in a peer-reviewed scientific comment article (3).

In 2018, ICNIRP published '*ICNIRP Note: Critical Evaluation of Two Radiofrequency Electromagnetic Field Animal Carcinogenicity Studies Published in 2018*' (36). It is surprising that this note claims that the histopathological evaluation in the US National Toxicology Program (NTP) study on animals exposed to RF radiation was not blinded (12,13). In fact, unfounded critique of the NTP study had already been rebutted (37); however, this seems to have had little or no impact on this ICNIRP note casting doubt on the findings of the animal study: '*This commentary addresses several unfounded criticisms about the design and results of the NTP study that have been promoted to minimize the utility of the experimental data on RFR [radiofrequency radiation] for assessing human health risks. In contrast to those criticisms, an expert peer-review panel recently concluded that the NTP studies were well designed, and that the results demonstrated that both GSM- and CDMA-modulated RFR were carcinogenic to the heart (schwannomas) and brain (gliomas) of male rats*' (37).

In contrast to the opinion of the 13 ICNIRP commission members, the IARC advisory group of 29 scientists from 18 countries has recently stated that the cancer bioassay in experimental animals and mechanistic evidence warrants high priority re-evaluation of the RF radiation-induced carcinogenesis (38).

ICNIRP draft. On July 11, 2018, ICNIRP released a draft on guidelines (39) for limiting exposure to time-varying electric, magnetic and electromagnetic fields (100 kHz to 300 GHz). It was open for public consultations until October 9, 2018. Appendix B was based on assessment of health risks based on a literature survey (39).

Surprisingly, the IARC classification of RF-EMF exposure as Group 2B ('possibly' carcinogenic to humans) from 2011 was concealed in the background material to the new ICNIRP draft on guidelines. Notably, one of the ICNIRP commission members, Martin Röösli (40), was also one of the IARC experts evaluating the scientific RF carcinogenicity in May 2011 (41). He should be well aware of the IARC classification. The IARC classification contradicts the scientific basis for the ICNIRP guidelines, making novel guidelines necessary and providing a basis to halt the rollout of 5G technology.

Therefore, the ICNIRP provides scientifically inaccurate reviews for various governments. One issue is that only thermal (heating) effects from RF radiation are considered, and all non-thermal effects are dismissed. An analysis from the UK demonstrates these inaccuracies (4), also discussed in another article (5). All members of the ICNIRP commission are responsible for these biased statements that are not based on solid scientific evidence.

ICNIRP release of novel guidelines for RF radiation. On March 11, 2020, ICNIRP published their novel guidelines for exposure to EMFs in the range of 100 kHz to 300 GHz, thus including 5G (8). The experimental studies demonstrating a variety of non-thermal biological/health effects (9,10) are not considered, as in their previous guidelines (6,7). Additionally, the ICNIRP increased the reference levels for the general public averaged over 6 min for RF frequencies >2-6 GHz (those that will be used for 5G in this frequency range), from 10 W/m^2 (Tables 5 and 7 in ref. no. 6) to 40 W/m^2 (Table 6 in ref. no. 8), which paves the way for even higher exposure levels to 5G than the already extremely high ones.

Background dosimetry is discussed in Appendix A of the ICNIRP 2020 guidelines (8). The discussion on 'Relevant Biophysical Mechanisms' should be criticized. The only mechanism considered by ICNIRP is temperature rise, which may also occur with 5G exposure, apart from the established non-thermal biological/health effects (42,43). It is well known among experts in the EMF-bioeffects field that the recorded cellular effects, such as DNA damage, protein damage, chromosome damage and reproductive declines, and the vast majority of biological/health effects are not accompanied by any significant temperature rise in tissues (44-47). The ion forced-oscillation mechanism (48) should be referred to as a plausible non-thermal mechanism of irregular gating of electrosensitive ion channels on cell membranes, resulting in disruption of the cell electrochemical balance and initiating free radical release and oxidative stress in the cells, which in turn causes genetic damage (15,49). The irregular gating of ion channels on cell membranes is associated with changes in permeability of the cell membranes, which ICNIRP admits in its summary (8).

Health risks are discussed in Appendix B of the ICNIRP 2020 guidelines (8). Again, only thermal effects are considered, whereas literature on non-thermal health consequences is disregarded (9,10,50). In spite of public consultations on the draft, the final published version on health effects is virtually identical to the draft version, and comments seem to have been neglected (19). In the following section, Appendix B on health effects (8) is discussed.

Appendix B starts with: '*The World Health Organization (WHO) has undertaken an in-depth review of the literature on radiofrequency electromagnetic fields (EMFs) and health, which was released as a Public Consultation Environmental Health Criteria Document in 2014... Further, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), a European Commission initiative, also produced a report on potential health effects of exposure to electromagnetic fields (SCENIHR 2015), and the Swedish Radiation Safety Authority (SSM) have produced several international reports regarding this issue (SSM 2015, 2016, 2018). Accordingly, the present guidelines have used these literature reviews as the basis for the health risk assessment associated with exposure to radiofrequency EMFs rather than providing another review of the individual studies'.*

In the last 11 years since its previous ICNIRP 2009 statement (7), ICNIRP has not managed to conduct a novel evaluation of health effects from RF radiation. However, as shown in Table I, several of the present ICNIRP members are also members of other committees, such as the EU Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), the Swedish Radiation Safety Authority (SSM) and the WHO, thus creating a cartel of individuals known to propagate the ICNIRP paradigm on RF radiation (4,5,22,51). In fact, six of the seven expert members of the WHO, including Emelie van Deventer, were also included in ICNIRP (5,7). Therefore, Emilie van Deventer, the team leader of the Radiation Programme at WHO (the International EMF Project), is an observer on the main ICNIRP commission, and SSM seems to be influenced by ICNIRP. Among the current seven external experts (Danker-Hopfe, Dasenbrock, Huss, Harbo Polusen, van Rongen, Röösli and Scarfi), five are also members of ICNIRP, and van Deventer used to be part of SSM.

As discussed elsewhere (5), it is unlikely that a person's evaluation of health risks associated with exposure to RF radiation would differ depending on what group the person belongs to. Therefore, by selecting group members, the final outcome of the evaluation may already be predicted (no-risk paradigm). Additionally, we believe that this may compromise sound scientific code of conduct.

The SCENIHR report from 2015 (52) has been used to legitimate the further expansion of the wireless technology and has been the basis for its deployment in a number of countries. One method, applied in the SCENIHR report, to dismiss cancer risks involves the selective inclusion of studies, excluding studies reporting cancer risks and including some investigations with inferior epidemiological quality. The report has been heavily criticized by researchers with no COI (53): '*In January of 2015, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) published its final opinion on (P)otential health effects of exposure to electromagnetic fields... SCENIHR has not answered the question it was appointed to investigate. The Committee has answered a*

different question, limiting its conclusions to whether certainty or causal effect is established, instead of possibility of health risks... Overall, SCENIHR has not conducted a scientific review process for judging possible health risks. This results in erroneous and deceptive conclusions by failing to conclude such possible health risks do exist. Evidence that SCENIHR has presented clearly and conclusively demonstrates that EMF health risks are possible, and in some cases are established. The Committee is obligated to draw to the attention of the European Commission that EMF is a new and emerging problem that may pose an actual or potential threat'.

Regarding the SSM, only yearly updates are available and no overall evaluations are made. Therefore, no thorough review is presented. Over the years, the ICNIRP has dominated this committee (Table I). Therefore, it is unlikely that the opinion of the SSM will differ from that of the ICNIRP.

In 2014, the WHO launched a draft of a Monograph on RF fields and health for public comments (54). It should be noted that the WHO issued the following statement: '*This is a draft document for public consultation. Please do not quote or cite*'. ICNIRP completely ignored that request and used the aforementioned document. The public consultations on the draft document were dismissed and never published.

In addition to van Deventer, five of the six members (Mann, Feychting, Oftedal, van Rongen, and Scarfi) of the Core Group in charge of the WHO draft were also affiliated with ICNIRP, which constitutes a COI (Table I). Scarfi is a former member of ICNIRP (5). Several individuals and groups sent critical comments to the WHO on the numerous shortcomings in the draft of the Monograph on RF radiation. In general, the WHO never responded to these comments and it is unclear to what extent, if any, they were even considered. Nevertheless, the final version of the WHO 'in-depth review' has never been published. Instead, WHO made a call on October 8, 2019 (Emelie van Deventer), for systematic reviews to analyze and synthesize the available evidence: '*Through this Call, WHO invites eligible teams to indicate their interest in undertaking a systematic review on one (or more) of the following topics: SR1 - Effect of exposure to RF on cancer (human observational studies); SR2 - Effect of exposure to RF on cancer (animal studies); SR3 - Effect of exposure to RF on adverse reproductive outcomes (human observational studies); SR4 - Effect of exposure to RF on adverse reproductive outcomes (animal and in vitro studies); SR5 - Effect of exposure to RF on cognitive impairment (human observational studies; SR6 - Effect of exposure to RF on cognitive impairment (human experimental studies); SR7 - Effect of exposure to RF on symptoms (human observational studies); SR8 - Effect of exposure to RF on symptoms (human experimental studies; SR9 - Effect of exposure to RF on biomarkers of oxidative stress; SR10 - Effect of exposure to heat from any source and pain, burns, cataract and heat-related illness*'.

The authors of the present article were part of a team that applied to review SR1- human cancer. On December 20, 2019, the following reply was received from the WHO Radiation Programme: '*After careful review, we have decided to choose another team for this systematic review*'.

Transparency is of importance for the whole process. Therefore, a query was sent to the WHO requesting information regarding the following points: '*Who did the evaluation of the groups that answered the call? What criteria were applied? How many groups had submitted and who were these? Which groups were finally chosen for the different packages?*'. In spite of sending the request four times, January 2, January 3, April 7 and April 30, 2020, there has been no reply from WHO. This appears to be a secret process behind closed doors. These circumstances have also been reported in Microwave News (55).

It is important to comment on the current ICNIRP evaluation. Notably, on February 27, 2020, two weeks before the ICNIRP publication, the WHO Team on Public Health, Environmental and Social Determinants of Health issued a statement on 5G mobile networks and health: '*To date, and after much research performed, no adverse health effect has been causally linked with exposure to wireless technologies*' (56). This statement is not correct based on current knowledge (4,5,9-11,17,19) and was without a personal signature. The lack of research on 5G safety has been previously discussed (19). Furthermore, there is no evidence that can 'causally link' an adverse effect to an exposure. Causality is no empirical fact, it is an interpretation.

In the following section, only one (cancer) of the eight different end points in the ICNIRP publication (8) is discussed, since it deals with our main research area.

viii) Cancer.

'I*n summary, no effects of radiofrequency EMFs on the induction or development of cancer have been substantiated.*

Summary

The only substantiated adverse health effects caused by exposure to radiofrequency EMFs are nerve stimulation, changes in the permeability of cell membranes, and effects due to temperature elevation. There is no evidence of adverse health effects at exposure levels below the restriction levels in the ICNIRP (1998) guidelines and no evidence of an interaction mechanism that would predict that adverse health effects could occur due to radiofrequency EMF exposure below those restriction levels'.

Comments

The ICNIRP draft (39) has been previously described to some extent (19). The published final version on health effects is virtually similar to the draft. It cannot be taken at face value as scientific evidence of no risk from RF radiation. One example is the following statement (p. 41): '*...a set of case-control studies from the Hardell group in Sweden report significantly increased risks of both acoustic neuroma and malignant brain tumors already after less than five years since the start of mobile phone use, and at quite low levels of cumulative call time'*.

This allegation is not correct according to our publication for glioma (11). In the shortest latency group >1-5 years, the risk of glioma was not increased (odds ratio (OR), 1.1; 95% CI, 0.9-1.4) for use of wireless phones (mobile phone and/or cordless phone). There was a statistically significant increased risk of glioma per 100 h of cumulative use (OR, 1.011; 95% CI, 1.008-1.014) and per year of latency (OR, 1.032; 95% CI,

1.019-1.046) (11). These published results are in contrast to the ICNIRP claims.

Regarding acoustic neuroma, the corresponding detailed results are reported in our previous study (57). The shortest latency period >1-5 years yielded an OR of 1.2 (95% CI, 0.8-1.6) for use of wireless phones; the risk increased per 100 h of cumulative use (OR, 1.008; 95% CI, 1.002-1.014) and per year of latency (OR, 1.056; 95% CI, 1.029-1.085) (57). Therefore, the allegation by ICNIRP is false.

It is remarkable that ICNIRP is uninformed and that their writing is based on a misunderstanding of the peer-reviewed published articles as exemplified above. Additionally, our studies (11,57) and another study by Coureau *et al* (58), as well as the IARC evaluation from 2011 (1,2), are not included among the references. Several statements by ICNIRP are made without any scientific references. On the other hand, the Danish cohort study on mobile phone use (59) is included, in spite of the fact that it was judged by IARC (1,2), as well as in our review (60), to be uninformative. A biased article written by authors including ICNIRP members, used to 'prove' the no-risk paradigm for RF radiation carcinogenesis (23), is cited by ICNIRP. Notably, the article has not undergone relevant peer-review and we believe that it should not have been published in its current version. The shortcomings in the aforementioned article are discussed in the following sections. As discussed below, another claim (23) is incorrect regarding increased risk of brain tumors associated with use of wireless phones: '*However, they are not consistent with trends in brain cancer incidence rates from a large number of countries or regions, which have not found any increase in the incidence since mobile phones were introduced'*.

The criticism of the ICNIRP draft guidelines from 2018 by the EMF call (61) can also be applied to the current ICNIRP publication. The call has been signed by 164 scientists and medical doctors, as well as 95 NGOs: '*The International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued draft Guidelines on 11th July 2018 for limiting exposure to electric, magnetic and electromagnetic fields (100 kHz to 300 GHz).1 These guidelines are unscientific, obsolete and do not represent an objective evaluation of the available science on effects from this form of radiation. They ignore the vast amount of scientific findings that clearly and convincingly show harmful effects at intensities well below ICNIRP guidelines.2 The guidelines are inadequate to protect humans and the environment. ICNIRP guidelines only protect against acute thermal effects from very short and intense exposure. The guidelines do not protect against harmful effects from low-intensity and long-term exposure, such as cancer, reproductive harm, or effects on the nervous system, although these effects are convincingly shown to appear from chronic exposure at intensities below ICNIRP limits.2,3*

ICNIRP's mandate to issue exposure guidelines needs to be seriously questioned. ICNIRP is not independent of industry ties as it claims.12,13 Its opinions are not objective, not representative of the body of scientific evidence, but are biased in favor of industry. It is obvious from their reluctance to consider scientific findings of harm that ICNIRP protects industry, not the public health, nor the environment.

We ask the United Nations, the World Health Organization, and all governments to support the development and consideration of medical guidelines16, that are independent of conflict of interests in terms of direct or indirect ties to industry, that represent the state of medical science, and that are truly protective'.

In the recent report on ICNIRP published by two Members of the European Parliament it is concluded: '*That is the most important conclusion of this report: For really independent scientific advice we cannot rely on ICNIRP. The European Commission and national governments, from countries like Germany, should stop funding ICNIRP. It is high time that the European Commission creates a new, public and fully independent advisory council on non-ionizing radiation*' (22).

Other examples of scientific misrepresentation

Published article. This section discusses an article with conclusions not substantiated by scientific evidence, representing a biased evaluation of cancer risks from mobile phone use and is an example of lack of objectivity and impartiality (23). The aforementioned report was used by ICNIRP 2020 (8) to validate that no risks have been found for brain and head tumors. Therefore, the article should be discussed in further detail.

The aforementioned article has numerous severe scientific deficiencies. One is that the results on use of cordless phones as a risk factor for brain tumors are not discussed. In fact, detailed results on cordless phones in studies by Hardell *et al* (11,57) are omitted.

When discussing glioma risk, all results on cumulative use of mobile phones, as well as ipsilateral or contralateral use associated with tumor localization in the brain, are omitted from the figures in the main text. Some results in the article by Röösli *et al* (23), such as cumulative use, can be found in the Supplementary Material, although the increased risk among heavy users is disregarded (11,57,58,62). In Supplementary Figure 4, all odds ratios regarding long-term (≥10 years) use of mobile phones are above unity (>1.0) for glioma and neuroma (23). No results are provided for ipsilateral mobile phone use (same side of tumor localization and mobile phone use), which is of large biological importance. Results on cumulative use, latency and ipsilateral use are especially important for risk assessment and have shown a consistent pattern of increased risk for brain and head tumors (11,57).

In the aforementioned article, recall bias is discussed as the reason for increased risk (23). The studies by Hardell *et al* (11,57) included all types of brain tumors. In one analysis, meningioma cases in the same study were used as the 'control' entity (11), and still a statistically significant increased risk of glioma was identified for mobile phone use (ipsilateral OR, 1.4; 95% CI, 1.1-1.8; contralateral OR, 1.0; 95% CI, 0.7-1.4) and for cordless phone use (ipsilateral OR, 1.4; 95% CI, 1.1-1.9; contralateral OR, 1.1; 95% CI, 0.8-1.6). If the results were 'explained' by recall bias, similar results would have been obtained for both glioma and meningioma. Thus, this type of analyses would not have yielded an increased glioma risk. Also, for acoustic neuroma a statistically significant increased risk was found using meningioma cases as 'controls' (57). Therefore, the results in the studies by Hardell *et al* (11,57) cannot be explained by a systematic difference in assessment

of exposure between cases and controls. These important methodological findings were disregarded by Röösli *et al* (23).

In the analyses of long-term use of mobile phones, a Danish cohort study on mobile phone use is included (59), which was concluded to be uninformative in the 2011 IARC evaluation (1,2). A methodological shortcoming of the aforementioned study was that only private mobile phone subscribers in Denmark between 1982 and 1995 were included in the exposure group (59). The most exposed group, comprising 200,507 corporate users of mobile phones, were excluded and instead included in the unexposed control group consisting of the rest of the Danish population. Users with mobile phone subscription after 1995 were not included in the exposed group and were thus treated as unexposed at the time of cut-off of the follow up. No analysis of laterality of mobile phone use in relation to tumor localization was performed. Notably, this cohort study is now included in the risk calculations, although Martin Röösli was a member of the IARC evaluation group and should have been aware of the IARC decision. The numerous shortcomings in the Danish cohort study, discussed in detail in a peer-reviewed article (60), are omitted in the article by Röösli *et al* (23).

Regarding animal studies, a study by Falcioni *et al* (14) at the Ramazzini Institute on RF radiation carcinogenesis is only mentioned as a reference, but the results are not discussed. In fact, these findings (14) provide supportive evidence on the risk found in human epidemiology studies (3), as well as the results in the NTP study (12,13).

Furthermore, for incidence studies on brain tumors, the results are not presented in an adequate way. There is a lot of emphasis on the Swedish Cancer Register data (63,64), but the numerous shortcomings in the reporting of brain tumor cases to the register are not discussed. These shortcomings have been presented in detail in a previous study (63), but are disregarded by Röösli *et al* (23).

There is clear evidence from several countries regarding increasing numbers of patients with brain tumors, such as in Sweden (63,64), England (65), Denmark (66) and France (67).

The article by Röösli *et al* (23), does not represent an objective scientific evaluation of brain and head tumor risk associated with the use of wireless phones, and should thus be disregarded. By omitting results of biological relevance and including studies that have been judged to be uninformative, the authors come to the conclusion that there are no risks: '*In summary, current evidence from all available studies including in vitro, in vivo, and epidemiological studies does not indicate an association between MP [mobile phone] use and tumors developing from the most exposed organs and tissues'*.

Röösli *et al* (23), disregard the concordance of increased cancer risk in human epidemiology studies (11,57,58,62) animal studies (12-14,68,69) and laboratory studies (15,16,37). It is unfortunate that the review process of the aforementioned article has not been of adequate quality. Finally, there is no statement in the article of specific funding of this particular work, which is not acceptable. Only a limited number of comments on general funding are provided. It is not plausible that there was no funding for the study. We believe that, due to its numerous limitations, the aforementioned article should not have been published.

CEFALO. In 2011, a case-control study on mobile phone use and brain tumor risk among children and adolescents termed CEFALO was published (70). The study appears to have been designed to misrepresent the true risk, since the following question regarding cordless phone use was asked: '*How often did [child] speak on the cordless phone in the first 3 years he/she used it regularly?*'.

There are no scientific valid reasons to limit the investigation to the first 3 years. The result is a misrepresentation and a wrong exposure classification, since Aydin *et al* (70) willingly omitted any increase in the child's use of and exposure from cordless phone radiation after the first 3 years of use. This unscientific treatment of cordless phone exposure was not mentioned in the article other than in a footnote of a table and in the methods section (70); however, no explanation was provided: '*Specifically, we analyzed whether subjects ever used baby monitors near the head, ever used cordless phones, and the cumulative duration and number of calls with cordless phones in the first 3 years of use'*.

Since previous studies have demonstrated that these phone types, in addition to mobile phones, increase brain tumor risk (11,57), we believe that the exclusion of a complete exposure history on the use of cordless phones represents scientific misconduct.

In a critical comment the authors of the present study wrote: '*Further support of a true association was found in the results based on operator-recorded use for 62 cases and 101 controls, which for time since first subscription >2.8 years yielded OR 2.15 (95% CI 1.07-4.29) with a statistically significant trend (P = 0.001). The results based on such records would be judged to be more objective than face-to-face interviews, as in the study that clearly disclosed to the interviewer who was a case or a control. The authors disregarded these results on the grounds that there was no significant trend for operator data for the other variables - cumulative duration of subscriptions, cumulative duration of calls and cumulative number of calls. However, the statistical power in all the latter groups was lower since data was missing for about half of the cases and controls with operator-recorded use, which could very well explain the difference in the results*' (71).

Our conclusion was that: '*We consider that the data contain several indications of increased risk, despite low exposure, short latency period, and limitations in the study design, analyses and interpretation. The information certainly cannot be used as reassuring evidence against an association, for reasons that we discuss in this commentary*' (71).

This is in contrast to the authors that claimed that the study was reassuring of no risk in a press release from Martin Röösli, July 28, 2011: '*Kein erhöhtes Hirntumorrisiko bei Kindern und Jugendlichen wegen Handys... Die Resultate sind beruhigend*' ['*No increased brain tumour risk in children and adolescents for mobile phone users... The results are reassuring*'] (72).

A similar press release was issued by Maria Feychting at the Karolinska Institute in Stockholm stating: '*Reassuring results from first study on young mobile users and cancer risk… The so called CEFALO study does not show an increased brain tumor risk for young mobile users'* (73). Considering the results and the numerous scientific shortcomings in the study (70), the statements in these press releases are not correct.

Discussion

There is no doubt that several individuals included in Table I are influential, being members, as well as having consulting assignments, in several organizations, such as ICNIRP, BERENIS, the SSM, the Program Electromagnetic Fields and Health from ZonMw in the Netherlands, and the Rapid Response Group for the Japan EMF Information Center (74).

In fact, there appears to be a cartel of individuals working on this issue (75). Associate Professor Martin Röösli has had the chance to provide his view on the content of the present article relating to him. The only message from him was in an e-mail dated January 16, 2020: '*Just to be clear, all my research is funded by public money or not-for -profit fundations [foundations]. I think you will not help an important debate if you spread fake news'*. Obviously, as described in the present article, his comment is not correct considering his funding from the telecom industry (76,77).

As shown in Table I, few individuals, and mostly the same ones, are involved in different evaluations of health risks from RF radiation and will thus propagate the same views on the risks in agencies of different countries associated with the ICNIRP views (4,5). Therefore, it is unlikely that they will change their opinions when participating in different organizations. Furthermore, their competence in natural sciences, such as medicine, is often low or non-existent due to a lack of education in these disciplines (2). Therefore, any chance for solid evaluations of medical issues is hampered. Additionally, it must be concluded that if the 'thermal only' dogma is dismissed, this will have wide consequences for the whole wireless community, including permissions for base stations, regulations of the wireless technology and marketing, plans to roll out 5G, and it would therefore have a large impact on the industry. This may explain the resistance to acknowledge the risk by ICNIRP, EU, WHO, SSM and other agencies. However, the most important aspects to consider are human wellbeing and a healthy environment. Telecoms can make profit in a variety of ways, and wireless is just one of them. They have the capacity to maintain profits by using different techniques, such as optical fiber, that will provide more data with less RF radiation exposure. Particularly when considering the liability, they are incurring in their misguided insistence of wireless expansion that may ultimately catch up to them in the form of lawsuits, such as those previously experienced by asbestos and tobacco companies (78,79).

A recent book describes how deception is used to capture agencies and hijack science (80). There are certain tools that can be used for this. One is to re-analyze existing data using methods that are biased towards predetermined results (23). For example, this can be performed by hiring 'independent experts' to question scientific results and create doubt (81,82). As clearly discussed in a number of chapters of the books (80-82), front groups may be created to gain access to politicians and to influence the public with biased opinions. Other methods may involve intimidating and harassing independent scientists that report health risks based on sound science, or removing all funding from scientists who do not adhere to the no-risk pro-industry paradigm. Another tool would be economic support and courting decision makers with special information sessions that mislead them on science and mask bribery (3,5,19,80-82). An industry with precise marketing goals has a big advantage over a loose scientific community with little funding. Furthermore, access to regulatory agencies and overwhelming them with comments on proposed regulations is crucial (3). To counteract all these actions is time consuming and not always successful (19). Nevertheless, it is important that these circumstances are explored and published in the peer-reviewed literature as historical notes for future use.

Based on the Swiss and ICNIRP experiences, some recommendations can be made. One is to include only unbiased and experienced experts without COIs for evaluation of health risks from RF radiation. All countries should declare a moratorium on 5G until independent research, performed by scientists without any ties to the industry, confirms its safety or not. 2G, 3G, 4G and WiFi are also considered not to be safe, but 5G will be worse regarding harmful biological effects (42,83,84). The authors of the present article recommend an educational campaign to educate the public about the health risks of RF radiation exposure, and safe use of the technology, such as the deployment of wired internet in schools (85), as previously recommended by the European Council resolution 1815 in 2011 (86) and The EMF Scientist Appeal (87). Additionally, it is recommended that the government takes steps to markedly decrease the current exposure of the public to RF radiation, (88,89). Notably, DNA damage has been identified in peripheral blood lymphocytes using the comet assay technique, and in buccal cells using the micronucleus assay, in individuals exposed to RF radiation from base stations (90).

Finally, an alternative approach to the flawed ICNIRP safety standards may be the comprehensive work of the European Academy for Environmental Medicine (EUROPAEM) EMF working group that has resulted in safety recommendations, which are free from the ICNIRP shortcomings (50). Recently, the International Guidelines on Non-Ionising Radiation (IGNIR) have accepted EUROPAEM safety recommendations (91). The Bioinitiative group has recommended similar safety standards based on non-thermal EMF effects (92). WHO and all nations should adopt the EUROPAEM/Bioinitiative/IGNIR safety recommendations, supported by the majority of the scientific community, instead of the obsolete ICNIRP standards.

In conclusion, it is important that all experts evaluating scientific evidence and assessing health risks from RF radiation do not have COIs or bias. Being a member of ICNIRP and being funded by the industry directly, or through an industry-funded foundation, constitute clear COIs. Furthermore, it is recommended that the interpretation of results from studies on health effects of RF radiation should take sponsorship from the telecom or other industry into account. It is concluded that the ICNIRP has failed to conduct a comprehensive evaluation of health risks associated with RF radiation. The latest ICNIRP publication cannot be used for guidelines on this exposure.

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Authors' contributions

LH and MC contributed to the conception, design and writing of the manuscript. Both authors read and approved the final manuscript.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
2. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Non-ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. Vol. 102. IARC, Lyon, France, 2013.
3. Hardell L: Notes on parliament hearing in Tallinn, Estonia June 4, 2019 as regards the deployment of the fifth generation, 5G, of wireless communication. World Acad Sci J 1: 47-54, 2019.
4. Starkey SJ: Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation. Rev Environ Health 31: 493-503, 2016.
5. Hardell L: World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). Int J Oncol 51: 405-413, 2017.
6. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.
7. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
8. International Commission on Non-Ionizing Radiation Protection (ICNIRP)1: Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz). Health Phys 118: 483-524, 2020.
9. Belpomme D, Hardell L, Belyaev I, Burgio E and Carpenter DO: Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. Environ Pollut 242 (Pt A): 643-658, 2018.
10. Miller AB, Morgan LL, Udasin I and Davis DL: Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). Environ Res 167: 673-683, 2018.
11. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22: 1-13, 2015.
12. National Toxicology Program: NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 596, March 26-28, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf. Accessed July 6, 2020.
13. National Toxicology Program: NTP technical report on the toxicology and carcinogenesis studies in Hsd:Sprague Dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595, March 26-28, 2018. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf. Accessed July 6, 2020.
14. Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, Gnudi F, Mandrioli D, Manservigi M, Manservisi F, Manzoli I, *et al*: Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ Res 165: 496-503, 2018.
15. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35: 186-202, 2016.
16. Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Shockley KR, Tice RR, *et al*: Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ Mol Mutagen 61: 276-290, 2020.
17. Carlberg M and Hardell L: Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. BioMed Res Int 2017: 9218486, 2017.
18. The 5G Appeal. http://www.5gappeal.eu/. Accessed July 6, 2020.
19. Hardell L and Nyberg R: Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mol Clin Oncol 12: 247-257, 2020. (Review).
20. Environmental Health Trust: Three-year moratorium on 4G and 5G in Geneva, Switzerland. https://ehtrust.org/three-year-moratorium-on-4g-5g-in-geneva-switzerland. Accessed July 6, 2020.
21. Flydal E: Head of Swiss Radiation Protection Committee accused of 5G-swindle. Nordic countries deceived, too. https://einarflydal.com/wp-content/uploads/2020/02/Einar-Flydal-The-Accusations-against-R%C3%B6%C3%B6sli-and-the-BERENIS-20200220_v-3.pdf. Accessed July 6, 2020.
22. Buchner K and Rivasi M: The International Commission on Non-Ionizing Radiation Protection: Conflicts of interest, corporate capture and the push for 5G. https://klaus-buchner.eu/wp-content/uploads/2020/06/ICNIRP-report-FINAL-19-JUNE-2020.pdf. Accessed July 6, 2020.
23. Röösli M, Lagorio S, Schoemaker MJ, Schüz J and Feychting M: Brain and salivary gland tumors and mobile phone use: Evaluating the evidence from various epidemiological study designs. Annu Rev Public Health 40: 221-238, 2019.
24. Federal Office for the Environment: BERENIS - Swiss expert group on electromagnetic fields and non-ionising radiation. https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/newsletter-of-the-swiss-expert-group-on-electromagnetic-fields-a/beratende-expertengruppe-nis-berenis.html. Accessed July 6, 2020.
25. Office fédéral de l'environnement: Téléphonie mobile et 5G: le Conseil fédéral décide de la suite de la procedure.https://www.bafu.admin.ch/bafu/fr/home/themes/electrosmog/dossiers/rapport-groupe-de-travail-telephonie-mobile-et-rayonnement.html. Accessed July 6, 2020.
26. Département fédéral de l'environnement, des transports, de l'énergie et de la communication: Groupe de travail Téléphonie mobile et rayonnement: présentation d'un rapport factuel global. Bern, November 28, 2019. https://www.uvek.admin.ch/uvek/fr/home/detec/medias/communiques-de-presse.msg-id-77294.html. Accessed July 6, 2020.
27. Groupe de travail Téléphonie mobile et rayonnement: Rapport Téléphonie mobile et rayonnement. Publié par le groupe de travail Téléphonie mobile et rayonnement sur mandat du DETEC. November 18, 2019. https://www.newsd.admin.ch/newsd/message/attachments/59385.pdf. Accessed July 6, 2020.
28. Arbeitsgruppe Mobilfunk und Strahlung: Bericht Mobilfunk und Strahlung. Herausgegeben von der Arbeitsgruppe Mobilfunk und Strahlung im Auftrag des UVEK. November 18, 2019. https://www.newsd.admin.ch/newsd/message/attachments/59384.pdf. Accessed July 6, 2020.
29. Boeglin P: L'énigme 5G demeure. Un groupe de travail fédéral temporise sur les risques de santé et ne fixe pas de limite aux rayonnements. Le Courrier, November 29, 2019. https://lecourrier.ch/2019/11/29/lenigme-5g-demeure/. Accessed July 6, 2020.

30. EMFscientist: International Appeal: Scientists call for Protection from Non-ionizing Electromagnetic Field Exposure. https://www.emfscientist.org/index.php/emf-scientist-appeal. Accessed July 6, 2020.
31. Swiss Research Foundation for Electricity and Mobile Communication: Organisation. https://www.emf.ethz.ch/en/foundation/organisation/. Accessed July 6, 2020.
32. Swiss Research Foundation for Electricity and Mobile Communication: Publications. https://www.emf.ethz.ch/en/promotion/publications/?author=664. Accessed July 6, 2020.
33. Swiss Research Foundation for Electricity and Mobile Communication: Annual Report 2017. https://www.emf.ethz.ch/fileadmin/redaktion/public/downloads/3_angebot/wissensvermittlung/jahresberichte/fsm-jb17_web_72dpi_red.pdf.Accessed July 6, 2020.
34. Swiss Research Foundation for Electricity and Mobile Communication: Sponsors and Supporters. https://www.emf.ethz.ch/en/foundation/sponsors-supporters/?text=50%2525252525252520hz&author=90&cHash=6acfa29405f91df1970b8a8e4cd2020e. Accessed July 6, 2020.
35. International Commission on Non-Ionizing Radiation Protection: Martin Röösli. Member. https://www.icnirp.org/en/about-icnirp/commission/details/member-roosli.html. Accessed July 6, 2020.
36. International Commission on Non-Ionizing Radiation Protection (ICNIRP)1: ICNIRP Note: Critical evaluation of two radiofrequency electromagnetic field animal carcinogenicity studies published in 2018. Health Phys 118: 525-532, 2020.
37. Melnick RL: Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ Res 168: 1-6, 2019.
38. Marques MM, Berrington de Gonzalez A, Beland FA, Browne P, Demers PA, Lachenmeier DW, Bahadori T, Barupal DK, Belpoggi F, Comba P, *et al*; IARC Monographs Priorities Group: Advisory Group recommendations on priorities for the IARC Monographs. Lancet Oncol 20: 763-764, 2019.
39. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (100 kHz to 300 GHz). https://www.icnirp.org/cms/upload/consultation_upload/ICNIRP_RF_Guidelines_PCD_2018_07_11.pdf. Accessed July 6, 2020.
40. International Commission on Non-Ionizing Radiation Protection: Commission. https://www.icnirp.org/en/about-icnirp/commission/index.html. Accessed July 6, 2020.
41. IARC: IARC Monographs on the evaluation of carcinogenic risks to humans. https://monographs.iarc.fr/wp-content/uploads/2018/06/mono102-F05.pdf. Accessed July 6, 2020.
42. Neufeld E and Kuster N: Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. Health Phys 115: 705-711, 2018.
43. Thielens A, Bell D, Mortimore DB, Greco MK, Martens L and Joseph W: Exposure of insects to radio-frequency electromagnetic fields from 2 to 120 GHz. Sci Rep 8: 3924, 2018.
44. Goodman EM, Greenebaum B and Marron MT: Effects of electromagnetic fields on molecules and cells. Int Rev Cytol 158: 279-338, 1995.
45. Velizarov S, Raskmark P and Kwee S: The effects of radiofrequency fields on cell proliferation are non-thermal. Bioelectrochem Bioenerg 48: 177-180, 1999.
46. Panagopoulos DJ: Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. Mutat Res 781: 53-62, 2019.
47. Panagopoulos DJ: Chromosome damage in human cells induced by UMTS mobile telephony radiation. Gen Physiol Biophys 38: 445-454, 2019.
48. Panagopoulos DJ, Karabarbounis A and Margaritis LH: Mechanism for action of electromagnetic fields on cells. Biochem Biophys Res Commun 298: 95-102, 2002.
49. Pall ML: Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. J Cell Mol Med 17: 958-965, 2013.
50. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, Kundi M, Moshammer H, Lercher P, Müller K, *et al*: EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 31: 363-397, 2016.
51. Eliassen I and Pena P: Real 5G issues overshadowed by Covid-19 conspiracy theories. Investigate Europe. https://www.investigate-europe.eu/en/2020/5g-covid-conspiracy/. Accessed July 6, 2020.
52. Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR): Opinion on potential health effects of exposure to electromagnetic fields (EMF). European Commission. https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf. Accessed July 6, 2020.
53. Sage C, Carpenter D and Hardell L: Comments on SCENIHR: Opinion on potential health effects of exposure to electromagnetic fields, Bioelectromagnetics 36:480-484 (2015). Bioelectromagnetics 37: 190-192, 2016.
54. World Health Organization: Radio frequency fields: Environmental health criteria monograph consultation on the scientific review for the upcoming WHO environmental health criteria. https://web.archive.org/web/20141221142734/http://www.who.int/peh-emf/research/rf_ehc_page/en/. Accessed July 6, 2020.
55. Microwave News: Will WHO kick its ICNIRP habit? Non-thermal effects hang in the balance. Repacholi's legacy of industry cronyism. https://microwavenews.com/news-center/can-who-kick-icnirp-habit. Accessed July 6, 2020.
56. World Health Organization: 5G mobile networks and health. https://www.who.int/news-room/q-a-detail/5g-mobile-networks-and-health. Accessed July 6, 2020.
57. Hardell L, Carlberg M, Söderqvist F and Mild KH: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.
58. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R, *et al*: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
59. Johansen C, Boice J Jr, McLaughlin J and Olsen J: Cellular telephones and cancer--a nationwide cohort study in Denmark. J Natl Cancer Inst 93: 203-207, 2001.
60. Söderqvist F, Carlberg M and Hardell L: Review of four publications on the Danish cohort study on mobile phone subscribers and risk of brain tumors. Rev Environ Health 27: 51-58, 2012.
61. The EMF Call: Scientists and NGOs call for truly protective limits for exposure to electromagnetic fields (100 kHz to 300 GHz). https://www.emfcall.org/. Accessed July 6, 2020.
62. INTERPHONE Study Group: Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.
63. Hardell L and Carlberg M: Increasing rates of brain tumours in the Swedish national inpatient register and the causes of death register. Int J Environ Res Public Health 12: 3793-3813, 2015.
64. Hardell L and Carlberg M: Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. PLoS One 12: e0185461, 2017.
65. Philips A, Henshaw DL, Lamburn G and O'Carroll MJ: Brain tumours: Rise in glioblastoma multiforme incidence in England 1995-2015 suggests an adverse environmental or lifestyle factor. J Environ Public Health: doi.org/10.1155/2018/7910754.
66. Microwave News: Spike in 'aggressive' brain cancer in Denmark. https://microwavenews.com/short-takes-archive/spike-brain-cancer-denmark. Accessed July 6, 2020.
67. Phonegate Alert: Brain cancers: 4 times more new cases of glioblastoma in 2018 according to Public Health France. https://www.phonegatealert.org/en/press-release-brain-cancers-4-times-more-new-cases-of-glioblastoma-in-2018-according-to-public-health-france. Accessed July 6, 2020.
68. Tillmann T, Ernst H, Streckert J, Zhou Y, Taugner F, Hansen V and Dasenbrock C: Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. Int J Radiat Biol 86: 529-541, 2010.
69. Lerchl A, Klose M, Grote K, Wilhelm AF, Spathmann O, Fiedler T, Streckert J, Hansen V and Clemens M: Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem Biophys Res Commun 459: 585-590, 2015.
70. Aydin D, Feychting M, Schüz J, Tynes T, Andersen TV, Schmidt LS, Poulsen AH, Johansen C, Prochazka M, Lannering B, *et al*: Mobile phone use and brain tumors in children and adolescents: A multicenter case-control study. J Natl Cancer Inst 103: 1264-1276, 2011.
71. Söderqvist F, Carlberg M, Hansson Mild K and Hardell L: Childhood brain tumour risk and its association with wireless phones: A commentary. Environ Health 10: 106, 2011.
72. Universität Basel: Kein erhöhtes Hirntumorrisiko bei Kindern und Jugendlichen wegen Handys. https://www.unibas.ch/de/Aktuell/News/Uni-Research/Kein-erh-htes-Hirntumorrisiko-bei-Kindern-und-Jugendlichen-wegen-Handys.html. Accessed July 6, 2020.

73. Karolinska Institutet: Reassuring results from first study on young mobile users and cancer risk. https://web.archive.org/web/20130203041836/https://ki.se/ki/jsp/polopoly.jsp?d=130&a=125250&l=en&newsdep=130. Accessed July 6, 2020.
74. Swedish Radiation Safety Authority: Declaration of disqualification, conflicts of interest and other ties for experts and specialists of the Swedish Radiation Safety Authority [Martin Röösli]. https://www.stralskyddsstiftelsen.se/wp-content/uploads/2020/03/martin_roosli_coi_ssm.pdf. Accessed July 6, 2020.
75. Electromagnetic Radiation Safety: ICNIRP's Exposure Guidelines for Radio Frequency Fields. https://www.saferemr.com/search?q=cartel. Accessed July 6, 2020.
76. Swiss Research Foundation for Electricity and Mobile Communication: List of funded research projects. https://www.emf.ethz.ch/en/promotion/projects/list-of-funded-research-projects/# refno-16. Accessed July 6, 2020.
77. Swiss Research Foundation for Electricity and Mobile Communication: Sponsors and Supporters. https://www.emf.ethz.ch/en/foundation/sponsors-supporters/?text=NmaF6u%27A%3D0&author=horny. Accessed July 6, 2020.
78. Tweedale G: Secret ties in asbestos - downplaying and effacing the risks of a toxic mineral. In: Corporate Ties That Bind. Walker MJ (ed). Skyhorse Publishing, New York, pp136-151, 2017.
79. Walhjalt B: Greenwashing: the Swedish experience. In: Corporate Ties That Bind. Walker MJ (ed). Skyhorse Publishing, New York, pp96-108, 2017.
80. Michaels D: The Triumph of Doubt: Dark Money and the Science of Deception. Oxford University Press, New York, 2020.
81. Michaels D: Doubt is Their Product. How Industry's Assault on Science Threatens Your Health. Oxford University Press, New York, 2008.
82. Walker MJ: Corporate Ties that Bind. An Examination of Corporate Manipulation and Vested Interest in Public Health. Skyhorse Publishing, New York, 2017.
83. Di Ciaula A: Towards 5G communication systems: Are there health implications? Int J Hyg Environ Health 221: 367-375, 2018.
84. Russell CL: 5 G wireless telecommunications expansion: Public health and environmental implications. Environ Res 165: 484-495, 2018.
85. Hedendahl LK, Carlberg M, Koppel T and Hardell L: Measurements of radiofrequency radiation with a body-borne exposimeter in Swedish schools with Wi-Fi. Front Public Health 5: 279, 2017.
86. Council of Europe: The potential dangers of electromagnetic fields and their effect on the environment. Resolution 1815, 2011. http://assembly.coe.int/nw/xml/XRef/Xref-XML2HTML-en.asp?fileid=17994. Accessed July 6, 2020.
87. EMFscientist: Welcome to EMFscientist.org. https://www.emfscientist.org/. Accessed July 6, 2020.
88. Koppel T, Ahonen M, Carlberg M, Hedendahl LK and Hardell L: Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. Oncol Lett 18: 5383-5391, 2019.
89. Hardell L, Carlberg M, Hedendahl LK, Koppel T and Ahonen M: Environmental radiofrequency radiation at the Järntorget Square in Stockholm Old Town, Sweden in May, 2018 compared with results on brain and heart tumour risks in rats exposed to 1.8 GHz base station environmental emissions. World Acad Sci J 1: 47-54, 2019.
90. Gulati S, Yadav A, Kumar N, Kanupriya, Aggarwal NK, Kumar R and Gupta R: Effect of GSTM1 and GSTT1 polymorphisms on genetic damage in humans populations exposed to radiation from mobile towers. Arch Environ Contam Toxicol 70: 615-625, 2016.
91. International Guidelines on Non-Ionising Radiation: Guidelines. IGNIR's latest independent guidelines on EMF exposure are available now to download and use. https://ignir.org/?page_id=8. Accessed July 6, 2020.
92. Bioinitiative: Bioinitiative 2012. A rationale for biologically-based exposure standards for low-intensity electromagnetic radiation. https://bioinitiative.org/. Accessed July 6, 2020.
93. Swedish Radiation Safety Authority: Publications. https://www.stralsakerhetsmyndigheten.se/en/publications/?area=Magnetf%c3%a4lt+och+tr%c3%a5dl%c3%b6s+teknik. Accessed July 6, 2020.
94. International Commission on Non-Ionizing Radiation Protection: Structure and Membership. https://www.icnirp.org/en/about-icnirp/structure-membership/index.html. Accessed July 6, 2020.
95. International Telecommunication Union: van DEVENTER Tahera Emilie. https://www.itu.int/en/ITU-T/Workshops-and-Seminars/emf/201307/Pages/vanDEVENTERTaheraEmilie.aspx. Accessed July 6, 2020.

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Review Article

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Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden

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Abstract: A previously healthy worker developed symptoms assigned to electromagnetic hypersensitivity (EHS) after moving to an office with exposure to high levels of anthropogenic electromagnetic fields (EMFs). These symptoms consisted of e.g. headache, arthralgia, tinnitus, dizziness, memory loss, fatique, insomnia, transitory cardiovascular abnormalities, and skin lesions. Most of the symptoms were alleviated after 2 weeks sick leave. The highest radiofrequency (RF) field level at the working place was 1.72 V/m (7,852 μW/m^2). Maximum value for extremely low frequency electromagnetic field (ELF-EMF) from electric power at 50 Hz was measured to 285 nT (mean 241 nT). For electric train ELF-EMF at 16.7 Hz was measured to 383 nT (mean 76 nT). Exposure to EMFs at the working place could be the cause for developing EHS related symptoms. The association was strengthened by the symptom reduction outside the working place.

Keywords: electromagnetic hypersensitivity; EMF; radiofrequency radiation; symptoms.

Introduction

Exposure to extremely low frequency (ELF) electromagnetic fields (EMF) and radiofrequency (RF) EMF is in most cases involuntary and unknown to people. Both ELF-EMF and RF-EMF have been evaluated by IARC to be possible human carcinogens, Group 2B [1–3]. In fact EMFs should be regarded to be environmental pollutants that do not smell, have no taste and are invisible.

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Already in the 1970s the 'microwave syndrome' was described in the former Soviet Union [4]. Persons working with radar or radio equipment reported symptoms of fatigue, headache, dizziness, disturbed sleep, concentration and memory problems.

In the 1980s similar symptoms were reported among Swedish persons working in front of cathode ray tube monitors [5]. In Finns such symptoms were attributed to exposure to EMF [6]. This syndrome was termed electromagnetic hypersensitivity (EHS), although still without an International Classification of Diseases (ICD-code) [7].

EHS consists of a wide range of different symptoms that may vary from person to person. EMF sensitivity varies among individuals from mild to severe. The prevalence has been reported to be 1.5% in Sweden [8], 3.2% in California [9], 5% in Switzerland [10], and 13% in Taiwan [11].

We report here on a person who developed symptoms consistent with those described among EHS subjects. The symptoms developed at a work place with exposure to EMFs. Our hypothesis is that the symptoms may be attributed to that exposure. We obtained informed consent by the person to publish the symptoms and work history anonymously.

Methods

The subject attributed the development of EHS symptoms to her office room where she had been working one year since April 2018 for a total of 183 working days. As the source of the adverse health effects was unknown, the investigators devised a broad spectrum approach for EMF measurements, to include all possible sources of EMFs.

The room was thoroughly measured encompassing different types of electromagnetic fields, including:

- Extremely low frequency (ELF) magnetic field (MF)
- Intermediate frequency (IF) magnetic field (MF)
- Radiofrequency (RF) electromagnetic field.

Three types of measurements approaches were utilized characterizing:

- Spatial field distribution
- Temporal field dynamics
- Spectrum analysis of EMF

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Spatial field distribution was done by conducting spot measurements across the room at evenly distributed locations. At each location the field was scanned in circular movements encompassing a one square meter area at the height of 0.7–2 m. Broadband field meter was used for spot measurements to account for any frequency in the monitored electromagnetic field type.

Spot measurement data, were fed to the contour map software 3DFIELD ver. 4.5.2.0 (by Vladimir Galouchko) and spatial field distribution maps were drawn.

Temporal field dynamics were investigated by using exposimeters. The meters were positioned at the location of the subject at the workstation and logging commenced for 40 min period. Electromagnetic fields spectrum was also measured using the same exposimeters with the frequency band discriminating function.

Measurement devices

Extremely low frequencies were investigated using broadband frequency selective electromagnetic field meter NFA400 by Gigahertz Solutions (Langenzenn, Germany). This meter is capable of simultaneous measurements of 6 frequency bands: (1) 16.7 Hz, (2) 50 Hz, (3) 100 Hz, (4) 150 Hz, (5) <2 kHz excluding the aforementioned, 6) >2 kHz. The frequency range covered: 5 Hz to 400 kHz. Measurement range for magnetic flux density is 1 nanoTesla (nT) to 20 microTesla (μT) and for electrical field strength 0.1–1999 Volt per meter (V m^{-1}).

Both magnetic and electric fields can be measured by the meter. The meter is a three-axial meter for magnetic field, capable of measuring all three axes separately and calculating the resultant field. The measurements are taken in tRMS (true Root Mean Square) mode. In exposimeter setting, logging 3D magnetic field was done at 0.1 s sampling rate.

Radiofrequency spatial mapping was done using RF broadband meter Narda NBM-520, with an E-field probe E0391 (Narda-Safety-Test-Solutions GmbH, Pfullingen, Germany). This Narda NBM-series meter is capable of time and spatial averaging and determining the maximum level during the period monitored. Narda EF0391 probe is produced by the manufacturer for base station measurements and has a frequency range from 100 kHz to 3 GHz, measurement range of 0.2–320 V m^{-1}.

Radiofrequency temporal dynamics and dominant frequencies were determined by using exposimeter EME SPY200 by Satimo. This exposimeter measures 20 predefined frequencies covering the frequencies of most public RF radiation emitting devices. The exposimeter covers frequencies from 87 to 5,850 MHz and measures different telecommunication protocols: FM radio broadcasting; TV broadcasting; TETRA emergency services (police, rescue, etc.); GSM second generation mobile communications; UMTS third generation mobile communications, 3G; long-term evolution (LTE) fourth generation mobile communications standard, 4G; digital European cordless telecommunications (DECT) cordless telephone systems standard; Wi-Fi 2.4 GHz and 5 GHz wireless local area network protocol; worldwide interoperability for microwave access (WiMAX) wireless communication standard for high-speed voice, data and Internet

For frequency modulation (FM), TV3, TETRA, TV4&5, Wi-Fi 2.4 GHz and Wi-Fi 5 GHz, the lower detection limit is 0.01 V m^{-1} (0.27 μW/m^2). For all other bands, the lower detection limit is 0.005 V m^{-1} (0.066 μW/m^2). For all bands, the upper detection limit is 6 V m^{-1} (95,544 μW/m^2). The sampling time used in this study was 4 s which is the fastest for the given exposimeter.

Next to measurements visual observations were conducted to identify openly detectable EMF sources near the investigated premises. Also the distance to the EMF sources was determined by visual assessments.

Conversion from V/m *to* W/m^2

In most of our earlier studies [12–17] we have used the EME Spy 200 from Satimo and preferred to show our results in power flux density in W/m^2 and μW/m^2 for RF radiation. In the current measurements the broadband analyzer Narda NBM-520 measures in V/m and the contour map software 3DFIELD is also constructed for measurements in V/m.

To convert from electric field strength, **E**, in V m^{-1} to power flux density in W/m^2, **S**, use the formula: $\mathbf{S} = 0.002654 * \mathbf{E}^2$.

To convert from power flux density in W/m^2, **S**, to electric field strength, **E**, in V m^{-1}, use the formula: $\mathbf{E} = 19.41 * \sqrt{\mathbf{S}}$.

The aim of the study was to assess the EMF levels at this work place and if they could be related to the symptoms of EHS in this individual.

Results

Case report

A 55 year old previously healthy female office worker changed her work place in April 2018. She had worked in the same building for almost 10 years but at another location. After 3 months job in another place she returned to this building, but this time to another office at the 6th floor close to base stations on the roof. In the surrounding 4G was installed a couple of years before her return. She had full time work in the office. At the previous working place she had no health problems.

During the following months after she had changed office she experienced increasing health problems. She attributed the symptoms to the working place, as the symptoms diminished while being away from the premises and reappeared and increased when back.

She experienced continuous heavy headache during the week, pain in the chest, shortness of breath, cough, fatigue, dizziness, uncontrolled movements of the body, low blood pressure (e.g. 86/57 mmHg), palpitations with rapid heart rate (e.g. 140–145) including fainting at one occasion. She had sensations of 'fever' in the head but not in the body. All these symptoms initially started at work and were aggravated over time including nose bleeding at the work place. She noticed loss of hair on the head and on eyebrows.

This person had never had skin problems, her skin was visually extremely healthy. Now she felt tenderness, burning and itching on the scalp, face and the body. She noticed leathery, exfoliating skin in the face; the skin

Table 1: Clinical symptoms graded 0–10; 0=no symptoms, 1=mild, 10=unbearable pain and/or discomfort. Percentages in parentheses represent frequencies in a survey on 100 patients by Belpomme et al. [18].

Symptoms	Office	After 2 weeks sick leave
Headache	8 (88%)	3
Dysesthesia	0 (82%)	0
Myalgia	3 (48%)	1
Arthralgia	7 (30%)	5
Ear heat/otalgia	2 (70%)	0
Tinnitus	9 (60%)	1
Hyperacousis	0 (40%)	0
Dizziness	8 (70%)	3
Balance disorder	10 (42%)	4
Concentration/attention deficiency	5 (76%)	2
Loss of immediate memory	9 (70%)	7
Confusion	2 (4%)	1
Fatigue	9 (88%)	5
Insomnia	8 (74%)	7
Depression tendency	1 (60%)	1
Suicidal ideation	0 (20%)	0
Transitory cardiovascular abnormalities	10 (50%)	3
Ocular deficiency	2 (48%)	2
Anxiety/panic	0 (38%)	0
Emotivity	2 (20%)	1
Irritability (irritabel)	1 (24%)	0
Skin lesions	10 (16%)	5
Global body dysthermia	0 (14%)	0
Lungs	5	1
Stomach	7	2
-Diarrehea (involuntary)	3	0
-Pricking, burning inside body	9	0
Skin (face, arms, legs)	10	6
-Burning, lancinating skin on hands and arms	7	0
Nose bleeding	7	0
Blood pressure	10	3
Anemia	8	Not evaluated
Hair loss	3	3
Mouth infection	4	3
-Tongue, fungus	10	3

seemed to have grown older in short time becoming aged and wrinkled, and had also burning sensations on the arms and hands. She used to wake up around 3 o'clock in the morning with stomach pain, nausea and sudden vomiting.

She noticed 'vibrating and pulsing' eardrums with tinnitus and pain in the ears. The short-term memory was impaired and she felt restless like being hyperactive with shaky hands, and in addition concentration difficulties.

It is also noteworthy that she had pain in her joints that tended to swell. Anemia was recorded at a health check by a general practitioner.

In Table 1 the different symptoms while at office in April 2019 and after 2 weeks of sick leave are described. This table is based with some additions on a publication by Belpomme et al. [18] on symptoms in the first 100 patients in their case series. It is noteworthy that for this presented person almost all symptoms declined during sick leave, most notably the most serious health problems. Thus headache, tinnitus, dizziness, balance disorder, cardiovascular problems including low blood pressure and mouth infection improved. Also skin lesions and sensations improved.

All these symptoms have been described in persons with EHS [6, 7, 19]. This person contacted our research team and we judged it to be pertinent to make EMF measurements at her work place. The contact was initiated by her observation of the proximity to the base stations.

The work environment

This person does a regular office job, working with a desktop computer. She is using an ergonomic desk, the height of which can be adjusted by a fitted lifting motor. Hence, the worker can choose to work at the desk either on foot or by sitting on a chair.

The lighting in the room was determined to meet the minimum requirement for office work stations (500 lux). There was no noise in the room, nor other detectable occupational health risks.

The building is fairly new so that noise, vibrations, or impaired air quality would not be expected. Also exposure to e.g. asbestos and radon was excluded. Furthermore, since she had worked in the same building, but at another place, for several years detrimental health effects from such working conditions would already have occurred. All health problems appeared after moving to the current office at the 6th floor of the building close to the base stations.

Measurements

Measurements were conducted on a business day afternoon in April 2019.

Visual observations

The working room where the subject had developed EHS symptoms was located on the 6th floor of a 6-floor office building. The closest mobile phone base station mast with several antennas was positioned right above the subjects workstation, distanced about 4 m away on the roof (see Figure 1).

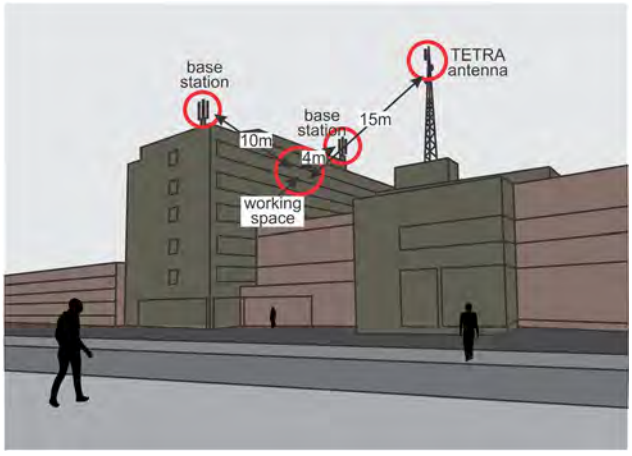


Figure 1: Location of the person's working space with respect to the RF sources indicated by circles.



Figure 2: The case study location – several mobile phone base station antennas and TETRA antennas on the roof.

Another mobile phone base station antenna array was positioned 10 m further away on top of the same building. Additionally, a lower radiofrequency communications antenna array (TETRA) was positioned some 15 m away positioned on adjacent wing of the building (see Figure 2).

Radiofrequency spatial mapping

Radiofrequency spatial mapping revealed a strong influence from above installed mobile phone base station. Radiofrequency mobile communications were the highest level type of electromagnetic field in the premises. Field distribution is pictured in Figure 3. The field is not notably higher close to the windows, which indicates that much of the radiofrequency field is penetrating into the room also from other directions, including paths through the walls and ceiling. The RF field level at subjects working position was 1.72 Vm^{-1} (7, 852 $\mu W/m^2$) which happens to be also the highest in the room. The minimum field level in the room was 1.06 Vm^{-1} (2,982 $\mu W/m^2$) and mean 1.21 Vm^{-1} (3,886 $\mu W/m^2$). This illustrates a uniformly exposed room to a high level of radiofrequency fields.

Radiofrequency temporal changes

Radiofrequency temporal changes were assessed based on the exposimeter placed on the subject's workstation (Table 2). The location was at her typical working position. Highest levels were found for LTE 800 DL, GSM + UMTS 900 down load, GSM 800 down load and LTE 2600 DL. These results represent RF electromagnetic radiation from the nearby base stations. Besides base station exposure, other RF sources were quite low and constituted a total mean value of 34.9 $\mu W/m^2$ (excluding down link; DL).

Extremely low frequency magnetic field exposure

Table 3 presents extremely low frequency magnetic field measurements at the subject's work station. 'Edges per hour' column present sharp rise of the measured field intensity. This indicator is used to analyze the number of sudden rising edges in field that can be due to spikes or high frequency transients of the corresponding field. The main frequencies in the room are (1) 50 Hz from electrical power grid and appliances and (2) 16.7 Hz electric train power frequency.

Extremely low and intermediate frequency temporal changes

The main frequency components of magnetic field were assessed with exposimeter total logging time 40 min. The results depict an MF exposure with high amplitude temporal variation. The main fluctuation was because of changing power drain in the railroad power cable due to electric train traffic. MF from power frequency 50 Hz is at stable level with little amplitude variation, indicating a stable consumption of electrical power in the area. MF at frequencies above 2 kHz are at negligent levels and show no abrupt changes over time.

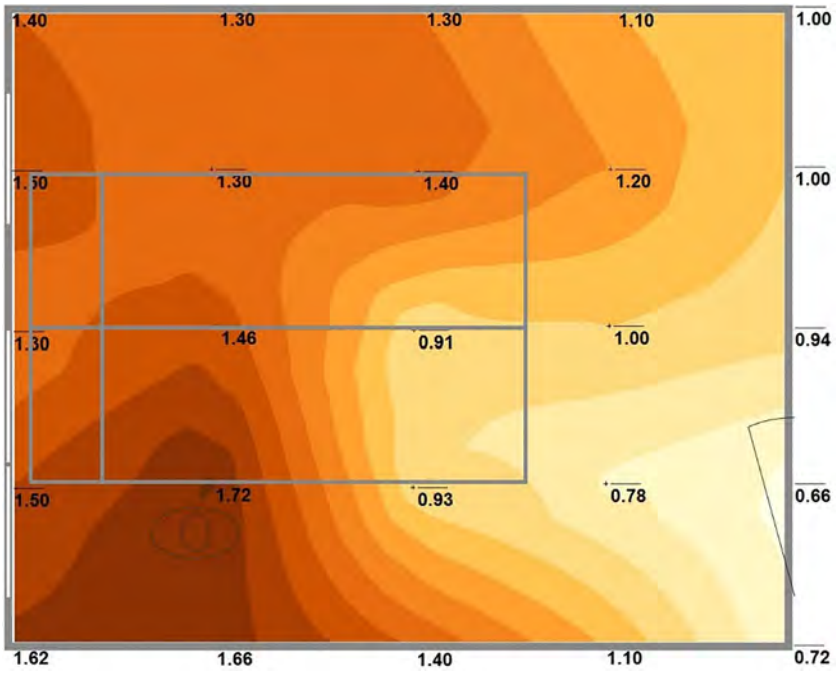


Figure 3: Radiofrequency field distribution in V m^{-1} in the work area; typical position of the person at marked with wireframe at the bottom left of the figure.

Table 2: Analysis of exposimeter data (μW/m^2) treating values at detection limit as 0. Total (n=891).

	Mean	Median	Min	Max
FM	0.8	0.0	0.0	45.5
TV3	0.0	0.0	0.0	0.0
TETRA I	16.3	6.9	0.0	1,520.0
TETRA II	0.0	0.0	0.0	0.4
TETRA III	0.0	0.0	0.0	0.0
TV4&5	1.0	0.0	0.0	40.8
LTE 800 (DL)	132.1	91.8	18.3	1,480.1
LTE 800 (UL)	0.0	0.0	0.0	0.2
GSM + UMTS 900 (UL)	0.0	0.0	0.0	0.4
GSM + UMTS 900 (DL)	269.6	224.6	38.8	1,340.9
GSM 1800 (UL)	16.5	11.9	2.7	175.2
GSM 1800 (DL)	447.6	340.0	114.8	2,506.1
DECT	0.1	0.0	0.0	25.0
UMTS 2100 (UL)	0.0	0.0	0.0	0.4
UMTS 2100 (DL)	32.6	30.9	9.2	113.7
WIFI 2G	0.1	0.0	0.0	4.7
LTE 2600 (UL)	0.1	0.0	0.0	7.7
LTE 2600 (DL)	181.9	136.7	26.0	2,077.5
WIMax	0.0	0.0	0.0	0.0
WIFI 5G	0.0	0.0	0.0	0.0
Total	1,098.7	968.3	423.5	4,183.8
Total excluding DL	34.9	23.2	5.0	1,585.4

Table 3: Magnetic field at work station, time logged exposure over 40 min.

Frequency band	Min	Max	Mean	95th percentile	Edges per hour
5 Hz–400 kHz	135 nT	497 nT	284 nT	319 nT	275/h
16.7 Hz	0 nT	383 nT	76 nT	167 nT	169/h
50 Hz	0 nT	285 nT	241 nT	274 nT	0/h
>2 kHz	0 nT	3.5 nT	1.8 nT	2.8 nT	50/h

Discussion

Within a couple of months, this person developed a series of health problems, after moving to an office with high EMF exposure. These symptoms are typical for persons with EHS [20]. This syndrome has been characterized by fatigue, chronic pain and impaired cognitive function, see the Paris Appeal (http://appel-deparis.com/?lang¼en). This person has all these symptoms in addition to a large number of other health problems as discussed by Belyaev et al. [19].

We will here take some of the symptoms this office worker presented and compare these with published scientific studies showing detrimental effects from ELF-EMF and RF radiation on humans, animals and biological material.

The symptoms may vary from person to person. There are no reliable biomarkers for EHS. In a case series by Belpomme et al. [18] a number of biomarkers were described. The 24 h urine 6-hydroxymelatonin sulfate (6-OHMS)/creatinin ratio was found to be decreased (<0.8) in all investigated cases which might be of interest. It may indicate one reason for the sleep problems in 74% of the

participants, see Table 1. Our case person graded her sleep problems as 8 on the 0–10 scale during her work time in the office and still as 7 during sick-leave and afterwards while working in another office at floor 2. Earlier she had had no sleeping problems at all.

Electroencephalografic (EEG) activity in the brain can be altered by RF radiation. Especially the second non-rapid eye movement (NREM) sleep after 2–3 h sleep was effected when 30 young healthy men were exposed to two different 900 MHz pulse modulated signal 30 min directly before sleep. The 14 Hz pulse modulated condition had a stronger influence on EEG than 217 Hz [21]. Also during the day when awake, RF radiation can have considerable influence on EEG [22, 23]. Pulsed extremely low frequency magnetic field (ELF MF) has been shown to lower the alpha frequency activity over the parietal-occipital regions of the brain [24]. Decreased β-trace protein, which is a key enzyme in the synthesis of a sleep-promoting neurohormone, has been seen in young adults with high-cumulative amounts of hours of mobile phone use [25]. RF radiation showed disturbed glucose metabolism in the brain after 50 min exposure from a mobile phone [26].

Our case person noticed loss of hair on her head and on her eyebrows and was severely affected by a burning sensation from her skin. A study on healthy human subjects showed DNA damage in hair root cells after 30 min of mobile phone talk [27]. A Finnish study showed that proteins in the skin could be affected after RF radiation exposure on the skin [28]. Dermatitis has also been seen near electronic wireless devices like lap tops [29].

Two studies from India have shown how long term, high users of mobile phones can get more micronuclei in oral mucosal cells from the same side as they hold their mobile phone, compared to low users. This indicates a genotoxic effect of RF radiation [30, 31]. Salivary oxidative stress has been seen in mobile phone users with decrease in salivary flow, total protein, albumin and amylase activity [32, 33]. It should be noted that Arbabi-Kalati et al. [33] did not provide details if the study groups were controlled for age and dietary intakes, which are crucial determinants of the antioxidant status. Salivary cortisol can increase after 50 min of RF radiation of GSM 900 MHz [34]. Also thyroid hormones have been effected for people living near mobile phone base stations [35]. A study in Germany showed that the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine increased or decreased after a 900 MHz base station was activated in 2004. The neurotransmitters were not normalized after 18 months especially not in children and chronically ill adults. Several of the 60 participants had got new symptoms like sleep disturbances, headache, dizziness, concentration problems and allergies [36].

In India 40 healthy people living <80 meter from a base station had lowered antioxidant levels and higher frequency of micronuclei in their blood lymphocytes compared to a control group living >300 m from a base station [37].

A study on mice showed that 900 MHz RF radiation exposure delayed wound healing several days in experimentally induced cutaneous candidiasis. The mortality rate also increased in the RF radiation exposed group, probably due to higher yeast loads in skin lesions and systemic infection [38].

Our case person had long lasting problems with candidiasis on her tongue. According to the above studies RF radiation may decrease her immune system defense, increase stress reactions and oxidative stress. Decreased production of melatonin can give sleep problems and has an important role on the antíoxidant system and wound healing [39]. Reduced immune functions, such as natural killer lymphocytes, as well as higher stress levels were reported in women in residencies with high levels of RF EMFs from radio-television broadcasting stations [40].

This case person had severe problems with tinnitus during her work in the office. After two weeks of sick-leave it had almost disappeared. Prolonged use of mobile phones can increase the risk of tinnitus on the same side as the mobile phone is used [41, 42]. There is also a higher degree of hearing loss in high amount users with over 2 h mobile phone talk per day [43, 44]. A study from Turkey showed that DNA damage of hair follicle cells in human ear canal increased with the daily duration of exposure from mobile phones. It was highest in the group that talked more than 60 min per day in their mobile phone [45].

An association between chemicals and EHS is not well studied. Regarding persistent organic pollutants a small study indicated increases concentration of the flame retardant PBDE #47 in EHS persons. This might be of interest since flame retardants have been used in electronic devices such as computer screens [46]. However, we had not information on chemical exposure to the study person.

In this case report certainly the decline or even disappearance of some symptoms during sick leave avoiding EMF exposure in the office might be a diagnostic criteria. The most promising treatment must be avoiding high EMF exposure. Today it is almost impossible to find any environment without any EMF exposure at all.

Although all the measured field levels are within the current safety limits, the working premises were demonstrating elevated exposure levels both to the radiofrequency electromagnetic field and the extremely low frequency magnetic field.

In our paper on long term glioma risk from occupational exposure to ELF MF [47] all the workers were divided

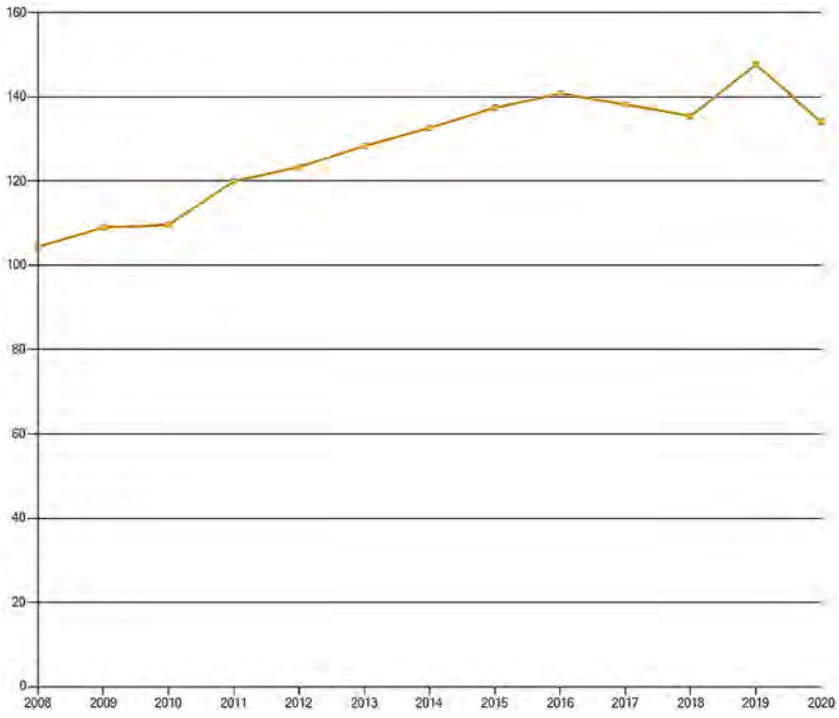


Figure 4: Number of patients per 100,000, both genders combined, diagnosed with myelin damage in CNS, ICD-codes G35-37, according to registers for in-patients and out-patients in Sweden during 2008–2020 (Statistikdatabaser – Diagnoser – Val (socialstyrelsen.se).

into five groups based on the average exposure level: (1) low exposure group (<0.11 μT); (2) low-medium exposure group (0.11 to <0.13 μT); (3) medium exposure group (0.13 to <0.18 μT); (4) medium-high exposure group (0.18 to <0.27 μT) and (5) highly exposed workers group (≥0.27 μT). Odds ratio (OR) 1.3, 95% confidence interval (CI) = 1.003–1.6 for glioma risk was found for average exposure ≥0.27 μT.

In the current study, the mean exposure level to extremely low frequency magnetic field at the subject's workstation was determined to be = 0.284 μT, which places the person into highly exposed workers' group in our study [47].

This person was in December 2021, much improved and is working full time at another office in the same building. The visible properties are similar to her previous office. There are no known problems with mold, dust or fabrics and the cleaning is similar in the whole building. However, she experiences some numbness, tremor and tingling in her extremities, especially fingers and toes, almost on a daily basis. The reason for those symptoms is unclear. RF radiation has been associated with neuron damage [48] including myelin damage [49].

Register data without personal identification is available in Sweden for hospital discharges and out-ward specialists (Statistikdatabaser – Diagnoser – Val (socialstyrelsen.se). We report numbers per 100,000 inhabitants for both genders combined. Age-standardized rates are not available in the registre. We found a clearly increasing number of patients per 100,000 diagnosed with myelin damage, ICD codes G35-37, during 2008–2020, Figure 4. Also for diseases of basal ganglia and movement disorders, G20-26, the numbers increased during the same time period, Figure 5. Note that data for 2020 are less reliable due to lag time for reporting to the register. The register started in 2008 and it should be considered that registration has improved over the years. Thus, the trends must be evaluated with caution, but indicate anyhow increasing rates.

Conclusions

This investigation established three possible reasons for developing health symptoms associated with the EMF exposure, including the following.

(1) The working room was right below the mobile phone base station antenna, located on the roof of the building. The close proximity to these antennas caused significantly high RF radiation exposure in the working area.
(2) The working room is also positioned close to lower radiofrequency transmitter (TETRA emergency services), located on the neighboring roof of the same building.
(3) The working room was positioned within 20 m from the electric train railroad. 16 Hz magnetic field from the railroad power cable was on some instances the

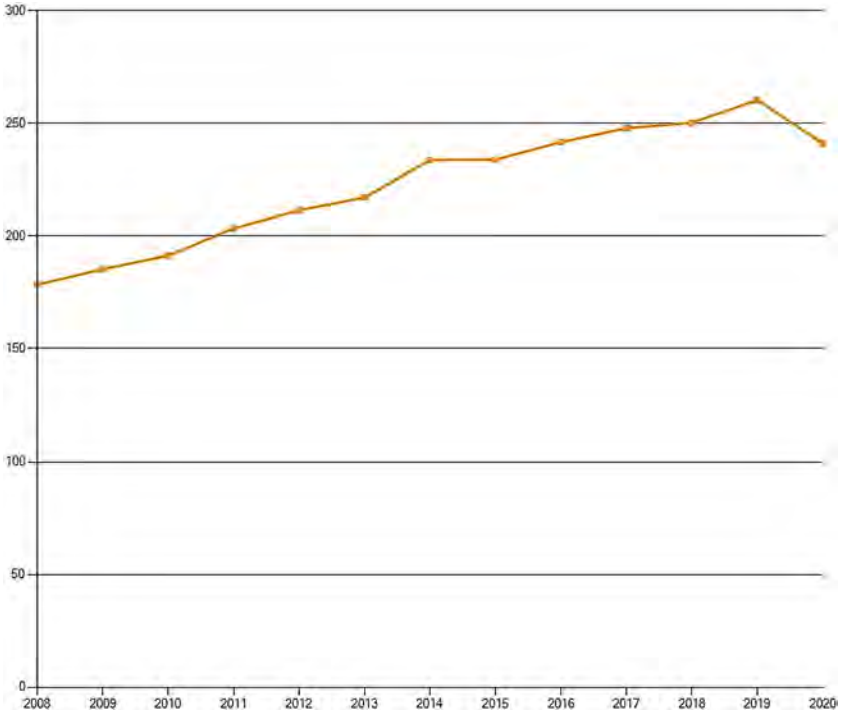


Figure 5: Number of patients per 100,000, both genders combined, diagnosed with diseases of basal ganglia and movement disorders, G20-26, according to the in-patient and out-patient registers during 2008–2020 (Statistikdatabaser – Diagnoser – Val (socialstyrelsen.se).

highest ELF MF component in the room, exceeding even the power grid 50 Hz MFs. Also, railroad power cable induced a fluctuating magnetic field in the office due to the coming and passing electric trains. As trains come and go, this introduces a change in the electric power supplied by the railroad electric cable. Consequently the magnetic field also changes in great amplitude.

In conclusion, there are at least three types of electromagnetic fields present in the working room, which cause a long term exposure to the workers. Exposure to multiple source electromagnetic fields could be the cause for developing EHS related symptoms. However, the person had been exposed to ELF-EMF also at other locations in the building, so exposure to RF-EMF seems to be the most probable cause to her developed health problems.

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Competing interests: Authors state no conflict of interest.
Informed consent: Informed consent was obtained by the study person for anonymous publication.
Ethical approval: Not applicable.

References

1. IARC. Monographs on the evaluation of carcinogenic risks to humans. In: Non-ionizing radiation, part 1: static and extremely low-frequency (ELF) electric and magnetic fields, vol 80. Lyon: International Agency for Research on Cancer; 2002.
2. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, et al. Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 2011;12:624–6.
3. IARC. Monographs on the evaluation of carcinogenic risks to humans. In: Non-ionizing radiation, part 2: radiofrequency electromagnetic fields, vol 102. Lyon: International Agency for Research on Cancer; 2013.
4. Petrov IR, editor. Influence of microwave radiation on the organism of man and animals. In: Report from academy of medical sciences of the USSR. Translated to english "vliyaniye SVCh- izlucheniya na organizm cheloveka i zhivotnykh". Meditsina Press, Leningrad. Springfield, Virginia; 1970, Report from NASA TT F-708.
5. Nordström G. The invisible disease: the dangers of environmental illnesses caused by electromagnetic fields and chemical emissions. Alresford (UK): O Books; 2004.
6. Hagström M, Auranen J, Ekman R. Electromagnetic hypersensitive Finns: symptoms, perceived sources and treatments, a questionnaire study. Pathophysiology 2013;20:117–22.
7. Hedendahl L, Carlberg M, Hardell L. Electromagnetic hypersensitivity—an increasing challenge to the medical profession. Rev Environ Health 2015;30:209–15.
8. Hillert L, Berglind N, Arnetz BB, Bellander T. Prevalence of self-reported hypersensitivity to electric or magnetic fields in a population-based questionnaire survey. Scand J Work Environ Health 2002;28:33–41.

9. Levallois P, Neutra R, Lee G, Hristova L. Study of self-reported hypersensitivity to electromagnetic fields in California. Environ Health Perspect 2002;110(4 Suppl):619–23.
10. Schreier N, Huss A, Röösli M. The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland. Soz Preventivmed 2006;51: 202–9.
11. Meg Tseng MC, Lin YP, Cheng TJ. Prevalence and psychiatric comorbidity of self-reported electromagnetic field sensitivity in Taiwan: a population-based study. J Formos Med Assoc 2011;110: 634–41.
12. Carlberg M, Hedendahl LK, Koppel T, Hardell L. High ambient radiofrequency radiation in Stockholm city, Sweden. Oncol Lett 2019;17:1777–83.
13. Hardell L, Koppel T, Carlberg M, Ahonen M, Hedendahl L. Radiofrequency radiation at Stockholm central railway station in Sweden and some medical aspects on public exposure to RF fields. Int J Oncol 2016;49:1315–24.
14. Hardell L, Carlberg M, Koppel T, Hedendahl L. High radiofrequency radiation at Stockholm old town: an exposimeter study including the royal castle, supreme court, three major squares and the Swedish Parliament. Mol Clin Oncol 2017;6: 462–76.
15. Hardell L, Carlberg M, Hedendahl LK, Koppel T, Ahonen M. Environmental radiofrequency radiation at the Järntorget Square in Stockholm Old Town, Sweden in May, 2018 compared with results on brain and heart tumour risks in rats exposed to 1.8 GHz base station environmental emissions. World Acad Sci J 2018;1: 47–54.
16. Hardell L, Carlberg M, Hedendahl LK. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: a case report. Oncol Lett 2018;15: 7871–83.
17. Hedendahl LK, Carlberg M, Koppel T, Hardell L. Measurements of radiofrequency radiation with a body-borne exposimeter in Swedish schools with Wi-Fi. Front Public Health 2017;5:279.
18. Belpomme D, Campagnac C, Irigaray P. Reliable disease biomarkers characterizing and identifying electrohypersensitivity and multiple chemical sensitivity as two etiopathogenic aspects of a unique pathological disorder. Rev Environ Health 2015;30:251–71.
19. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 2016;31:363–97.
20. Belpomme D, Hardell L, Belyaev I, Burgio E, Carpenter DO. Thermal and non-thermal health effects of low intensity non-ionizing radiation: an international perspective. Environ Pollut 2018;242:643–58.
21. Schmid MR, Loughran SP, Regel SJ, Murbach M, Grunauer AB, Rusterholz T, et al. Sleep EEG alterations: effects of different pulse-modulated radio frequency electromagnetic fields. J Sleep Res 2012;21:50–8.
22. Krause CM, Björnberg CH, Pesonen M, Hulten A, Liesivuori T, Koivisto M, et al. Mobile phone effects on children's event-related oscillatory EEG during an auditory memory task. Int J Radiat Biol 2006;82:443–50.
23. Roggeveen S, van Os J, Viechtbauer W, Lousberg R. EEG changes due to experimentally induced 3G mobile phone radiation. PLoS One 2015;10:e0129496.
24. Cook CM, Saucier DM, Thomas AW, Prato FS. Changes in human EEG alpha activity following exposure to two different pulsed magnetic field sequences. Bioelectromagnetics 2009;30:9–20.
25. Hardell L, Söderqvist F, Carlberg M, Zetterberg H, Hansson-Mild K. Exposure to wireless phone emissions and serum beta-trace protein. Int J Mol Med 2010;26:301–6.
26. Volkow ND, Tomasi D, Wang GJ, Vaska P, Fowler JS, Telang F, et al. Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. JAMA 2011;305:808–13.
27. Cam ST, Seyhan N. Single-strand DNA breaks in human hair root cells exposed to mobile phone radiation. Int J Radiat Biol 2012; 88:420–4.
28. Karinen A, Heinävaara S, Nylund R, Leszczynski D. Mobile phone radiation might alter protein expression in human skin. BMC Genom 2008;9:77.
29. Corazza M, Minghetti S, Bertoldi AM, Martina E, Virgili A, Borghi A. Modern electronic devices: an increasingly common cause of skin disorders in consumers. Dermatitis 2016;27:82–9.
30. Banjeree S, Singh NN, Sreedhar G, Mukherjee S. Analysis of the genotoxic effects of mobile phone radiation using buccal micronucleus assay: a comparative evaluation. J Clin Diagn Res 2016;10:ZC82–5.
31. Vanishree M, Manvikar V, Rudrataju A, Reddy KMP, Kumar NHP, Quadri SYM. Significance of micronuclei in buccal smears of mobile phone users: a comparative study. J Oral Maxillofac Pathol 2018;22:448.
32. Hamzany Y, Feinmesser R, Shpitzer T, Mizrachi A, Hilly O, Hod R, et al. Is human saliva and indicator of adverse health effects of using mobile phones? Antioxidants Redox Signal 2013;18:622–7.
33. Arbabi-Kalati F, Salimis S, Vaziry-Rabiee A, Noraeei M. Effect of mobile phone usage time on total antioxidant capacity of saliva and salivary immunoglobulin. Iran J Public Health 2014;43: 480–4.
34. Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J, et al. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed Environ Sci 2010;23:199–207.
35. Eskander EF, Estefan SF, Abd-Rabou AA. How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin Biochem 2012;45:157–61.
36. Buchner K, Eger H. Changes of clinically important neurotransmitters under the influence of modulated RF-fields-a long term study under real-life conditions. Umwelt Med Ges 2011; 24:44–57.
37. Zothansiama, Zosangzuali M, Lalramdinpuii M, Jagetia GC. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med 2017;36:295–305.
38. Bayat M, Hemati S, Soleimani-Estyar R, Shahin-Jafari A. Effect of exposure of mice to 900 MHz GSM radiation on cutaneous candidiasis. Saudi J Biol Sci 2017;24:907–14.
39. Tok L, Naziroglu M, Dogan S, Kahya MC, Tok O. Effects of melatonin on WiFi-induced oxidative stress in lens of rats. Indian J Ophthalmol 2014;62:12–5.
40. Boscolo P, Di Giampaolo L, Di Donato A, Antonucci A, Paiardini G, Morelli S. The immune response of women with prolonged exposure to electromagnetic fields produced by radiotelevision broadcasting stations. Int J Immunopathol Pharmacol 2006; 19(4 Suppl):43–8.

41. Hutter HP, Moshammer H, Wallner P, Cartellieri M, Denk-linnert DM, Katzinger M, et al. Tinnitus and mobile phone use. Occup Environ Med 2010;67:804–8.
42. Medeirosa LN, Sanchez TG. Tinnitus and cell phones: the role of electromagnetic radiofrequency radiation. Braz J Otorhinolaryngol 2016;82:97–104.
43. Callejo FJG, Callejo FG, Santamaría JP, Castañeira IA, Gil ES, Algarra JM. Hearing level and intensive use of mobile phones. Acta Otorrinolaringol Esp 2005;56:187–91.
44. Oktay MF, Dasdag S. Effects of intensive and moderate cellular phone use on hearing function. Electromagentic Biol Med 2006; 25:13–21.
45. Akdag M, Dasdag S, Canturk F, Akdag MZ. Exposure to non-ionizing electromagnetic fields emitted from mobile phones induced DNA damage in human ear canal hair follicle cells. Electromagn Biol Med 2018;37:66–75.
46. Hardell L, Carlberg M, Söderqvist F, Hardell K, Björnfoth H, van Bavel B, et al. Increased concentration of certain persistent organic pollutants in subjects with self-reported electromagnetic hypersensitivity – a pilot study. Electromagn Biol Med 2008;27: 197–203.
47. Carlberg M, Koppel T, Ahonen M, Hardell L. Case-control study on occupational exposure to extremely low-frequency electromagnetic fields and glioma risk. Am J Ind Med 2017;60: 494–503.
48. Salford LG, Brun AE, Eberhardt JL, Malmgren L, Persson BR. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ Health Perspect 2003;111: 881–3.
49. Kim JH, Lee JK, Kim HG, Kim KB, Kim HR. Possible effects of radiofrequency electromagnetic field exposure on central nerve system. Biomol Ther (Seoul) 2019;27:265–75.

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World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review)

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Abstract. In May 2011 the International Agency for Research on Cancer (IARC) evaluated cancer risks from radiofrequency (RF) radiation. Human epidemiological studies gave evidence of increased risk for glioma and acoustic neuroma. RF radiation was classified as Group 2B, a possible human carcinogen. Further epidemiological, animal and mechanistic studies have strengthened the association. In spite of this, in most countries little or nothing has been done to reduce exposure and educate people on health hazards from RF radiation. On the contrary ambient levels have increased. In 2014 the WHO launched a draft of a Monograph on RF fields and health for public comments. It turned out that five of the six members of the Core Group in charge of the draft are affiliated with International Commission on Non-Ionizing Radiation Protection (ICNIRP), an industry loyal NGO, and thus have a serious conflict of interest. Just as by ICNIRP, evaluation of non-thermal biological effects from RF radiation are dismissed as scientific evidence of adverse health effects in the Monograph. This has provoked many comments sent to the WHO. However, at a meeting on March 3, 2017 at the WHO Geneva office it was stated that the WHO has no intention to change the Core Group.

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2. The WHO fact sheet
3. The WHO EMF project
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6. Exposure to RF radiation within the WHO building in Geneva
7. Concluding remarks

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Key words: electromagnetic fields, EMF, radiofrequency radiation, public exposure, cancer, WHO, monograph, conflict of interest, ICNIRP, non-thermal effects, health risks

1. Introduction

The use of wireless digital technology has grown rapidly during the last couple of decades (http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2016.pdf). During use, mobile phones and cordless phones emit radiofrequency (RF) radiation. The brain is the main target organ for RF emissions from the handheld wireless phone (1,2). An evaluation of the scientific evidence on the brain tumour risk was made in May 2011 by the International Agency for Research on Cancer (IARC) at the World Health Organization (WHO). IARC is independently financed and has its own governing and scientific councils, which WHO staff only attend as observers (http://www.who.int/ionizing_radiation/research/iarc/en/).

Epidemiological studies provided supportive evidence of increased risk for head and brain tumours, i.e., acoustic neuroma and glioma. The working group reached the conclusion that RF radiation from devices that emit non-ionizing RF radiation in the frequency range 30 kHz-300 GHz, is a Group 2B, i.e. a 'possible', human carcinogen (3,4). Later studies have corroborated these findings and have thus strengthened the evidence (5-8).

Several laboratory studies have indicated mechanisms of action for RF radiation carcinogenesis such as on DNA repair, oxidative stress, down regulation of mRNA and DNA damage with single strand breaks (9-13). A report was released from The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in USA on the largest ever animal study on cell phone RF radiation and cancer (14). An increased incidence of glioma in the brain and malignant schwannoma in the heart was found in rats. Acoustic neuroma or vestibular schwannoma is a similar type of tumour as the one found in the heart, although benign. Thus, this animal study supported human epidemiological findings on RF radiation and brain tumour risk (8).

The IARC cancer classification includes all sources of RF radiation. The exposure from mobile phone base stations, Wi-Fi access points, smart phones, laptops and tablets can be long-term, sometimes around the clock, both at home and at

school. For children this risk may be accentuated because of a cumulative effect during a long lifetime use (15). Developing and immature cells can also be more sensitive to exposure to RF radiation (9).

In spite of the IARC evaluation little has happened to reduce exposure to RF fields in most countries. On the contrary, with new technology increasing environmental exposure levels are found as in measurements of ambient RF radiation at e.g. Stockholm Central Station and Stockholm Old Town in Sweden (16,17). The exposure guideline used by many agencies was established in 1998 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and was based only on established short-term thermal (heating) effects from RF radiation neglecting non-thermal biological effects (18). The heating effects arise when radiation is so high that it warms up the whole body by 1˚C or more after 30 min exposure at 4 W/kg specific absorption rate. The guidelines are set with a safety factor of 50 for the general public (http://www.who.int/peh-emf/about/WhatisEMF/en/index4.html).

Basis for limiting exposure according to ICNIRP: 'Only established effects were used as the basis for the proposed exposure restrictions. Induction of cancer from long-term EMF exposure was not considered to be established, and so these guidelines are based on short-term, immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EMF. In the case of potential long-term effects of exposure, such as an increased risk of cancer, ICNIRP concluded that available data are insufficient to provide a basis for setting exposure restrictions, although epidemiological research has provided suggestive, but unconvincing, evidence of an association between possible carcinogenic effects.' (http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf).

This is an exceptional statement by ICNIRP, and found in many statements of groups following the ICNIRP philosophy like the AGNIR and on the WHO EMF Project's homepage as well, that epidemiology found 'suggestive, but unconvincing' evidence. What is convincing or not is so decidedly subjective that no scientific body will ever make this as a basis for a decision. There might be gaps in knowledge that make it difficult to decide about the mechanisms that underlie an observation and even an observation could be considered unreliable but the conviction must not enter a rational discourse about a scientific issue.

The guidelines were updated in 2009 but still do not cover cancer and other long-term or non-thermal health effects. ICNIRP gives the guideline 2 to 10 W/m^2 for RF radiation depending on frequency, thus only based on a short-term immediate thermal effect (19). ICNIRP is a private organisation (NGO) based in Germany. New expert members can only be elected by members of ICNIRP. Many of ICNIRP members have ties to the industry that is dependent on the ICNIRP guidelines. The guidelines are of huge economic and strategic importance to the military, telecom/IT and power industry.

In contrast to ICNIRP, the BioInitiative Reports from 2007 and updated in 2012, based the evaluation also on non-thermal health effects from RF radiation (20,21). The scientific benchmark for possible health risks was defined to be 30 to 60 μW/m^2. Thus, using the significantly higher guideline by ICNIRP gives a 'green card' to roll out the wireless digital technology thereby not considering non-thermal health effects from RF radiation. Numerous health hazards are disregarded such as cancer (8), effects on neurotransmitters and neuroprotection (22,23), blood-brain-barrier (24,25), cognition (26-29), psychological addiction (30-32), sleep (33-36), behavioral problems (37-41) and sperm quality (13,42,43).

No doubt the IARC decision started a world-wide spinning machine to question the evaluation. It was similar to the one launched by the tobacco industry when IARC was studying and evaluating passive smoking as a carcinogen in the 1990s (44). Sowing confusion and manufacturing doubt about scientific facts is a well-known strategy used by the tobacco and other industries (8,45-48).

2. The WHO fact sheet

A Fact Sheet from WHO issued in June 2011 shortly after the IARC cancer classification in May 2011 stated that 'To date, no adverse health effects have been established as being caused by mobile phone use' (http://www.who.int/mediacentre/factsheets/fs193/en/). This statement was not based on scientific evidence at that time on a carcinogenic effect from RF radiation. It was certainly a remarkable conclusion by WHO since IARC is part of WHO although seemingly independent, see above.

However, it is also important to note that the statement in the Fact Sheet does not fully contradict the IARC statement. A Group 2B carcinogen is considered by IARC as an agent where an association with cancer has been detected that can be causally interpreted but for which chance, bias and confounding cannot be ruled out with sufficient scientific certainty. Hence, the statement in the Fact Sheet is in line with IARC's classification although, of course, it will rather be understood as a full dismissal of claims of harm.

In the WHO Fact Sheet it was also stated that 'WHO will conduct a formal risk assessment of all studied health outcomes from radiofrequency fields exposure by 2012.' The pertinent question is why WHO was so keen to make a new risk evaluation shortly after the IARC evaluation. It was hardly expected that new studies would be published in short time changing the classification of RF radiation as a possible, Group 2B, human carcinogen. Considering the WHO statement of 'no adverse health effects' the aim might have been to undermine the IARC decision and give the telecom industry a 'clean bill' of health (8). It might, however, be argued that as a result of the IARC classification, it was necessary for WHO to also look at other effects, and not just tumours.

3. The WHO EMF project

The biophysicist Michael Repacholi from Australia was the first chairman of ICNIRP in 1992. His own research within this field is scanty, although a study on lymphoma incidence in mice exposed to RF radiation published in 1997 has attracted interest (49). Repacholi suggested in 1995 that WHO should start the EMF project. This was adopted by WHO in 1996, see WHO Press office: WHO launches new international project

to assess health effects of electric and magnetic fields; 4 June 1996 (50). Repacholi was during 1996-2006 the leader of the WHO department of electromagnetic radiation, the WHO EMF project.

The WHO EMF project is supposed to: 1) provide information on the management of EMF protection programs for national and other authorities, including monographs on EMF risk perception, communication and management; 2) provide advice to national authorities, other institutions, the general public and workers, about any hazards resulting from EMF exposure and any needed mitigation measures. (http://www.who.int/peh-emf/project/EMF_Project/en/index1.html).

Michael Repacholi immediately set up a close collaboration between WHO and ICNIRP (being head of both organizations) inviting the electric, telecom and military industries to meetings. He also arranged for large part of the WHO EMF project to be financed by the telecommunication industry's lobbying organisations; GSM Association and Mobile Manufacturers Forum, now called Mobile & Wireless Forum (MWF) (51) in addition to WHO, see the International EMF Project, Progress Report June 2005-2006 (http://www.who.int/peh-emf/publications/reports/IAC_Progress_Report_2005-2006.pdf).

Repacholi acted like a representative for the telecom industry while responsible for the EMF health effects department at the WHO (http://microwavenews.com/news/time-stop-who-charade). Since he left WHO in 2006 he has been involved in industry propaganda video interviews with GSM Association and Hydro Quebec (https://www.youtube.com/watch?v=fDZx7MphDjQ; https://www.youtube.com/watch?v=1MI_fa5YsgY) where he clearly speaks in favor of the telecommunications and the power industries, respectively.

Michael Repacholi is still the Chairman emeritus at ICNIRP (http://www.icnirp.org/en/about-icnirp/emeritus-members/index.html) and has propagated during almost 20 years worldwide the 'only thermal effect' paradigm of health risks from RF-EMF exposure, ignoring the abundant evidence for non-thermal effects or cancer risks.

Repacholi recruited Emilie van Deventer to the WHO EMF Project in 2000. She is the current project manager at WHO for the EMF project. She has been a long time member of the industry dominated organization Institute of Electrical and Electronics Engineers (IEEE). IEEE is the world's most powerful federation of engineers. The members are or have been employed in companies or organizations that are producers or users of technologies that depend on radiation frequencies, such as power companies, the telecom and the military industry. IEEE has prioritized international lobbying efforts for decades especially aimed at the WHO, for more information see (http://www.ices-emfsafety.org/wp-content/uploads/2016/10/Approved-Minutes-TC95-Jan_16.pdf).

Van Deventer is an electrical engineer. She has no formal or earlier knowledge in medicine, epidemiology or biology, so it is surprising that she was selected for such an important position at the WHO (http://www.waves.utoronto.ca/people_vandeventer.htm) (http://www.itu.int/ITU-T/worksem/emc-emf/201107/bios.html).

The very same year she was recruited to the WHO EMF Project Toronto University Magazine wrote about Emilie van Deventer's work stating that it was 'invaluable' to industry: 'The software modelling done by teams like van Deventer's is invaluable.' 'The industrial community is very interested in our research capabilities,' says van Deventer. 'It always needs to be working on the next generation of products, so it turns to universities to get the research done.' (http://www.research.utoronto.ca/edge/fall2000/content2b.html).

The importance of this work is reflected in the research funding van Deventer and her team received from the Natural Sciences & Engineering Research Council of Canada (NSERC), Communications & Information Technology Ontario (CITO), and their major industrial partner, Nortel. 'We are fulfilling a very real need in the industry today, which will only increase as technology creates more opportunity. In the process, consumers will continue to enjoy faster computers, lighter cell phones, smaller electronic organizers and the vast array of other electronic gadgets the high-tech world has to offer.' (http://www.research.utoronto.ca/edge/edgenet/fall2000/a-clear-signal/).

4. WHO radio frequency fields: Environmental health criteria monograph

Two years after the anticipated 'formal risk assessment' by WHO in 2012 a draft was launched in 2014 (http://www.who.int/peh-emf/research/rf_ehc_page/en/). It was open for public consultation until December 31, 2014, but is now closed according to the WHO home page.

It was stated that: 'The process used in developing the chapters is described in Appendix X. Note that the chapters 1, 13 and 14 which will provide a summary, health risk assessment and protective measures are not available for this consultation. The drawing of conclusions from the literature and the drafting of these chapters is the remit of a formal Task Group that will be convened by WHO at a later stage in the process.'

It must be regarded to be unusual and scientifically inadequate not to provide for review the health risk assessment and protective measures which would be most important parts of the Monograph. Furthermore, it turned out that of the six members in the WHO Core Group four are active members of ICNIRP and one is a former member. This was published in 2016 (52) and also discussed more recently (8). Only one person seems to be independent of ICNIRP, see Table I. Several persons have also affiliation(s) to other advisory groups, authorities and/or committees. Six of the 20 additional experts are affiliated with ICNIRP.

Being a member of ICNIRP is a conflict of interest in the scientific evaluation of health hazards from RF radiation through ties to military and industry. This is particularly true since the ICNIRP guidelines are of huge importance to the influential telecommunications, military and power industries. Another conflict of interest is for members officially assessing possible health effects below their own set ICNIRP guidelines, which they have already stated as beeing safe, see also discussion in (52). Such persons would hardly have different opinions than those stated by ICNIRP. Critical views are not heard and a balanced scientific evaluation is not obtained.

It should be noted that the Ethical Board at the Karolinska Institute in Stockholm, Sweden concluded already in 2008 that being a member of ICNIRP may be a conflict of interest that

Table I. Members of WHO Monograph core group and their involvement in different other groups (8).

Name	WHO	ICNIRP	UK/AGNIR	SSM	SCENIHR
Simon Mann	X	X	X		
Maria Feychting	X	X	X	X[a]	
Gunnhild Oftedal	X	X			
Eric van Rongen	X	X		X	
Maria Rosaria Scarfi	X	X[a]		X	X
Denis Zmirou	X				

[a]Former. WHO, World Health Organization; ICNIRP, International Commission on Non-Ionizing Radiation Protection; AGNIR, Advisory Group on Non-Ionising Radiation; SSM, Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority); SCENIHR, Scientific Committee on Emerging and Newly Identified Health Risks.

should be stated officially whenever a member from ICNIRP makes opinions on health risks from EMF (Karolinska Institute diary number: 3753-2008-609). No statement of such conflict of interest can be found in the WHO draft of the Monograph on RF radiation.

Several persons and groups have sent critical comments to WHO on the many shortcomings in the draft of the Monograph on RF fields. In general WHO has not responded to these comments and it is unclear to what extent, if any, they are considered. Due to the short time for submission our (Lennart Hardell, Michael Carlberg) comments related only to section 12.1 Cancer Epidemiology. Our concluding remarks dated December 15, 2014 were: 'In conclusion the WHO draft is biased towards the null results. Findings on an association between use of wireless phones (mobile phones and cordless phones) and increased risk for brain tumours are misinterpreted, selectively reported and/or omitted in total. The draft cannot be used as science-based evaluation of increased risk. It needs to be re-written in a balanced way by scientists trained in epidemiology and oncology, not the least in medicine, and without conflicts of interest.'

Moreover, after the formal closing date for comments on the Monograph several additional submissions have been made to WHO. Professor Michael Kundi at Center for Public Health, Institute of Environmental Health, Vienna, Austria stated in his summary dated January 12, 2015: 'I was only able to check chapter 12 about cancer and only the epidemiological studies. While the EHC (Environmental Health Criteria) team did a great job in allocating the relevant literature with only few more recent papers missing, I'm not fully satisfied with the assessment of the evidence. There is a striking imbalance in the comments made on studies that were positive in contrast to those that were negative. Only the most obvious shortcomings of studies that didn't report an effect of exposure are mentioned while positive findings are often discussed at length, sometimes with very far-fetched assumptions about potential sources of bias. This is in marked contrast to other EHC monographs that are discussing the evidence in a way not to overlook a potential harmful effect. My comments, giving reference to the lines of the draft are detailed on the following pages.'

The BioInitiative Working Group issued December 19, 2016 a 'No Confidence' Letter to the WHO EMF Program Manager: 'The BioInitiative Working Group urges the World Health Organization to make changes to the WHO RF EHC Core Group membership to more fairly reflect membership and expertise of the 2011 IARC RF Working Group. At present, the WHO RF EHC Core Group is indistinguishable from ICNIRP... undermining credibility of the process and ensuring doubt about conclusions... Even if schedule delays occur as a result, an acceptable outcome depends on public confidence. There [are] now many thousands of high quality scientific papers indicating possible non-thermal RF risks to health and those experts most competent by virtue of their research contributions are absent from this process... Both human and animal results are now available to incorporate in the RF EHC risk assessment. This important effort can only be assured with a more balanced composition of core participants in the process. As well, the membership needs to be inclusive of under-represented countries such as Russia, China, India, Turkey, and Iran whose research communities have produced the majority of studies on non-thermal effects of RF in recent years.' (http://www.bioinitiative.org/report/wp-content/uploads/2016/12/BIWG-final-draft-WHO-RF-EHC-Monograph-team-composition.pdf).

This letter was followed by another from the BioInitiative Working Group on January 24, 2017 including suggestion of experts to replace present persons in the Core Group and Additional Experts: 'We have not yet received a reply acknowledging our letter... It is important that the most knowledgeable panel of experts be appointed to prepare the RF EHC Monograph. At present, the EHC Core Group members uniformly represent attitudes and scientific positions of ICNIRP, an organization whose membership has steadfastly refused to accept new scientific evidence of potential health risks from non-thermal, low-intensity radiofrequency radiation despite recent scientific advances in knowledge on the subject. We are recommending substitutions for membership as indicated on the attached page. Please note that we are suggesting a complete replacement for those persons currently holding positions.' (http://www.bioinitiative.org/report/wp-content/uploads/2017/01/BIWG-EHC-substitution-letter.pdf).

Call for Protection from Non-ionizing Electromagnetic Field Exposure was made by the International Electromagnetic Field Scientist Appeal, initial release date May 11, 2015, latest version's date January 29, 2017 with 222 signatures

from 41 nations: 'We are scientists engaged in the study of biological and health effects of non-ionizing electromagnetic fields (EMF)... Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life. These findings justify our appeal to the United Nations (UN) and, all member States in the world, to encourage the World Health Organization (WHO) to exert strong leadership in fostering the development of more protective EMF guidelines, encouraging precautionary measures, and educating the public about health risks, particularly risk to children and fetal development. By not taking action, the WHO is failing to fulfil its role as the preeminent international public health agency.' (https://www.emfscientist.org/index.php/emf-scientist-appeal).

A press release was issued on February 24, 2017 by the European coordination of organizations for an EMF exposure regulation which truly protects public health. The European citizens' organizations failed, however, to include in their letter the conflict of interest associated with ICNIRP members assessing possible effects below set ICNIRP guidelines, see discussion above. They stated that: 'The Conflict of Interest Scandal is repeating itself in the WHO: European citizens' organizations uncover conflicts of interest between the health and radiofrequency WHO expert group and telecommunications or electric companies. Almost 40 organizations and European Platforms (which in turn include many regional, national or local social organizations), supported by the International EMF Alliance (IEMFA), denounce the flagrant conflict of interest of the Core Group of experts for drafting, in the current year, of a WHO Environmental Health Criteria Monograph on Radio-Frequency Fields...

The preponderant presence of members of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) reminds us that this organization (and other institutions with the same criteria) refused to accept new scientific evidence of potential health risks from non-thermal, low-intensity radiofrequency radiation despite recent scientific advances in knowledge on the subject. The ICNIRP not only does not guarantee transparency or independence but conflicts of interest of its members are well known and reported, due to their relationships with telecommunications or electric companies, thereby undermining the impartiality that should govern the regulation of Public Exposure Standards for non-ionizing radiation... By not taking action, the WHO is failing to fulfill its role as the preeminent international public health agency...' (http://www.peccem.org/DocumentacionDescarga/Plataforma-Estatal/notasprensa/European.coordination.press.release-february-2017.pdf).

Letter dated March 1, 2017 from Russian National Committee on Non-Ionizing Radiation Protection to Maria Neira, Director, Public Health and Environment with copy to Dr. E. van Deventer, Public Health and Environment, WHO: 'It has just come to our attention that the WHO RF Working group consists mainly from present and past ICNIRP members. In general, the WG is not balanced and... the private self-elected organization ICNIRP, similar as majority of the current WHO RF WG members, does not recognize the non-thermal RF effects,... Thus, the guidelines of ICNIRP are irrelevant to present situation when majority of population over the world is chronically exposed to non-thermal RF from mobile communication.' (http://www.radiationresearch.org/articles/rusncnirp-letter-to-who/), letter available at (http://www.mast-victims.org/resources/docs/RNCNIRP-letter-WHO/2017_03_01.pdf).

5. Human Health Effects of Non-Ionizing Radiation - Informal meeting at WHO March 3, 2017

It is quite obvious that it would be of utmost value to learn what is on-going at WHO regarding the Monograph on RF radiation, especially since formal responses to submissions with comments are virtually absent. Thus, some 9 months after initial contact Dr Maria Neira accepted to organize a meeting, relating to the effects of electromagnetic fields on health, in her office at WHO in Geneva. The request for a meeting was made by independent researchers from different universities. An informal meeting was organized on March 3, 2017. (http://eceri-institute.org/fichiers/1490952497_newsletter_ECERI_5.pdf).

Dr Maria Neira is Director of the Public Health and the Environment Department at WHO. Present at the meeting was also Dr Emilie van Deventer, the Team Leader of the Radiation Programme at WHO which deals with non-ionizing and ionizing radiation topics related to human health. She has been working at WHO since 2000 where she heads the International EMF Project, the Ultraviolet INTERSUN Programme and the International Radon Project. Dr van Deventer received a Ph.D. in Electrical Engineering from the University of Michigan, USA. She was adjunct professor of Electrical and Computer Engineering, financed by the telecom industry, at the University of Toronto in Canada from 1992 to 2000. She is the WHO Observer on the Main Commission of ICNIRP, e.g. participating in ICNIRP meetings. (http://www.itu.int/en/ITU-T/Workshops-and-Seminars/emf/201307/Pages/vanDEVENTERTaheraEmilie.aspx). She is also one of 8 members of the Swedish Radiation Safety Authority (SSM).

The allocated time at the WHO office was 1.5 h. Dr Maria Neira opened the meeting stressing that it was not official but informal. She told that her department is very much interested in challenging science. In addition to myself, four additional experts were also present. The experts gave short presentations on health effects of RF radiation, biological effects from exposure to non-thermal RF radiation, overview of epidemiological studies on brain tumour risk, RF radiation and electromagnetic hypersensitivity (EHS), and finally epigenetic mechanisms by which children are especially-vulnerable to RF radiation. Obviously the five presentations were very short in order to give time for discussions, the most important part of the meeting.

The participating team of five experts with considerable knowledge and own research within this area offered to collaborate with WHO, especially to finalize the WHO Monograph on RF radiation. Maria Neira stated clearly that no collaboration with WHO is to be considered, and further that she does not intend to have another meeting with the group. However,

Table II. World Health Organization (Geneva, Switzerland) levels of RF-radiation March 3, 2017 (μW/m^2) treating values at detection limit as 0.[a]

	n	Mean	Median	Min	Max
FM	1,813	2.0	1.2	0.0	128.4
TV3	1,813	0.0	0.0	0.0	1.7
TETRA I	1,813	0.1	0.0	0.0	136.7
TETRA II	1,813	0.0	0.0	0.0	0.0
TETRA III	1,813	0.0	0.0	0.0	3.2
TV4&5	1,813	0.1	0.0	0.0	11.9
LTE 800 (DL)	1,813	1.3	0.4	0.0	101.9
LTE 800 (UL)	1,813	0.0	0.0	0.0	0.0
GSM + UMTS 900 (UL)	1,813	0.0	0.0	0.0	4.7
GSM + UMTS 900 (DL)	1,813	8.6	4.9	0.3	268.2
GSM 1800 (UL)	1,813	0.3	0.0	0.0	182.1
GSM 1800 (DL)	1,813	4.2	1.7	0.3	268.2
DECT	1,813	0.3	0.1	0.0	38.2
UMTS 2100 (UL)	1,813	0.0	0.0	0.0	0.4
UMTS 2100 (DL)	1,813	4.5	2.5	0.4	199.1
WIFI 2G	1,813	0.0	0.0	0.0	1.3
LTE 2600 (UL)	1,813	0.0	0.0	0.0	0.0
LTE 2600 (DL)	1,813	0.0	0.0	0.0	0.6
WIMax	1,813	0.0	0.0	0.0	0.0
WIFI 5G	1,813	0.0	0.0	0.0	4.0
Total	1,813	21.5	13.3	4.8	432.3

[a]Frequency bands and number (n) of readings are given.

she added that she is open to new data. She also said that there is no conflict of interest with ICNIRP since ICNIRP is a WHO collaborative organization. The scientific group, as above, was instead invited to send to WHO peer-reviewed publications, especially meta-analyses that would be the 'best gift'.

It was stated by the WHO officials that ICNIRP is an NGO with an official relationship with WHO that 'helps us a lot in our analyses' and their members work as WHO's experts. Thus, in spite of five of six persons in the Core Group for the Monograph being affiliated with ICNIRP, WHO seems to have no intention to change these members. On the other hand, the Task Group is not finalized. According to the meeting all experts are selected on individual basis and not as members of ICNIRP. Further, it was stated that the WHO guideline documents are in full WHO's responsibility. It is not known when the Monograph on RF radiation will be published. WHO still 'keeps looking at the evidence' and is still adding new documents to the Monograph.

The decision by the Ethical Board at the Karolinska Institute in Stockholm, Sweden from 2008 that being a member of ICNIRP may be a conflict of interest that should be stated in scientific publications was brought into attention during the meeting. WHO was unaware of that document and promised to 'look into it'. Obviously that conflict of interest applies to almost the whole Core Group of the Monograph, several members of additional experts, not to say Emilie van Deventer and thus the whole WHO EMF project and the Monograph on RF radiation.

6. Exposure to RF radiation within the WHO building in Geneva

In our on-going project on measurements of ambient RF radiation in some cities Geneva is part of the study. Results of parts of Stockholm, Sweden have been published (16,17) and will be used e.g. for comparison with levels in the future due to further development of this technology. In Geneva also measurements within the WHO building; main entrance, some corridors and the meeting room were included. These previously unpublished results have been communicated to the representatives at WHO including that they will be published. There has been no reaction from the WHO.

An EME Spy 200 exposimeter with a valid calibration was used to collect the exposure data. The exposimeter measures 20 predefined frequency bands that cover frequencies from 88-5,850 MHz. The sampling time was every 4th sec which is the fastest for the given exposimeter, for further details see our publications. For frequency modulation (FM), TV3, TETRA, TV4&5, Wi-Fi 2G and Wi-Fi 5G, the lower detection limit is 0.01 V/m (0.27 μW/m^2); for all other bands, the lower detection limit is 0.005 V/m (0.066 μW/m^2) (16,17).

The results, presented in Table II, show low mean total exposure level, 21.5 μW/m^2, thus below the scientific benchmark of 30 to 60 μW/m^2 that has been proposed to be the 'lowest observed effect level' (LOEL) for RF radiation, see Chapter 24

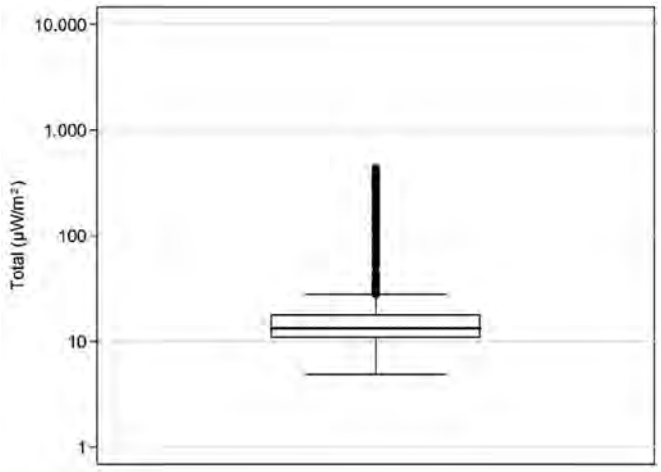


Figure 1. World Health Organization, 20 Avenue Appia, CH-1211 Geneva 27, Switzerland. Box plot for total exposure in μW/m2, logarithmic scale. The median is indicated by a black line inside the box; the bottom and top of the boxes show first and third quartiles; the end of the whisker is calculated as 1.5xIQR (interquartile range). Points represent outliers.

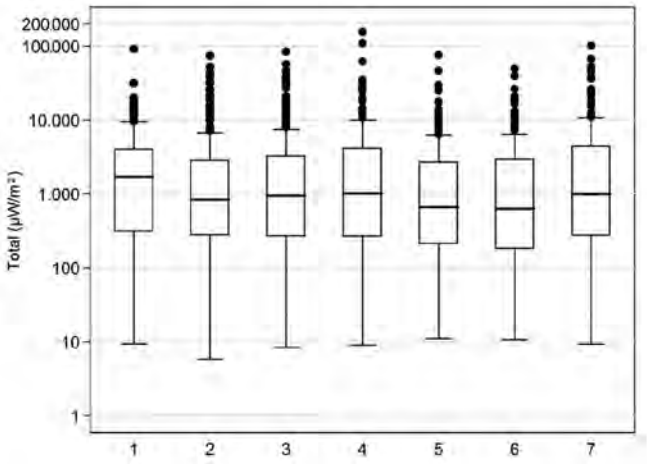


Figure 3. Box plot for total exposure in μW/m^2 for the seven measurement rounds in the Stockholm Central Railway Station (16). The median is indicated by a black line inside each box; the bottom and top of the boxes show first and third quartiles; the end of the whiskers are calculated as 1.5xIQR (interquartile range). Points represent outliers.

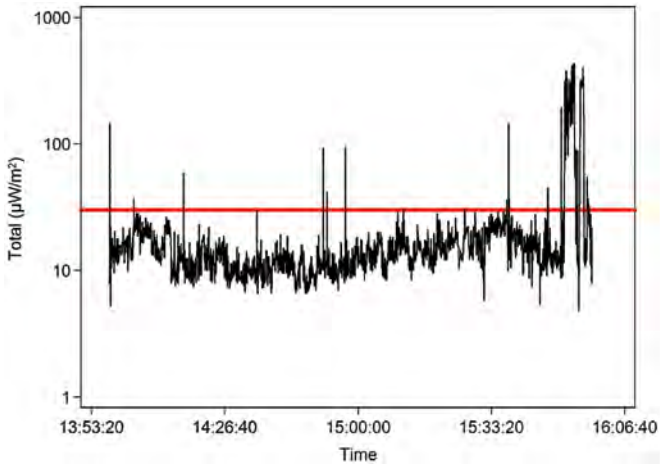


Figure 2. World Health Organization, Geneva, Switzerland. Total RF field exposure (μW/m^2, mean exposure=21.5 μW/m^2, logarithmic scale) over time of one exposure round, March 3, 2017 time 13:57:53-15:58:31. The horizontal line represents the LOEL exposure limit of 30 μW/m^2 suggested by the Bioinitiative Report (21).

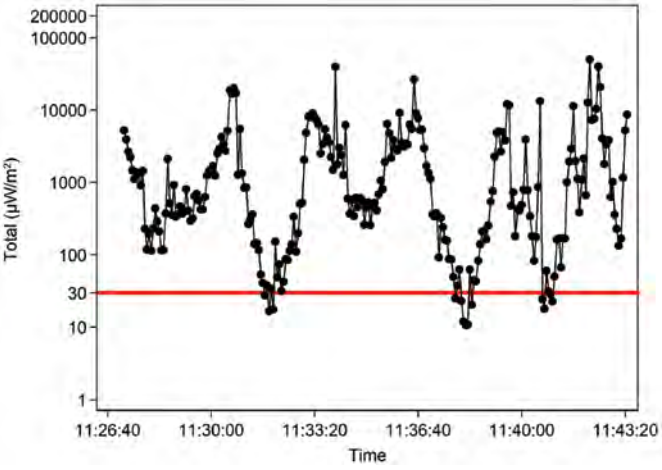


Figure 4. Total radiofrequency field exposure (μW/m^2) of the lowest exposure round (November 9, 2015; mean exposure 2,817.0 μW/m^2) by walking across the Stockholm Central Station (16). The line represents the exposure limit of 30 μW/m^2 suggested by the Bioinitiative Report (21).

of the BioInitiative Report (21). Note that only for the mean it is possible to calculate the total as the sum of means of the individual frequency bands, mathematically this is not possible for median, min and max in Table II. The major sources were GSM + UMTS 900 DL (3G), GSM 1800 DL (2G) and UMTS 2100 DL (3G), i.e. downlink (DL) of RF radiation from outside base stations. The results for total exposure are also presented as box plot in Fig. 1. In Fig. 2 total exposure over time is presented. Almost all RF radiation was below 30 μW/m^2, the LOEL of RF radiation for possible health risks as shown with the horizontal line. The highest peak level, 432.3 μW/m^2, was measured at 15:54:07. Most contribution was from GSM 1800 (DL), 268.2 μW/m^2, and UMTS 2100 (DL), 110.4 μW/m^2. This was measured just inside the building at the entrance and represent RF radiation from base stations in the vicinity.

The exposure to RF radiation within the WHO building is very low compared to other measurements, for example our measurements inside the Stockholm Central station where people both are passing through but also are there for hours each day such as security and police staff, cafe workers, shop workers, janitors, information counter people, etc., see Figs 3 and 4. Here, the mean total exposure for the lowest exposure round was 2,817 μW/m^2, mostly from down loading from GSM, 3G and 4G base stations (16). Thus, the measured mean level in the WHO building is more than 130 times lower than in the Stockholm Central Station.

7. Concluding remarks

The meeting at WHO was an obvious disappointment. During the discussion the two WHO officials showed little interest to collaborate with the scientists convened at the meeting in spite of the scientific evidence on adverse health effects. Their in-house experts seem to be members of ICNIRP,

although not exclusively. This may explain why only short-term thermal effects from RF radiation are accepted as proofs of harm, and why non-thermal biological effects are ignored. In the draft of the Monograph a large bulk of peer-reviewed scientific publications on non-thermal effects are dismissed, c.f. as also by ICNIRP (19). Most remarkable is that WHO has no intention to replace the Core Group of experts affiliated with ICNIRP. Thereby ICNIRP is given full access to and exclusive possibilities to influence the Monograph. In view of the huge economic interests built into the ICNIRP guidelines, and several of its expert members' ties to industry, no doubt this is a large conflict of interest that will seriously undermine not only the credibility of the Monograph on RF radiation but also the credibility of WHO as a protector of world health. Seriously enough, the Monograph will be the hallmark for years to come on evaluation of health hazards from RF radiation and pave the way for increasing exposure to RF radiation to people and environment, e.g. the fifth generation (5G), internet of things, etc.

Children and adolescents may be more sensitive to RF radiation than adults (2). Thus as an authoritative agency, WHO has an obligation to reference all the scientific research results and call the experts from all the related fields like engineering, health and medicine to engage in the re-evaluation of all health effects including non-thermal of RF radiation. Related agencies should launch an objective and transparent project for this assessment. The EMF project was started many years ago and many new wireless digital technologies are developed and new devices are popularizing with a very fast speed.

Protests and comments by scientific experts and several organizations seem to be ignored. The Monograph might be political and industry supportive more than scientific and health promoting. For a definitive conclusion a more thorough review of the whole draft document would be needed. By now it is time for laymen, NGOs and scientists to exert pressure on politicians to change the WHO agenda on RF radiation and health hazards and decide that WHO's purpose is to support world health instead of industry interests. It is also time to evaluate the competence of the persons making the evaluations and decisions before publishing the Monograph. Of note, evidence has been published (52) which indicated that members of ICNIRP have written scientifically incorrect and misleading information. It is unknown if WHO has responded to this evidence of suggested scientific misconduct.

To evaluate cancer risks it is necessary to include scientists with competence in medicine, especially oncology. Furthermore, what are the personal advantages, at least in the short time, for those refusing to accept peer-reviewed scientific publications on adverse effects on health and environment from RF radiation? Ironically enough, whether knowingly or not, the WHO staff seems to protect themselves from high involuntary RF radiation levels at least in the measured areas within the Geneva building.

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References

1. Cardis E, Deltour I, Mann S, Moissonnier M, Taki M, Varsier N, Wake K and Wiart J: Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. Phys Med Biol 53: 2771-2783, 2008.
2. Gandhi OP, Morgan LL, de Salles AA, Han Y-Y, Herberman RB and Davis DL: Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 31: 34-51, 2012.
3. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
4. International Agency for Research on Cancer: IARC monographs on the evaluation of carcinogenic risks to humans, Volume 102. In: Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. WHO Press, Lyon, France, 2013. Available online: http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf. Accessed April 1, 2017.
5. Hardell L, Carlberg M, Söderqvist F and Hansson Mild K: Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. Int J Oncol 43: 1833-1845, 2013.
6. Hardell L, Carlberg M and Hansson Mild K: Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. Pathophysiology 20: 85-110, 2013.
7. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R, *et al*: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
8. Carlberg M and Hardell L: Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints form 1965 on association or causation. BioMed Res Int 2017: 9218486, 2017.
9. Markovà E, Malmgren LO and Belyaev IY: Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: Possible mechanistic link to cancer risk. Environ Health Perspect 118: 394-399, 2010.
10. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R and Abegaonkar MP: Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology 51: 158-165, 2015.
11. Dasdag S, Akdag MZ, Erdal ME, Erdal N, Ay OI, Ay ME, Yilmaz SG, Tasdelen B and Yegin K: Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue. Int J Radiat Biol 91: 555-561, 2015.
12. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35: 186-202, 2016.
13. Akdag MZ, Dasdag S, Canturk F, Karabulut D, Caner Y and Adalier N: Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats? J Chem Neuroanat 75: 116-122, 2016.
14. Wyde M, Cesta M, Blystone C, Elmore S, Foster P, Hooth M, Kissling G, Malarkey D, Sills R, Stout M, *et al*: Report of Partial findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposures). US National Toxicology Program (NTP), 2016. doi: org/10.1101/055699. http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf. Accessed on April 1, 2017.
15. Hedendahl L, Carlberg M and Hardell L: Electromagnetic hypersensitivity - an increasing challenge to the medical profession. Rev Environ Health 30: 209-215, 2015.
16. Hardell L, Koppel T, Carlberg M, Ahonen M and Hedendahl L: Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields. Int J Oncol 49: 1315-1324, 2016.
17. Hardell L, Carlberg M, Koppel T and Hedendahl L: High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament. Mol Clin Oncol 6: 462-476, 2017.

18. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.
19. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
20. BioInitiative Working Group: BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2007. http://www.bioinitiative.org/table-of-contents/. Accessed on April 1, 2017.
21. BioInitiative Working Group: BioInitiative 2012. A Rationale for a Biologically-based Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2012. http://www.bioinitiative.org/table-of-contents/. Accessed on April 1, 2017.
22. Buchner K and Eger H: Changes of clinically important neurotransmitters under the influence of modulated RF fields - A long-term study under real-life conditions. Umwelt-Medizin-Gesellschaft 24: 44-57, 2011 (In German). https://www.avaate.org/IMG/pdf/Rimbach-Study-20112.pdf.
23. Fragopoulou AF, Samara A, Antonelou MH, Xanthopoulou A, Papadopoulou A, Vougas K, Koutsogiannopoulou E, Anastasiadou E, Stravopodis DJ, Tsangaris GT, *et al*: Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. Electromagn Biol Med 31: 250-274, 2012.
24. Nittby H, Brun A, Eberhardt J, Malmgren L, Persson BR and Salford LG: Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. Pathophysiology 16: 103-112, 2009.
25. Tang J, Zhang Y, Yang L, Chen Q, Tan L, Zuo S, Feng H, Chen Z and Zhu G: Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. Brain Res 1601: 92-101, 2015.
26. Abramson MJ, Benke GP, Dimitriadis C, Inyang IO, Sim MR, Wolfe RS and Croft RJ: Mobile telephone use is associated with changes in cognitive function in young adolescents. Bioelectromagnetics 30: 678-686, 2009.
27. Deshmukh PS, Nasare N, Megha K, Banerjee BD, Ahmed RS, Singh D, Abegaonkar MP, Tripathi AK and Mediratta PK: Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation. Int J Toxicol 34: 284-290, 2015.
28. Calvente I, Pérez-Lobato R, Núñez MI, Ramos R, Guxens M, Villalba J, Olea N and Fernández MF: Does exposure to environmental radiofrequency electromagnetic fields cause cognitive and behavioral effects in 10-year-old boys? Bioelectromagnetics 37: 25-36, 2016.
29. OECD: Students, Computers and Learning: Making the Connection. PISA, OECD Publishing, 2015. http://www.oecd-ilibrary.org/education/students-computers-and-learning_9789264239555-en. Accessed on April 1, 2017.
30. Spitzer M: Information technology in education: Risks and side effects. Trends Neurosci Educ 3: 81-85, 2014.
31. Hensinger P: Big data: A paradigm shift in education from personal autonomy to conditioning toward excessive consumerism. Umwelt-Medizin-Gesellschaft 28: 206-213, 2015.
32. Roser K, Schoeni A, Foerster M and Röösli M: Problematic mobile phone use of Swiss adolescents: Is it linked with mental health or behaviour? Int J Public Health 61: 307-315, 2016.
33. Hardell L, Söderqvist F, Carlberg M, Zetterberg H and Hansson Mild K: Exposure to wireless phone emissions and serum β-trace protein. Int J Mol Med 26: 301-306, 2010.
34. Sangün Ö, Dündar B, Çömlekçi S and Büyükgebiz A: The effects of electromagnetic field on the endocrine system in children and adolescents. Pediatr Endocrinol Rev 13: 531-545, 2015.
35. Belyaev I, Dean A, Eger H, Hubmann G, Jandrisovits R, Kern M, Kundi M, Moshammer H, Lercher P, Müller K, *et al*: EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 31: 363-397, 2016.
36. Carter B, Rees P, Hale L, Bhattacharjee D and Paradkar MS: Association between portable screen-based media device access or use and sleep outcomes: A systematic review and meta-analysis. JAMA Pediatr 170: 1202-1208, 2016.
37. Thomas S, Heinrich S, von Kries R and Radon K: Exposure to radio-frequency electromagnetic fields and behavioural problems in Bavarian children and adolescents. Eur J Epidemiol 25: 135-141, 2010.
38. Divan HA, Kheifets L, Obel C and Olsen J: Cell phone use and behavioural problems in young children. J Epidemiol Community Health 66: 524-529, 2012.
39. Herbert MR and Sage C: Autism and EMF? Plausibility of a pathophysiological link - Part I. Pathophysiology 20: 191-209, 2013.
40. Herbert MR and Sage C: Autism and EMF? Plausibility of a pathophysiological link part II. Pathophysiology 20: 211-234, 2013.
41. Sudan M, Olsen J, Arah OA, Obel C and Kheifets L: Prospective cohort analysis of cellphone use and emotional and behavioural difficulties in children. J Epidemiol Community Health: May 23, 2016 (Epub ahead of print). doi: 10.1136/jech-2016-207419.
42. Avendaño C, Mata A, Sanchez Sarmiento CA and Doncel GF: Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril 97: 39-45.e2, 2012.
43. Dasdag S, Taş M, Akdag MZ and Yegin K: Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. Electromagn Biol Med 34: 37-42, 2015.
44. Ong EK and Glantz SA: Tobacco industry efforts subverting International Agency for Research on Cancer's second-hand smoke study. Lancet 355: 1253-1259, 2000.
45. Michaels D (ed): Doubt is Their Product. How Industry's Assault on Science Threatens Your Health. Oxford University Press, New York, 2008.
46. McGarity TO and Wagner WE: Bending Science. How Special Interests Corrupt Public Health Research. Harvard University Press, Cambridge, London, 2008.
47. Oreskes N and Conway EM: Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming. Bloomsbury Press, New York, 2010.
48. Walker MJ (ed): Corporate Ties that Bind. An Examination of Corporate Manipulation and Vested Interest in Public Health. Skyhorse Publishing, New York, 2017.
49. Repacholi MH, Basten A, Gebski V, Noonan D, Finnie J and Harris AW: Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. Radiat Res 147: 631-640, 1997.
50. WHO Launches New International Project to Assess Health Effects of Electric and Magnetic Fields. Press release WHO/42, June 4, 1996.
51. Leloup D: Téléphonie mobile: Trafic d'influence à l'OMS? Mediaattitudes, 2007. http://www.mediattitudes.info/2006/12/trafic-dinfluence-loms.html. Accessed on April 1, 2017.
52. Starkey SJ: Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation. Rev Environ Health 31: 493-503, 2016.

High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament

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Abstract. Exposure to radiofrequency (RF) radiation was classified as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer at WHO in 2011. The exposure pattern is changing due to the rapid development of technology. Outdoor RF radiation level was measured during five tours in Stockholm Old Town in April, 2016 using the EME Spy 200 exposimeter with 20 predefined frequencies. The results were based on 10,437 samples in total. The mean level of the total RF radiation was 4,293 μW/m^2 (0.4293 μW/cm^2). The highest mean levels were obtained for global system for mobile communications (GSM) + universal mobile telecommunications system (UMTS) 900 downlink and long-term evolution (LTE) 2600 downlink (1,558 and 1,265 μW/m^2, respectively). The town squares displayed highest total mean levels, with the example of Järntorget square with 24,277 μW/m^2 (min 257, max 173,302 μW/m^2). These results were in large contrast to areas with lowest total exposure, such as the Supreme Court, with a mean level of 404 μW/m^2 (min 20.4, max 4,088 μW/m^2). In addition, measurements in the streets surrounding the Royal Castle were lower than the total for the Old Town, with a mean of 756 μW/m^2 (min 0.3, max 50,967 μW/m^2). The BioInitiative 2012 Report defined the scientific benchmark for possible health risks as 30-60 μW/m^2. Our results of outdoor RF radiation exposure at Stockholm Old Town are significantly above that level. The mean exposure level at Järntorget square was 405-fold higher than 60 μW/m^2. Our results were below the reference level on 10,000,000 μW/m^2 established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which, however, are less credible, as they do not take non-thermal effects into consideration and are not based on sound scientific evaluation. Our highest measured mean level at Järntorget was 0.24% of the ICNIRP level. A number of studies have found adverse, non-thermal (no measurable temperature increase) health effects far below the ICNIRP guidelines.

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Key words: radiofrequency radiation, radiofrequency electromagnetic field, base stations, exposimeter, public exposure, health, cancer

Introduction

The results of a study on public exposure to radiofrequency (RF) radiation at the Stockholm Central Railway Station in Sweden were recently published (1). The exposimeter EME Spy 200 that covers 20 different radiofrequency bands from 87 to 5,850 MHz was used. The results were based on 1,669 data points recorded in November, 2015. The median value for total exposure was 921 μW/m^2 (0.092 μW/cm^2), with certain outliers >95,544 μW/m^2 (6 V/m, which is the upper detection limit). One example of such very high measured power density was from a global system for mobile communications (GSM) + universal mobile telecommunications system (UMTS) 900 downlink band from a base station located at the Stockholm Central Station lower level (1). People standing at that area or passing by are involuntarily exposed to high RF radiation without their knowledge. It was concluded that this represented an improper location of a base station with an unnecessary high downlink level.

In European countries, the Old Town is a point of a national heritage, a place and source of cultural and historical development throughout centuries. Stockholm Old Town has already been retrofitted with several existing antennas to accommodate voice and data transmission. The aim of the present study was to characterize RF radiation already in place and its effect on the public. The antenna grid is expected to be further expanded to accommodate the rollout of 5G mobile networking as the next wave of mobile technology is implemented. As mobile base station antennas are placed on rooftops, outer walls of buildings and other places, visual perturbations appear in the form of antenna casings, cables and other peripheral devices. Not only does this damage the aesthetic appearance of the historic districts of the Old Town,

but it is associated with exposure of the public to invisible RF radiation. Even where hidden antennas have been architecturally camouflaged (stealth installations), the RF radiation exposure is still present and remains a growing concern for environmental health.

The most drastic change brought about by the mobile telephony network is the change in the electromagnetic climate. The streets of old towns are filled with visually imperceptible RF radiation. As modern mobile telephony and data networking provide services at several different bands, there are different frequencies that also require band-specific antennas, therefore multiplying the number of antennas.

One major concern regarding RF radiation exposure in Sweden, as well as in a number of other countries, is that various authorities base their guidelines for exposure on the International Commission on Non-Ionizing Radiation Protection's (ICNIRP) guidelines that are based on short-term (acute) exposure. Chronic, low-intensity cumulative exposure, possible long-term health risks and non-thermal biological effects are not taken into consideration. The ICNIRP safety limit was established in 1998 (2) and updated in 2009 (3), without any further changes, and it still recommends 10 W/m^2 (10,000,000 μW/m^2) as the reference level for limiting the public's exposure to RF radiation (2-300 GHz) (2). The Swedish Radiation Safety Authority (SSM) has adopted the ICNIRP guidelines. Several members of the SSM expert panel are also members of ICNIRP, which may entail a conflict of interest, since these members would rarely compromise the ICNIRP view so that critical opinions are not heard.

Our results on public RF radiation exposure at the Stockholm Central Station are orders of magnitude lower than the ICNIRP guidelines, where the median level of exposure was ~10,000 times lower. Wireless internet access in schools is also a concern (4), although measurements of levels are scanty.

In contrast to ICNIRP, the BioInitiative Reports from 2007 (5), updated in 2012 (6), also based their evaluation on the non-thermal effects of RF radiation. The BioInitiative 2012 Report assessed ~1,800 new peer-reviewed studies published between 2006 and 2012 that documented the new and lower scientific benchmark for health harm to be 30-60 μW/m^2 (0.003-0.006 μW/cm^2), which is 0.0003-0.0006% below ICNIRP's guidelines. Also considering chronic exposure and sensitivity among children, the precautionary target level was proposed to be one-tenth of this value, namely 3-6 μW/m^2 (6). This exposure target level is not acknowledged by SSM, thus making it possible to overlook results on exposure, such as those at the Stockholm Central Station, and not providing precautions against potential detrimental effects on public health.

Interestingly, scientific evidence on the carcinogenic potential of RF radiation in laboratory studies has long been accumulating, but has mostly been ignored or entirely overlooked by decision-makers.

In 1982, Szmigielski *et al* published a study on the co-carcinogenic effects of RF radiation exposure and benzopyrene in mice (7) and demonstrated that 2,450 MHz of RF radiation at either 50 or 150 W/m^2 promoted carcinogenesis. The authors concluded that the resulting acceleration of development of spontaneous and chemically induced cancers indicated the carcinogenic potential of RF radiation.

Two studies published in 1990 demonstrated that non-thermal 2,450 MHz continuous-wave RF radiation exerted a biphasic effect on glioma cells (8) and lymphocytes (9). Cell proliferation was found at a specific absorption rate (SAR) of ≤50 W/kg, whereas a higher SAR suppressed DNA and RNA synthesis. These effects were reported to be non-thermal.

In 1992, Chou *et al* published a study on 200 rats exposed to 2,450 MHz pulsed RF radiation for 21.5 h/day for 25 months and 200 controls (10). SAR ranged between 0.144 and 0.4 W/kg, depending on the rat's weight. A statistically significantly increased incidence of primary malignant diseases was found in exposed animals compared with sham exposure. It should be noted that malignant lymphoma and thyroid cancer were among the malignancies found in exposed rats. These findings are interesting in view of the low SAR values in that study compared with the ICNIRP safety limit of SAR 2 W/kg in the brain for use of mobile phones (2).

In 1997, a study on mice carrying a lymphomagenic oncogene exposed to RF radiation was published (11). A total of 100 mice were sham-exposed and 101 were exposed for two 30-min periods per day for up to 18 months to 900 MHz pulsed RF radiation with power densities of 2.6-13 W/m^2 (SAR 0.008-4.2 W/kg; mean, 0.13-1.4 W/kg). The lymphoma risk was found to be statistically significantly higher in the exposed mice compared with that in the controls.

Those results were not confirmed in the study by Utteridge *et al* (12), which has been criticized for not being a replication study. However, the findings on lymphoma risk by Repacholi *et al* (11) and Chou *et al* (10) are of relevance in terms of increased non-Hodgkin lymphoma (NHL) risk in epidemiological studies on humans associated with the use of wireless phones. Thus, a statistically significantly increased risk of T-cell NHL was found in a previous study [odds ratio (OR)=8.75] (13) and in a second study for all NHL cases among subjects with >6 years of mobile phone use (OR=4.4 in men) (14), although based on limited numbers. Furthermore, the finding of thyroid cancer risk in the Chou *et al* study (10) is interesting in view of the sharp increase in the incidence of thyroid cancer during recent years (15). The thyroid gland is among the organs with highest exposure to RF radiation during use of handheld wireless phones, particularly smartphones (16,17).

The effects on tumour susceptibility in mice exposed to a UMTS test signal from the fetal period for up to 24 months was studied by Tillman *et al* (18). Animals were exposed to UMTS fields with intensities of 0, 4.8 and 48 W/m^2. The low-dose group (4.8 W/m^2) was subjected to additional prenatal ethylnitrosourea (ENU) treatment. The group that was ENU-treated and UMTS-exposed at 4.8 W/m^2 exhibited an increased rate of lung tumours and an increased incidence of lung carcinomas as compared with the controls treated with ENU alone. The authors concluded that the study demonstrated a co-carcinogenic effect of lifelong UMTS exposure in female mice subjected to pretreatment with ENU (18).

A follow-up study of the Tillman *et al* investigation was published in 2015 (19). The exposure levels were 0 (sham), 0.04, 0.4 and 2 W/kg SAR. The numbers of lung and liver tumours in exposed animals were statistically significantly higher compared with those in sham-exposed controls, as were the numbers of malignant lymphoma. A tumour-promoting

effect of RF radiation was found at low to moderate levels (0.04 and 0.4 W/kg SAR), which were well below the exposure limits for users of mobile phones (19).

A report was released from The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in USA on the largest ever animal study on cell phone RF radiation and cancer (20). An increased incidence of glioma in the brain and malignant schwannoma in the heart was found. Acoustic neuroma or vestibular schwannoma is a similar type of tumour as the one found in the heart, although benign. The use of mobile as well as cordless phones has been associated with increased risk for glioma and acoustic neuroma in humans, as described below.

The same RF radiation that led male rats to develop brain tumours in the NTP study also caused DNA breaks in their brains. Female rats, which did not have statistically significantly elevated tumour counts, had fewer DNA breaks (http://microwavenews.com/news-center/ntp-comet-assay). According to Ron Melnick, who led the team that designed the NTP study, the results provide 'strong evidence for the genotoxicity of cell phone radiation' and this 'should put to rest the old argument that RF radiation cannot cause DNA damage'. The study is currently under peer review.

These new NTP study results appear to corroborate the findings of the 1995 study by Lai and Singh regarding increased levels of DNA single-strand breaks in brain cells from rats acutely exposed to low-intensity 2,450 MHz microwaves (21). A dose-rate-dependent increase in DNA single-strand breaks was found in brain cells of rats at 4 h post-exposure to 0.6 and 1.2 W/kg whole-body SAR. In rats exposed for 2 h to continuous-wave 2,450 MHz microwaves (SAR 1.2 W/kg), increases in brain cell DNA single-strand breaks were observed immediately as well as at 4 h post-exposure (21).

Our research group published the first results on the increased risk for brain tumours associated with the use of mobile and cordless phones ~15 years ago (22-25). More results have been obtained from our subsequent studies, as well as from studies conducted in other countries. The International Agency for Research on Cancer (IARC) at WHO concluded in 2011 that RF radiation is a possible human carcinogen, Group 2B (26,27). The IARC decision was based on human Swedish studies by our group (28-30) and the IARC Interphone Study (31-33) giving evidence of increased risk for brain tumours, mainly glioma, and acoustic neuroma in subjects using mobile phones. These results have been replicated in our subsequent studies (34-37) and the French CERENAT study on glioma and meningioma (38). IARC concluded that there is limited evidence from experimental animal studies supporting the carcinogenicity of RF radiation. However, later published human and animal studies reported that there is sufficient evidence of the carcinogenicity of RF radiation. That conclusion is supported by our review (39) using the Bradford Hill viewpoints (40) on the association or causation on environment and disease. Mechanistic studies that support a causal inference are also currently available and discussed below.

As areas with high RF radiation were previously recorded at the Stockholm Central Station in Sweden (1), the aim of the present study was to continue with outdoor measurements in locations visited by numerous individuals in Stockholm. Stockholm Old Town is a popular place for tourists that is located in Stockholm City within walking distance from the Central Railway Station. Several people reside in the Old Town and a number of shops and restaurants are located within this area. In addition, certain government buildings, such as the Supreme Court and the Royal Castle and the nearby Swedish Parliament, are located in that region as well.

As this was a measurement study with no involvement of test subjects, no ethical permission was required.

Materials and methods

EME Spy 200 exposimeter. In this study, an EME Spy 200 exposimeter (Satimo, MVG Industries, Brest, France) with a valid calibration was used to collect the exposure data. The exposimeter measures 20 predefined frequency bands, as presented in Table I. These cover the frequencies of most public RF radiation emitting devices currently used in Sweden. The exposimeter covers frequencies of 87-5,850 MHz. For frequency modulation (FM), TV3, TETRA, TV4&5, Wi-Fi 2G and Wi-Fi 5G, the lower detection limit is 0.01 V/m (0.27 μW/m^2); for all other bands, the lower detection limit is 0.005 V/m (0.066 μW/m^2). For all bands, the upper detection limit is 6 V/m (95,544 μW/m^2; 9.5544 μW/cm^2). The sampling time used in this study was every 4th sec, which is the fastest for the given exposimeter.

The exposimeter measures different telecommunications protocols: FM radio broadcasting; TV broadcasting; TETRA emergency services (police, rescue, etc.); GSM second-generation mobile communications; UMTS third-generation mobile communications, 3G; long-term evolution (LTE) fourth-generation mobile communications standard, 4G; digital European cordless telecommunications (DECT) cordless telephone systems standard; Wi-Fi wireless local area network protocol; worldwide interoperability for microwave access (WiMAX) wireless communication standard for high-speed voice, data and internet.

EME SPY 200 utilizes 3-axis antennas to capture RF radiation from all possible directions. The exposimeter was held at a distance of ~0.4 m from the body. The unit reports the exposure in a conservative manner, since each reported value is the sampling outcome, where many samples are collected and statistically processed including minimum, mean, median and maximum values.

Study design. The study was performed during daytime in April 8, 9, 10, 11, 13 and 22, 2016. These were all business days, except for April 9 and 10 (Saturday and Sunday). The length of the measurement route was up to 2.5 h, depending on the investigation. All major streets were covered during the investigation rounds. A few very short and narrow streets were not included. In addition, special measurement rounds were made using the streets surrounding the Supreme Court and the Royal Castle. The Swedish Parliament was also measured using the streets surrounding the Parliament as well as the central street, Riksgatan. Special measurement rounds were made at three squares, Stortorget, Kornhamnstorg and Järntorget. All measurements were included in the total result for the Old Town, except for the Swedish Parliament, which is located on the island of Helgeandsholmen and is reported separately. The buildings were selected as they are important sites

for decision-makers in Sweden. The squares were included as they are frequented by numerous visitors sitting outdoors at the restaurants and cafés. The selected locations as major streets, squares and buildings were measured several times, whereas small streets were measured only once. It should be noted that the Old Town is located on an island surrounded by water and, thus, is geographically well-defined (Fig. 1).

Statistical methods. Means, medians, minimum and maximum values in $\mu W/m^2$ were calculated for all measured frequency bands and for total exposure, and box plots were constructed to illustrate the distribution of total exposure for all measurement rounds. Values below the lower detection limit were treated as null (0). Total exposure was calculated as the sum of all measured frequency bands at each measured data point. Stata/SE 12.1 for Windows (StataCorp., College Station, TX, USA) was used for all calculations.

Results

The results of the Old Town measurements were based on 10,437 measurements in total during five separate measurement rounds, with a total of 696 min of measurements (~12 h). The results are displayed in Table II. The mean total level of RF radiation was 4,292.7 $\mu W/m^2$. The highest mean values were obtained for GSM + UMTS 900 downlink and LTE 2600 downlink (1,558.2 and 1,264.9 $\mu W/m^2$, respectively). It should be noted that the highest maximum levels were from base stations (5 bands) varying from 24,384.7 (LTE 800 downlink) to 95,522.5 (LTE 2600 downlink) $\mu W/m^2$. The highest maximum uplink (from a mobile phone) was found for GSM 1800, yielding 19,136.9 $\mu W/m^2$.

In Fig. 2, the box plot shows the results for five old town measurements and all exposure (total). The total median level was 534.0 $\mu W/m^2$ with several outliers of >100,000 $\mu W/m^2$.

In Fig. 3. the RF exposure variation over time is displayed for one of the measurement rounds. There was a large variation over time during these >2 h measurements covering major parts of the Old Town (streets and squares). The mean level was 5,371.4 $\mu W/m^2$ (median, 701.8 $\mu W/m^2$; range, 4.2-83,348.8 $\mu W/m^2$). Only for few moments the exposure was <100 $\mu W/m^2$, whereas several measurements were >10,000 $\mu W/m^2$.

Royal castle. The Swedish Royal Castle was covered by measurement rounds on the surrounding streets and also the Castle Square (Yttre Borggården) during ~4 h measurement time in total. These measurements represent an area with among the lowest RF radiation in the Old Town. The results were also included in the total measurement of the Old Town. Rather low mean values were found for most downlink bands (Table III). The highest mean level was measured for UMTS 2100 downlink (306.2 $\mu W/m^2$). The total mean RF radiation level for the Royal Castle area was 755.6 $\mu W/m^2$, representing only 17.6 % of the total mean level for the Old Town. In addition, the total highest level (maximum) was lower than all (50,967.1 $\mu W/m^2$, or 29.4% of the total).

The box plot in Fig. 4 of the six measurement tours to the Royal Castle area and total clearly shows lower levels compared with those for all the Old Town. The total median level was 387.8 $\mu W/m^2$, without any significant variation between different tours.

Table I. Frequency ranges of predefined measurement frequency bands of EME Spy 200 exposimeter.

Frequency band	Frequency min (MHz)	Frequency max (MHz)
FM	87	107
TV3	174	223
TETRA I	380	400
TETRA II	410	430
TETRA III	450	470
TV4&5	470	770
LTE 800, 4G (DL)	791	821
LTE 800, 4G (UL)	832	862
GSM 900 + UMTS 900, 3G (UL)	880	915
GSM 900 + UMTS 900, 3G (DL)	925	960
GSM 1800 (UL)	1,710	1,785
GSM 1800 (DL)	1,805	1,880
DECT	1,880	1,900
UMTS 2100, 3G (UL)	1,920	1,980
UMTS 2100, 3G (DL)	2,110	2,170
Wi-Fi 2 GHz	2,400	2,483.5
LTE 2600, 4G (UL)	2,500	2,570
LTE 2600, 4G (DL)	2,620	2,690
WiMAX	3,300	3,900
Wi-Fi 5 GHz	5,150	5,850

FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

Fig. 5 shows the RF exposure variation over time during one of the measurement rounds around the Royal Castle, clearly indicating that most measurements were <1,000 $\mu W/m^2$, with few spikes exceeding 10,000 $\mu W/m^2$.

Supreme court. The results for the Supreme Court are displayed in Table IV. These measurements represent the lowest levels of RF radiation among all measurements. The total mean level was 403.6 $\mu W/m^2$ and the maximum level was 4,088.1 $\mu W/m^2$. Almost all exposure represented downlink bands from mobile telephony base stations.

Fig. 6 displays the box plot for the measurement tours around the Supreme Court and all exposure (total). The total median level was 274.5 $\mu W/m^2$. Total exposure over time during the tours exhibited little difference over time, mostly <1,000 $\mu W/m^2$. The time variation for one tour is shown in Fig. 7.

Old town squares. The mean values for three major squares in the Old Town are shown in Table V. Several shops, restaurants and cafés are located in this region, including outdoor sitting



Figure 1. Map of Stockholm Old Town and Helgeandsholmen. Specific measurement locations are shown as follows: 1, Royal Castle; 2, Supreme Court; 3, Stortorget; 4, Kornhamnstorg; 5, Järntorget and 6, Swedish Parliament. Map from Lantmäteriet, Sweden.

areas. The results represent the highest measurements in the Old Town.

The highest levels were measured at the Järntorget square, as presented in Table VI. Only at Järntorget some levels for FM radio were detected, which were comparatively low in other parts of the Old Town. Very high mean and maximum levels were found for all downlinks from mobile telephony base stations, except for GSM 1800. The mean level for GSM + UMTS 900 downlink was noteworthy (10,272.7 μW/m^2). An exceptionally high total maximum level of 95,522.5 μW/m^2 was measured for LTE 2600 downlink.

The box plot for the measurements in Järntorget is shown in Fig. 8 and variation over time during one tour is shown in Fig. 9. High levels were measured, with a total median of 19,990.0 μW/m^2.

Swedish parliament. The Swedish Parliament is located on a separate island, Helgeandsholmen, just outside the Old Town. The results of four measurement rounds of ~1.5 h measurement time in total are shown in Table VII. Significantly lower levels were found compared with total measurements for the Old Town. RF level dynamics for one measurement tour are seen in Fig. 10.

Old town summary. The box plot in Fig. 11 shows a large variation in total exposure across measured sites in Stockholm Old Town. Relatively low RF levels were measured at the Royal Castle and the Supreme Court, whereas the Stortorget, Kornhamnstorg and Järntorget squares had exposure levels of at least an order of magnitude higher.

Discussion

The Stockholm Old Town RF radiation levels were measured on five occasions, yielding a total of 10,437 readings for the Old Town. This study showed a large variation in outdoor RF radiation level in the Stockholm Old Town. Furthermore, it should be noted that the measurements mainly characterize downlink exposure, without considering personal use of wireless devices, such as mobile phones. Indoor RF levels are likely to be somewhat lower with respect to inbound radiation, since the walls and windows of buildings attenuate the signals. On the other hand, on the premises on the opposite side of the transmitter antennas, the exposure levels may be even an order of magnitude higher if the beam happens to be directed towards these premises. For accurate information it would be necessary to make measurements inside buildings such as the Royal Castle, the Supreme Court, restaurants, apartments and the Swedish Parliament. Several buildings contain Wi-Fi routers for wireless communication, which would increase exposure at Wi-Fi bands. Furthermore, personal use of wireless phones (mobile as well as cordless), use of tablets and wireless internet via computers, add to RF radiation exposure.

This study provides information on the passive RF radiation exposure in a popular area of Stockholm, which is a destination for a number of visitors, such as tourists, citizens contacting different authorities, employees and residents. The study determined low levels at the surroundings of the Royal Castle, with a mean level of 755.6 μW/m^2, which is 17.6% of the total mean level in the Old Town (4,292.7 μW/m^2). An even lower mean level was measured for the Supreme Court (403.6 μW/m), representing 9.4% of the total mean level for the Old Town. It should also be noted that certain hotspots had somewhat higher RF radiation levels, both for the Royal Castle and the Supreme Court (Figs. 5 and 7). This is also illustrated by the box plots (Figs. 4 and 6) with third quartiles of <1,000 μW/m^2, with the exception of one of the Royal Castle measurements.

The abovementioned results are in large contrast to the squares of the Old Town. The three major squares were

Table II. Stockholm Old Town levels of radiofrequency radiation in total for five different tours on 8, 9, 11, 13 and 22 April, 2016.

Frequency band	No. of readings	Mean	Median	Min	Max
FM	10,437	11.1	0.0	0.0	3,674.6
TV3	10,437	1.5	0.0	0.0	273.3
TETRA I	10,437	18.6	0.0	0.0	2,913.3
TETRA II	10,437	0.2	0.0	0.0	253.3
TETRA III	10,437	0.6	0.0	0.0	790.8
TV4&5	10,437	4.0	0.0	0.0	2,775.9
LTE 800 (DL)	10,437	473.6	9.5	0.0	24,384.7
LTE 800 (UL)	10,437	0.0	0.0	0.0	1.7
GSM + UMTS 900 (UL)	10,437	4.3	0.0	0.0	9,972.7
GSM + UMTS 900 (DL)	10,437	1,558.2	38.2	0.0	84,495.3
GSM 1800 (UL)	10,437	10.3	1.0	0.0	19,136.9
GSM 1800 (DL)	10,437	215.2	37.6	0.0	73,221.5
DECT	10,437	5.0	0.0	0.0	1,127.6
UMTS 2100 (UL)	10,437	0.0	0.0	0.0	51.2
UMTS 2100 (DL)	10,437	720.4	152.8	0.0	71,228.5
Wi-Fi 2G	10,437	0.4	0.0	0.0	288.9
LTE 2600 (UL)	10,437	4.6	0.0	0.0	3,832.4
LTE 2600 (DL)	10,437	1,264.9	84.0	0.0	95,522.5
WiMAX	10,437	0.0	0.0	0.0	3.1
Wi-Fi 5G	10,437	0.0	0.0	0.0	62.1
Total	10,437	4,292.7	534.0	0.0	173,301.8

Analysis of all data (μW/m^2) treating values at detection limit as 0. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

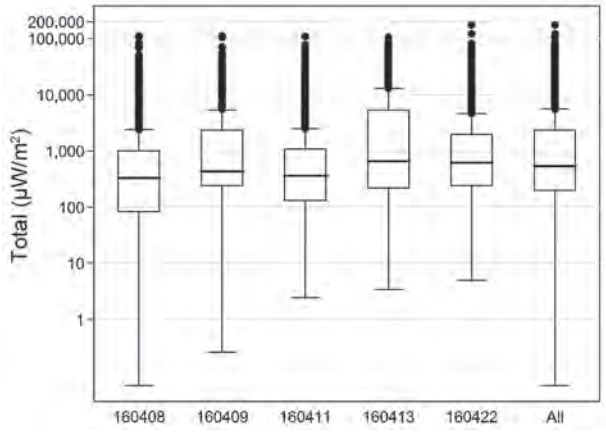


Figure 2. Stockholm Old Town. Box plot for exposure in μW/m^2, logarithmic scale, for the five measurement rounds and total exposure. The median is indicated by the black line inside each box; the bottom and top of the boxes represent the first and third quartiles; the end of the whiskers are calculated as 1.5 x interquartile range. The points represent the outliers.

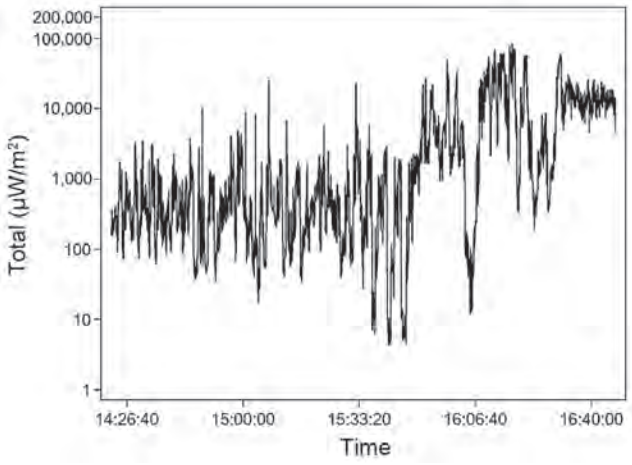


Figure 3. Stockholm Old Town. Total radiofrequency field exposure (mean exposure, 5,371.4 μW/m^2, logarithmic scale) over time of one typical exposure round (13 April, 2016; time, 14:22:14-16:46:58).

measured, namely Stortorget in the area of the Royal Castle, Kornhamnstorg and Järntorget at the other end of the Old Town. Particularly striking is the RF radiation level at Järntorget, although high mean levels were measured in all squares.

The mean RF radiation level at Järntorget was 24,277.1 μW/m^2, which is 60 times higher compared with that for the Supreme Court. It should also be noted that the maximum level for Järntorget was 173,301.8 μW/m^2, compared with 4,088.1 μW/m^2 for the Supreme Court, which is 42 times higher.

Table III. Stockholm Royal Castle levels of radiofrequency radiation in total as measured on 9, 11, 13 and 22 April, 2016.

Frequency band	No. of readings	Mean	Median	Min	Max
FM	3,385	3.7	0.9	0.0	140.3
TV3	3,385	1.8	0.0	0.0	85.9
TETRA I	3,385	51.6	1.7	0.0	2,913.3
TETRA II	3,385	0.3	0.0	0.0	74.9
TETRA III	3,385	0.8	0.0	0.0	655.2
TV4&5	3,385	1.4	0.0	0.0	133.1
LTE 800 (DL)	3,385	19.3	2.4	0.0	492.7
LTE 800 (UL)	3,385	0.0	0.0	0.0	0.3
GSM + UMTS 900 (UL)	3,385	9.7	0.0	0.0	9,972.7
GSM + UMTS 900 (DL)	3,385	51.2	6.6	0.0	3,961.0
GSM 1800 (UL)	3,385	14.4	1.2	0.0	19,136.9
GSM 1800 (DL)	3,385	172.4	42.1	0.0	44,198.2
DECT	3,385	1.4	0.0	0.0	234.0
UMTS 2100 (UL)	3,385	0.0	0.0	0.0	51.2
UMTS 2100 (DL)	3,385	306.2	126.1	0.1	32,530.5
Wi-Fi 2G	3,385	0.1	0.0	0.0	26.0
LTE 2600 (UL)	3,385	0.7	0.0	0.0	60.5
LTE 2600 (DL)	3,385	120.6	40.8	0.0	6,909.8
WiMAX	3,385	0.0	0.0	0.0	0.0
Wi-Fi 5G	3,385	0.0	0.0	0.0	1.4
Total	3,385	755.6	387.8	0.3	50,967.1

Analysis of all data (μW/m^2) treating values at detection limit as 0. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

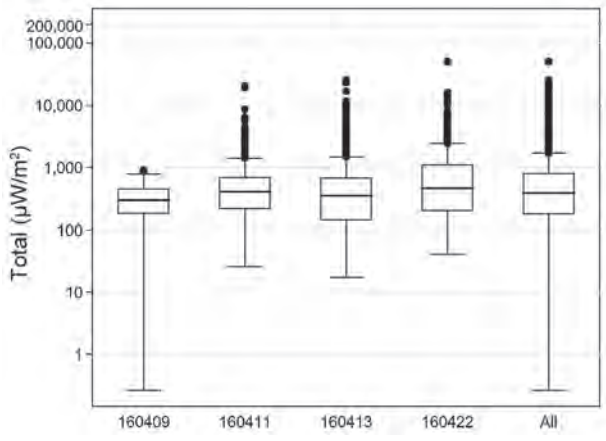


Figure 4. Stockholm Royal Castle. Box plot for exposure in μW/m^2, logarithmic scale, for four measurement rounds and total exposure. The median is indicated by the black line inside each box; the bottom and top of the boxes represent the first and third quartiles; the end of the whiskers are calculated as 1.5 x interquartile range. The points represent the outliers.

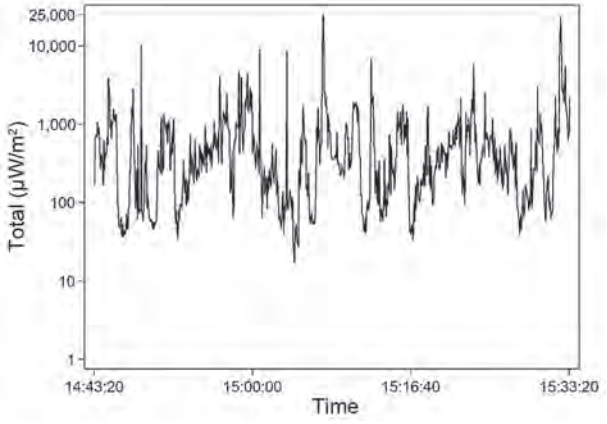


Figure 5. Stockholm Royal Castle. Total radiofrequency field exposure (mean exposure, 721.2 μW/m^2, logarithmic scale) over time of one typical exposure round (13 April, 2016; time, 14:43:22-15:33:26).

The high RF radiation exposure at the squares is of major concern due to the numerous shops, outdoor restaurants and cafés. The measured RF radiation is almost exclusively from mobile telephony base stations (e.g., see Table VI for Järntorget). Some of the base stations appear to be located in buildings of rather low height, with the radiation directed towards the sitting area of restaurants and coffee shops. The location of a base station at one of the measured squares is shown in Fig. 12; it was placed rather low, with the main emission directed towards an outdoor restaurant at a short distance.

Our results are significantly lower compared with the ICNIRP exposure guideline of 10,000,000 μW/m^2. However,

Table IV. Stockholm Supreme Court levels of radiofrequency radiation in total, as measured on 13 and 22 April, 2016.

Frequency band	No. of readings	Mean	Median	Min	Max
FM	715	0.6	0.0	0.0	29.2
TV3	715	1.2	0.0	0.0	35.7
TETRA I	715	0.3	0.0	0.0	58.9
TETRA II	715	0.3	0.0	0.0	12.6
TETRA III	715	0.1	0.0	0.0	26.0
TV4&5	715	0.1	0.0	0.0	19.2
LTE 800 (DL)	715	18.4	4.7	0.1	898.5
LTE 800 (UL)	715	0.0	0.0	0.0	0.0
GSM + UMTS 900 (UL)	715	6.1	0.0	0.0	2,874.5
GSM + UMTS 900 (DL)	715	32.7	11.2	0.2	578.5
GSM 1800 (UL)	715	4.7	2.5	0.0	65.4
GSM 1800 (DL)	715	104.6	54.2	3.4	2,196.6
DECT	715	0.0	0.0	0.0	1.1
UMTS 2100 (UL)	715	0.0	0.0	0.0	0.3
UMTS 2100 (DL)	715	82.0	46.2	0.4	1,966.4
Wi-Fi 2G	715	0.1	0.0	0.0	8.3
LTE 2600 (UL)	715	0.1	0.0	0.0	4.5
LTE 2600 (DL)	715	152.3	87.9	3.8	3,674.6
WiMAX	715	0.0	0.0	0.0	0.0
Wi-Fi 5G	715	0.0	0.0	0.0	0.9
Total	715	403.6	274.5	20.4	4,088.1

Analysis of all data ($\mu W/m^2$) treating values at detection limit as 0. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

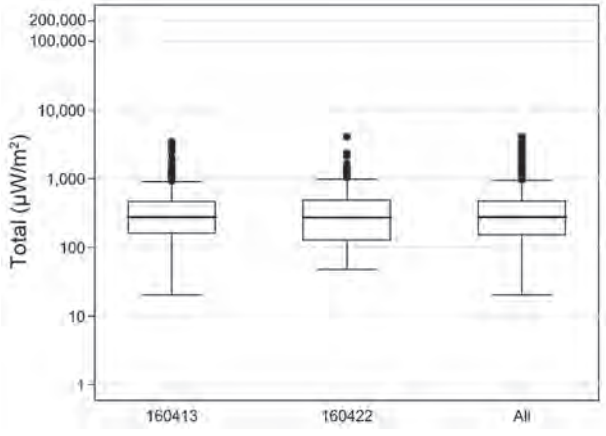


Figure 6. Stockholm Supreme Court. Box plot for exposure in $\mu W/m^2$, logarithmic scale, for two measurement rounds and total exposure. The median is indicated by the black line inside each box; the bottom and top of the boxes represent the first and third quartiles; the end of the whiskers are calculated as 1.5 x interquartile range. The points represent the outliers.

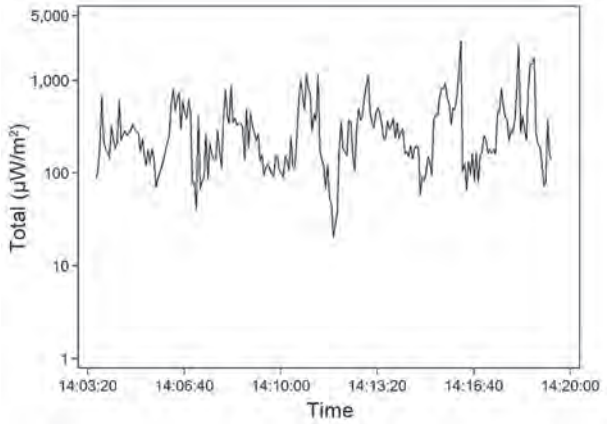


Figure 7. Stockholm Supreme Court. Total radiofrequency field exposure (mean exposure, 335.6 $\mu W/m^2$, logarithmic scale) over time of one typical exposure round (13 April, 2016; time, 14:03:37-14:19:21).

that guideline is outdated, since it does not include current scientific findings in humans and laboratory studies on RF radiation exposure. On the other hand, most measurements were higher than the scientific benchmark of 30-60 $\mu W/m^2$ that has been proposed to be the lowest observed effect level for RF radiation in Chapter 24 of the BioInitiative Report (6). Furthermore, our result on a total mean RF radiation level of 4,292.7 $\mu W/m^2$ in the Old Town (Table II) is of major concern, considering the oxidative effects on living cells from exposure to a level of RF radiation as low as 2,500 $\mu W/m^2$, as described by Yakymenko *et al* (41). This is also of

Table V. Stockholm Old Town mean levels of radiofrequency radiation ($\mu W/m^2$) for three squares, treating values at detection limit as 0.

	Stortorget, April 13 and 22, 2016		Kornhamnstorg, April 13 and 22, 2016		Järntorget, April 11, 13 and 22, 2016	
Frequency band	No.[a]	Mean	No.[a]	Mean	No.[a]	Mean
FM	527	2.8	1,191	24.4	574	67.9
TV3	527	0.0	1,191	0.4	574	0.7
TETRA I	527	0.6	1,191	0.0	574	0.9
TETRA II	527	0.0	1,191	0.3	574	0.0
TETRA III	527	0.1	1,191	0.0	574	0.4
TV4&5	527	4.3	1,191	3.4	574	30.8
LTE 800 (DL)	527	863.0	1,191	1,762.6	574	2,917.6
LTE 800 (UL)	527	0.0	1,191	0.0	574	0.0
GSM + UMTS 900 (UL)	527	0.0	1,191	0.0	574	0.0
GSM + UMTS 900 (DL)	527	2,721.9	1,191	5,222.3	574	10,272.7
GSM 1800 (UL)	527	10.8	1,191	7.5	574	0.1
GSM 1800 (DL)	527	194.4	1,191	590.8	574	12.1
DECT	527	0.0	1,191	39.2	574	0.0
UMTS 2100 (UL)	527	0.0	1,191	0.0	574	0.0
UMTS 2100 (DL)	527	1,811.0	1,191	672.2	574	4,049.7
Wi-Fi 2G	527	0.1	1,191	2.2	574	0.3
LTE 2600 (UL)	527	2.7	1,191	0.0	574	0.8
LTE 2600 (DL)	527	3,441.8	1,191	3,677.1	574	6,923.0
WiMAX	527	0.0	1,191	0.0	574	0.0
Wi-Fi 5G	527	0.0	1,191	0.1	574	0.0
Total	527	9,053.7	1,191	12,002.6	574	24,277.1

[a] Number of readings. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

concern, since reactive oxidative species are crucial in carcinogenesis.

In Sweden, the dominating sources are currently exposure from mobile communication with UMTS, 3G and LTE, 4G with addition of Wi-Fi indoors, but also in certain outdoors locations. Our study from Stockholm Central Railway Station in 2015 yielded a mean total radiation level of 2,817-4,891 $\mu W/m^2$ for each measurement round and a median value of 921 $\mu W/m^2$ for all rounds. The mean for all rounds was 3,860 $\mu W/m^2$. In addition, hotspots were registered yielding >95,544 $\mu W/m^2$, which exceeded the exposimeter EME-Spy 200's upper detection limit. GSM+UMTS 900 downlink and UMTS 2100 downlink contributed the most, but LTE 800 downlink, GSM 1800 downlink and LTE 2600 downlink were also in the higher range of measurements (1). Thus, these results are similar to those of the present study.

The results of the present study show a large variation in passive outdoor RF radiation exposure in Stockholm Old Town. One explanation may be that there are no outdoor places with sitting areas to accommodate people during lunch or coffee breaks around the Royal Castle or the Supreme Court. This also applies to the Swedish Parliament, which is located on a separate island close to the Old Town. Thus, base stations are located around the squares to enable good network access. However, a lower level of radiation would still enable good network access (6). Comparatively low levels of RF radiation were measured for the Swedish Parliament compared with Järntorget. However, no indoor measurements were performed at the Swedish Parliament, where the RF radiation level would be quite different due to wireless internet access within the Parliament.

Unlike in other city districts, where mobile phone base station antennas are placed at a certain height, in the Old Town some antennas are located significantly closer to humans, sometimes only a few meters from the ground level. This creates areas of significantly high RF radiation, particularly in the immediate vicinity of such antennas. The exposure situation is worsened by the narrow streets and tall walls, which tend to trap the radio waves, hence creating reflections and increasing the exposure. The highest radiation zones may be proposed at buildings with windows facing the mobile base station antenna just across the street at the same height. The

Table VI. Järntorget mean levels of radiofrequency radiation (μW/m^2) on 11, 13 and 22 April, 2016, treating values at detection limit as 0.

Frequency band	No. of readings	Mean	Median	Min	Max
FM	574	67.9	0.4	0.0	3,674.6
TV3	574	0.7	0.0	0.0	69.6
TETRA I	574	0.9	0.0	0.0	41.4
TETRA II	574	0.0	0.0	0.0	0.7
TETRA III	574	0.4	0.0	0.0	27.1
TV4&5	574	30.8	0.0	0.0	2,775.9
LTE 800 (DL)	574	2,917.6	1,504.0	3.8	20,367.2
LTE 800 (UL)	574	0.0	0.0	0.0	0.0
GSM + UMTS 900 (UL)	574	0.0	0.0	0.0	4.9
GSM + UMTS 900 (DL)	574	10,272.7	6,140.5	29.8	65,440.6
GSM 1800 (UL)	574	0.1	0.0	0.0	8.9
GSM 1800 (DL)	574	12.1	4.5	0.6	590.9
DECT	574	0.0	0.0	0.0	0.0
UMTS 2100 (UL)	574	0.0	0.0	0.0	2.5
UMTS 2100 (DL)	574	4,049.7	2,716.7	38.2	21,078.9
WIFI 2G	574	0.3	0.0	0.0	25.5
LTE 2600 (UL)	574	0.8	0.0	0.0	35.1
LTE 2600 (DL)	574	6,923.0	4,157.8	30.4	95,522.5
WiMAX	574	0.0	0.0	0.0	3.1
Wi-Fi 5G	574	0.0	0.0	0.0	1.7
Total	574	24,277.1	19,990.0	257.0	173,301.8

FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

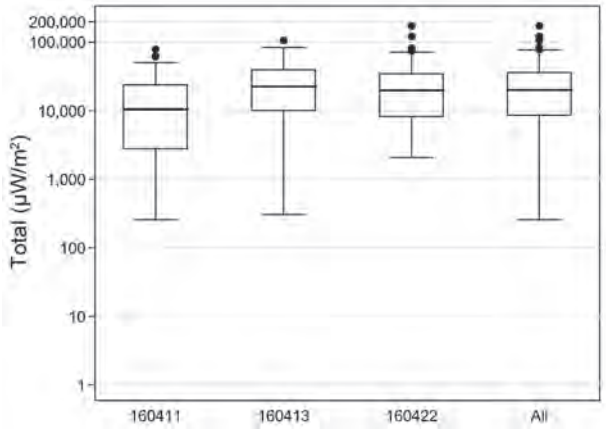


Figure 8. Stockholm Old Town, Järntorget. Box plot for exposure in μW/m^2, logarithmic scale, for three measurement rounds and total exposure. The median is indicated by the black line inside each box; the bottom and top of the boxes represent the first and third quartiles; the end of the whiskers are calculated as 1.5 x interquartile range. The points represent the outliers.

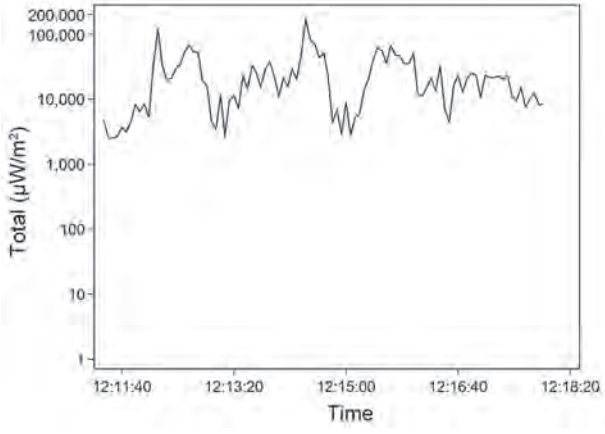


Figure 9. Stockholm Old Town, Järntorget. Total radiofrequency field exposure (mean exposure, 24,766.2 μW/m^2, logarithmic scale) over time of one typical exposure round (22 April, 2016; time, 12:11:24-12:17:56).

most affected are the individuals that have to stay longer in such places, also referred to as hotspots. Individuals whose living quarters, workstation or work area happen to be located in hotspots, are exposed to the heaviest RF load, whereas those who walk by hotspots only undergo momentary exposure and are less affected.

As the mobile telephony network is currently under development, the base station antennas are positioned following the current legal safety limits. However, the current limits only provide protection from short-term health effects (heating), but

Table VII. Stockholm Swedish Parliament mean levels of radiofrequency radiation ($\mu W/m^2$) on 8, 10, 11 and 22 April, 2016, treating values at detection limit as 0.

Frequency band	No. of readings	Mean	Median	Min	Max
FM	1,196	1.7	0.0	0.0	129.6
TV3	1,196	6.7	0.0	0.0	485.9
TETRA I	1,196	62.8	0.4	0.0	3,157.2
TETRA II	1,196	2.0	0.3	0.0	52.0
TETRA III	1,196	1.5	0.0	0.0	208.0
TV4&5	1,196	0.3	0.0	0.0	50.5
LTE 800 (DL)	1,196	99.7	5.9	0.0	5,623.2
LTE 800 (UL)	1,196	0.0	0.0	0.0	0.1
GSM + UMTS 900 (UL)	1,196	0.0	0.0	0.0	16.1
GSM + UMTS 900 (DL)	1,196	240.7	99.8	1.0	5,176.7
GSM 1800 (UL)	1,196	8.6	3.4	0.0	426.5
GSM 1800 (DL)	1,196	322.6	137.9	6.1	9,395.0
DECT	1,196	5.5	0.0	0.0	347.6
UMTS 2100 (UL)	1,196	0.0	0.0	0.0	1.5
UMTS 2100 (DL)	1,196	450.7	163.1	6.4	9,717.2
Wi-Fi 2G	1,196	0.1	0.0	0.0	8.9
LTE 2600 (UL)	1,196	7.1	1.1	0.0	313.9
LTE 2600 (DL)	1,196	293.9	129.6	5.1	9,385.0
WiMAX	1,196	0.0	0.0	0.0	0.0
Wi-Fi 5G	1,196	0.0	0.0	0.0	8.9
Total	1,196	1,503.9	957.4	99.6	16,781.9

FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

do not exclude possible long-term effects, which are currently under investigation. To grant better service coverage, the base station antennas are continuously placed in new locations, and the mobile telephony network becomes denser annually. Thus, the RF exposure of the population is increasing, particularly in densely populated areas.

As the research on long-term health hazards is ongoing, it is mostly focused on clearly identifiable biological effects. Knowledge on the effect of RF fields on mental health is of utmost importance, as in chronic exposure to RF radiation levels, such as those measured in hotspots in the Old Town. It should also be noted that long-term health effects, such as cancer, have not been investigated for this type of environmental contamination.

EME Spy 200 is a band-specific exposimeter and it enables identification and measurement of the majority of RF radiation bands currently used in Sweden. This study describes measurements mostly from far-field RF radiation and the exposure that the citizens may undergo without using personal wireless devices. Near-field exposure from personal mobile phones held near the ear or in the hand when on the internet will likely contribute considerably to an individual's total exposure.

The shielding effect from the body of a person carrying an exposimeter may be considerable, as shown by Bolte *et al* (42) when comparing a body-worn exposimeter with an exposimeter mounted on the roof of a car. This was partly compensated in our study by holding the exposimeter at a certain distance from the body.

Other studies have measured the exposure of RF radiation in public places. In 2012, Estenberg and Augustsson (43) used a car-mounted device to measure the frequency range 30-3,000 MHz in public places (rural, urban and large cities). The arithmetic mean measured exposure was 6,700 $\mu W/m^2$ in Stockholm, 1,500 $\mu W/m^2$ in 4 urban towns and 230 $\mu W/m^2$ in 2 rural areas. Similar to our study, the major sources were GSM and UMTS downlinks.

Earlier studies, prior to the use of smartphones, when 3G and 4G protocols became more common, reported lower exposure. Joseph *et al* (44) performed measurements with a personal exposimeter (EME-Spy 120-121) in different urban areas across Europe during 2007-2009. They found mean values for outdoor areas of 372-569 $\mu W/m^2$, mostly from mobile communications. In 2010, Bolte and Eikelboom (45) also performed measurements in The Netherlands with a personal exposimeter (EME-Spy 121) and found a mean value in outdoor activities of 208 $\mu W/m^2$. Visits to pubs, cafés, discos and snack bars yielded the highest mean value in their study (526 $\mu W/m^2$), mostly from mobile uplink at 1,800 MHz. Urbinello *et al* (46) used the same exposimeter in three different European cities (Basel, Ghent and Brussels), every month for 1 year (April, 2011-March, 2012). The

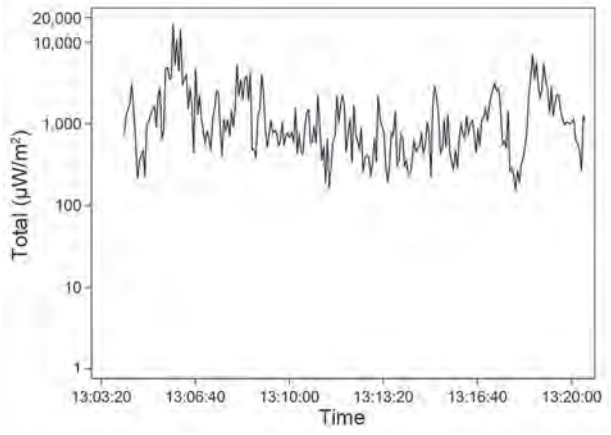


Figure 10. Stockholm, Swedish Parliament. Total radiofrequency field exposure (mean exposure, 1,460.2 μW/m^2, logarithmic scale) over time of one typical exposure round (11 April, 2016; time, 13:04:09-13:20:29).

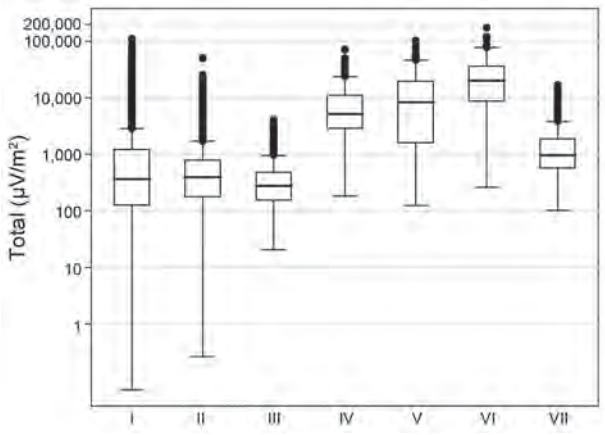


Figure 11. Box plot, total exposure (μW/m^2), all locations, logarithmic scale for the measurement rounds. The median is indicated by the black line inside each box; the bottom and top of the boxes represent the first and third quartiles; the end of the whiskers are calculated as 1.5 x interquartile range. The points represent the outliers. I=Stockholm Old Town; II=Royal Castle; III=Supreme Court; IV=Stortorget; V=Kornhamnstorg; VI=Järntorget; VII=Swedish Parliament.

total from all sources of RF radiation in downtown outdoor areas increased by 56% in Basel, 27% in Ghent and 25% in Brussels. The mean levels were 0.32-0.58 V/m (271-892 μW/m^2). In 2012, Aerts *et al* (47) conducted measurements in an urban/suburban area of Ghent, Belgium covering an area of 1 km^2. They selected 0.7 V/m (1,300 μW/m^2) as a threshold for a hotspot and found five hotspots in the area. GSM 900 base station signals contributed the most to all five hotspots with 45-100%, with GSM 1800 and 3G present in two of the hotspots.

Verlock *et al* (48) used a Narda NBM-550 in public places in Belgium during 2012-2013. The total average from all RF radiation sources between 100 kHz and 3 GHz was 0.62 V/m (1,020 μW/m^2), with a maximum of 2.4 V/m (15,287 μW/m^2).

Calvente *et al* (49) conducted measurements outside the homes of 123 families in Granada, Spain during 2012-2013. The arithmetic mean root square (RMS) for power density was 799 μW/m^2 and the median value was 285 μW/m^2. For the different homes, the median RMS ranged from 5 to 11,559 μW/m^2. In 2015, Gonzalez-Rubio *et al* (50) used an EME-Spy 140 located inside the plastic basket of a bicycle. With this bicycle they covered all 110 regions in the city of Albecete, Spain, performing measurements. The average for the 3 bands of mobile telephone antennas (GSM, Digital Combat Simulator and UMTS) in the different regions varied from 0.04 V/m (4.2 μW/m^2) to 0.89 V/m (2,102 μW/m^2).

The mean values for exposure to RF radiation from the earlier studies indicate a clear increase in the more recent exposimeter studies. It is clear from our present and previous (1) studies that the level of ambient RF radiation exposure is increasing. With the development of mobile communications technologies and the widespread use of wireless services, the exposure will continue to increase with higher exposure levels and also other frequency bands, despite the already proven adverse health effects.

Long-term studies with laboratory animals at or below the levels in the present study have shown the effects of RF radiation on several physiological parameters in the body of mammals. These are non-thermal effects and are discussed briefly below, including a few human studies.



Figure 12. Stockholm Old Town measurement location with a relatively high radiofrequency radiation level, due to a mobile telephony base station antenna positioned at a low height and targeted towards the square.

Several studies on rats have demonstrated that the blood-brain barrier (BBB) may open when exposed to RF radiation, resulting in pathological leakage of large molecules that may be toxic to the brain, with condensed dark neurons in the brain representing a sign of damage (51-54). The hippocampus, a center for memory and learning in the brain, appears to be particularly sensitive to neuronal damage from RF radiation and an opened BBB. Long-term exposure to 900 MHz RF radiation has been associated with extravasation of albumin in the hippocampus and cortex and impaired spatial memory in exposed rats (55-57).

A long-term study with exposure from GSM 900 MHz 3 h/day or DECT base station 8 h/day during 8 months reported a statistically significant downregulation or an overexpression for one-third of the 432 analyzed proteins from the brains of the RF-irradiated mice. Several neural function-related proteins, such as apolipoprotein E, heat shock proteins and cytoskeletal proteins, as well as proteins involved in brain metabolism, were altered (58).

Up to 12 months of exposure to Wi-Fi exerted an effect on microRNA in the brain (59) and in the testes, with head defects and DNA damage in sperm cells (60-62).

Yakymenko *et al* (41) published a review of 100 studies investigating the oxidative effects of low-intensity RF radiation in living cells, and demonstrated that exposure down to 2,500 μW/m^2 (63) with SAR values as low as 600 μW/kg (64,65) may increase oxidative stress in the cells. Long-term, low-intensity RF radiation exposure has also been associated with reduced levels of neurotransmitters, downregulation of microRNA, increase in pro-inflammatory cytokines and DNA damage with single-strand breaks in the hippocampus and cognitive impairments in learning and memory in exposed rats (65-67). An increase in frequency appears to exert more deleterious effect on several of the parameters (66).

Exposure levels in rats down to a SAR of 85 μW/kg, for 900 MHz during 2 h/day, 5 days/week for 30 days, increased the oxidative stress parameters in lipid peroxidation and protein oxidation. In addition, there was a statistically significant impairment in cognitive function in terms of spatial memory in the rats (68).

RF radiation has been shown to increase protein synthesis in proliferating human cells after 8 h of exposure, but not in quiescent white blood cells. This indicates a higher sensitivity of growing organisms (69). Furthermore, the capacity to repair DNA double-strand breaks was more affected by RF radiation in stem cells compared with differentiated cells, such as fibroblasts (70).

Epidemiological studies of mobile phone base stations have indicated health risks for humans. In particular, increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at a distance of <500 m from base stations was found in 80% of the available studies in a review by Khurana *et al* (71). In another review, Levitt and Lai (72) included 56 studies. Exposure from base stations and other antenna arrays brought about changes in the immunological and reproductive systems of animals and humans, changes in biological material, DNA double-strand breaks, changes in calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells.

Long-term studies on low exposure to RF radiation of humans have demonstrated an effect on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine when a GSM 900 MHz base station was installed in the village of Rimbach in Germany (73), as well as on cortisol and thyroid gland hormones in individuals living near base stations (74,75). Chronic dysregulation of psychobiological stress markers may contribute to health problems and chronic illnesses.

The results from these studies report levels of environmental exposure to RF radiation below the ICNIRP target level (2,3), but far above the BioInitiative Report level for biological effects (5,6). It has been argued that the BioInitiative Reports are not peer-reviewed. However, peer-reviewed and published studies also document health effects at low RF radiation levels (76,77). A recent article highlights the need for accurate information on the safety of exposure to RF radiation (78).

In conclusion, the aim of our study was to assess outdoor exposure to RF radiation at the Old Town and the nearby Parliament in Stockholm, Sweden. The Old Town is a part of Stockholm that is very popular among tourists, but also a destination for locals visiting the official buildings located in the area. In this study, real-time band-specific exposure measurements showed the highest contributors to the exposure to be download frequencies from the base stations of GSM + UMTS 900, UMTS 2100, LTE 800, LTE 2600 and GSM 1800 bands. The highest mean levels were found for GSM + UMTS 900 (3G) downlink and LTE 2600 (4G) downlink. The differences in exposure levels between the Supreme Court and Järntorget were striking, with the mean level 60 times higher at Järntorget. Unfortunately, studies on human risk from long-term environmental RF radiation based on personal exposure monitoring do not exist to the best of our knowledge. Future studies on cancer risk and other health effects from such exposure are imperative. The results of this study revealed unnecessarily high RF radiation areas in several parts of Stockholm Old Town. Using unnecessarily high power levels and placing mobile phone base station antennas too close to the ground and in heavily frequented areas pose an excess health risk to a significant part of the population.

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References

1. Hardell L, Koppel T, Carlberg M, Ahonen M and Hedendahl L: Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields. Int J Oncol 49: 1315-1324, 2016.
2. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. Health Phys 74: 494-522, 1998.
3. ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
4. Hedendahl L, Carlberg M and Hardell L: Electromagnetic hypersensitivity-an increasing challenge to the medical profession. Rev Environ Health 30: 209-215, 2015.
5. BioInitiative Working Group: BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2007. Available online: http://www.bioinitiative.org/table-of-contents/. Accessed October 3, 2016.
6. BioInitiative Working Group: BioInitiative 2012. A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds.). Bioinitiative, 2012. Available online: http://www.bioinitiative.org/table-of-contents/. Accessed October 3, 2016.
7. Szmigielski S, Szudzinski A, Pietraszek A, Bielec M, Janiak M and Wrembel JK: Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. Bioelectromagnetics 3: 179-191, 1982.

8. Cleary SF, Liu LM and Merchant RE: Glioma proliferation modulated in vitro by isothermal radiofrequency radiation exposure. Radiat Res 121: 38-45, 1990.
9. Cleary SF, Liu LM and Merchant RE: In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions. Bioelectromagnetics 11: 47-56, 1990.
10. Chou CK, Guy AW, Kunz LL, Johnson RB, Crowley JJ and Krupp JH: Long-term, low-level microwave irradiation of rats. Bioelectromagnetics 13: 469-496, 1992.
11. Repacholi MH, Basten A, Gebski V, Noonan D, Finnie J and Harris AW: Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. Radiat Res 147: 631-640, 1997.
12. Utteridge TD, Gebski V, Finnie JW, Vernon-Roberts B and Kuchel TR: Long-term exposure of E-mu-Pim1 transgenic mice to 898.4 MHz microwaves does not increase lymphoma incidence. Radiat Res 158: 357-364, 2002.
13. Hardell L, Eriksson M, Carlberg M, Sundström C and Mild KH: Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. Int Arch Occup Environ Health 78: 625-632, 2005.
14. Linet MS, Taggart T, Severson RK, Cerhan JR, Cozen W, Hartge P and Colt J: Cellular telephones and non-Hodgkin lymphoma. Int J Cancer 119: 2382-2388, 2006.
15. Carlberg M, Hedendahl L, Ahonen M, Koppel T and Hardell L: Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data. BMC Cancer 16: 426, 2016.
16. Lauer O, Frei P, Gosselin MC, Joseph W, Röösli M and Fröhlich J: Combining near- and far-field exposure for an organ-specific and whole-body RF-EMF proxy for epidemiological research: A reference case. Bioelctromagnetics 34: 366-374, 2013.
17. Lu M and Wu XY: Study of specific absorption rate (SAR) induced in human endocrine glands for using mobile phones. IEEE Asia-Pacific International Symposium on Electromagnetic Compatibility (APEMC): 1084-1086, 2016.
18. Tillmann T, Ernst H, Streckert J, Zhou Y, Taugner F, Hansen V and Dasenbrock CT: Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. Int J Radiat Biol 86: 529-541, 2010.
19. Lerchl A, Klose M, Grote K, Wilhelm AF, Spathmann O, Fiedler T, Streckert J, Hansen V and Clemens M: Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem Biophys Res Commun 459: 585-590, 2015.
20. Wyde M, Cesta M, Blystone C, Elmore S, Foster P, Hooth M, Kissling G, Malarkey D, Sills R, Stout M, *et al*: Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposures). Draft 5-19-2016. US National Toxicology Program (NTP), 2016. doi: http://dx.doi.org/10.1101/055699. Available online: http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf. Accessed October 3, 2016.
21. Lai H and Singh NP: Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. Bioelectromagnetics 16: 207-210, 1995.
22. Hardell L, Näsman Å, Påhlson A, Hallquist A and Hansson Mild K: Use of cellular telephones and the risk for brain tumours: A case-control study. Int J Oncol 15: 113-116, 1999.
23. Hardell L, Hansson Mild K, Påhlson A and Hallquist A: Ionizing radiation, cellular telephones and the risk for brain tumours. Eur J Cancer Prev 10: 523-529, 2001.
24. Hardell L, Hallquist A, Mild KH, Carlberg M, Påhlson A and Lilja A: Cellular and cordless telephones and the risk for brain tumours. Eur J Cancer Prev 11: 377-386, 2002.
25. Hardell L, Mild KH and Carlberg M: Further aspects on cellular and cordless telephones and brain tumours. Int J Oncol 22: 399-407, 2003.
26. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
27. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 102. Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. International Agency for Research on Cancer: Lyon, France, 2013. Available online: http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf. Accessed October 3, 2016.
28. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of two case-control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997-2003. Int Arch Occup Environ Health 79: 630-639, 2006.
29. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of two case-control studies on the use of cellular and cordless telephones and the risk of benign brain tumours diagnosed during 1997-2003. Int J Oncol 28: 509-518, 2006.
30. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 38: 1465-1474, 2011.
31. Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.
32. Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Cancer Epidemiol 35: 453-464, 2011.
33. Cardis E, Armstrong BK, Bowman JD, Giles GG, Hours M, Krewski D, McBride M, Parent ME, Sadetzki S, Woodward A, *et al*: Risk of brain tumours in relation to estimated RF dose from mobile phones: Results from five Interphone countries. Occup Environ Med 68: 631-640, 2011.
34. Hardell L, Carlberg M, Söderqvist F and Mild KH: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.
35. Hardell L, Carlberg M, Söderqvist F and Mild KH: Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. Int J Oncol 43: 1833-1845, 2013.
36. Hardell L, Carlberg M and Hansson Mild K: Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. Pathophysiology 20: 85-110, 2013.
37. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma-Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22: 1-13, 2015.
38. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R and Baldi I: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
39. Hardell L and Carlberg M: Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones. Rev Environ Health 28: 97-106, 2013.
40. Hill AB: The environment and disease: Association or causation? Proc R Soc Med 58: 295-300, 1965.
41. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35: 186-202, 2016.
42. Bolte JF, Maslanyj M, Addison D, Mee T, Kamer J and Colussi L: Do car-mounted mobile measurements used for radio-frequency spectrum regulation have an application for exposure assessments in epidemiological studies? Environ Int 86: 75-83, 2016.
43. Estenberg J and Augustsson T: Extensive frequency selective measurements of radiofrequency fields in outdoor environments performed with a novel mobile monitoring system. Bioelectromagnetics 35: 227-230, 2014.
44. Joseph W, Frei P, Röösli M, Thuróczy G, Gajsek P, Trcek T, Bolte J, Vermeeren G, Mohler E, Juhász P, *et al*: Comparison of personal radio frequency electromagnetic field exposure in different urban areas across Europe. Environ Res 110: 658-663, 2010.
45. Bolte JF and Eikelboom T: Personal radiofrequency electromagnetic field measurements in The Netherlands: Exposure level and variability for everyday activities, times of day and types of area. Environ Int 48: 133-142, 2012.
46. Urbinello D, Joseph W, Verloock L, Martens L and Röösli M: Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities. Environ Res 134: 134-142, 2014.
47. Aerts S, Deschrijver D, Verloock L, Dhaene T, Martens L and Joseph W: Assessment of outdoor radiofrequency electromagnetic field exposure through hotspot localization using kriging-based sequential sampling. Environ Res 126: 184-191, 2013.

48. Verlock L, Joseph W, Goeminne F, Martens L, Verlaek M and Constandt K: Assessment of radiofrequency exposures in schools, homes, and public places in Belgium. Health Phys 107: 503-513, 2014.
49. Calvente I, Fernández MF, Pérez-Lobato R, Dávila-Arias C, Ocón O, Ramos R, Ríos-Arrabal S, Villalba-Moreno J, Olea N and Núñez MI: Outdoor characterization of radio frequency electromagnetic fields in a Spanish birth cohort. Environ Res 138: 136-143, 2015.
50. Gonzalez-Rubio J, Najera A and Arribas E: Comprehensive personal RF-EMF exposure map and its potential use in epidemiological studies. Environ Res 149: 105-112, 2016.
51. Eberhardt JL, Persson BR, Brun AE, Salford LG and Malmgren LO: Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. Electromagn Biol Med 27: 215-229, 2008.
52. Salford LG, Brun AE, Eberhardt JL, Malmgren L and Persson BR: Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ Health Perspect 111: 881-883, A408, 2003.
53. Nittby H, Brun A, Eberhardt J, Malmgren L, Persson BR and Salford LG: Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. Pathophysiology 16: 103-112, 2009.
54. Sirav B and Seyhan N: Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood-brain barrier in male & female rats. J Chem Neuroanat 75: 123-127, 2016.
55. Tang J, Zhang Y, Yang L, Chen Q, Tan L, Zuo S, Feng H, Chen Z and Zhu G: Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. Brain Res 1601: 92-101, 2015.
56. Nittby H, Grafström G, Tian DP, Malmgren L, Brun A, Persson BR, Salford LG and Eberhardt J: Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation. Bioelectromagnetics 29: 219-232, 2008.
57. Grafström G, Nittby H, Brun A, Malmgren L, Persson BR, Salford LG and Eberhardt J: Histopathological examinations of rat brains after long-term exposure to GSM-900 mobile phone radiation. Brain Res Bull 77: 257-263, 2008.
58. Fragopoulou A, Samara A, Antonelou MH, Xanthopoulou A, Papadopoulou A, Vougas K, Koutsogiannopoulou E, Anastasiadou E, Stravopodis DJ, Tsangaris GT and Margaritis LH: Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. Electromagn Biol Med 31: 250-274, 2012.
59. Dasdag S, Akdag MZ, Erdal ME, Erdal N, Ay OI, Ay ME, Yilmaz SG, Tasdelen B and Yegin K: Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue. Int J Radiat Biol 91: 555-561, 2015.
60. Dasdag S, Tas M, Akdag MZ and Yegin K: Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. Electromagn Biol Med 34: 37-42, 2015.
61. Avendaño C, Mata A, Sanchez Samiento CA and Doncel GF: Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril 97: 39-45.e2, 2012.
62. Akdag MZ, Dasdag S, Canturk F, Karabulut D, Caner Y and Adalier N: Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats? J Chem Neuroanat 75: 116-122, 2016.
63. Burlaka A, Tsybulin O, Sidorik E, Lukin S, Polishuk V, Tsehmistrenko S and Yakymenko I: Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation. Exp Oncol 35: 219-225, 2013.
64. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK and Abegaonkar MP: Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. Indian J Exp Biol 50: 889-896, 2012.
65. Megha K, Deshmukh PS, Ravi AK, Tripathi AK, Abegaonkar MP and Banerjee BD: Effect of low-intensity microwave radiation on monoamine neurotransmitters and their key regulating enzymes in rat brain. Cell Biochem Biophys 73: 93-100, 2015.
66. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R and Abegaonkar MP: Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology 51: 158-165, 2015.
67. Deshmukh PS, Nasare N, Megha K, Banerjee BD, Ahmed RS, Singh D, Abegaonkar MP, Tripathi AK and Mediratta PK: Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation. Int J Toxicol 34: 284-290, 2015.
68. Deshmukh PS, Banerjee BD, Abegaonkar MP, Megha K, Ahmed RS, Tripath AK and Mediratta PK: Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats. Indian J Biochem Biophys 50: 114-119, 2013.
69. Gerner C, Haudek V, Schandl U, Bayer E, Gundacker N, Hutter HP and Mosgoeller W: Increased protein synthesis by cells exposed to a 1,800-MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling. Int Arch Occup Environ Health 83: 691-702, 2010.
70. Markovà E, Malmgren LO and Belyaev IY: Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: Possible mechanistic link to cancer risk. Environ Health Perspect 118: 394-399, 2010.
71. Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M and Ahonen M: Epidemiological evidence for a health risk from mobile phone base stations. Int J Occup Environ Health 16: 263-267, 2010.
72. Levitt BB and Lai H: Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ Rev 18: 369-395, 2010.
73. Buchner K and Eger H: Changes of clinically important neurotransmitters under the influence of modulated RF fields-A long-term study under real-life conditions. Umwelt-Medizin-Gesellschaft 24: 44-57, 2011.
74. Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J and Pauser G: Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed Environ Sci 23: 199-207, 2010.
75. Eskander EF, Estefan SF and Abd-Rabou AA: How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin Biochem 45: 157-161, 2012.
76. Carpenter DO and Sage C: Setting prudent public health policy for electromagnetic field exposures. Rev Environ Health 23: 91-117, 2008.
77. Hardell L and Sage C: Biological effects from electromagnetic field exposure and public exposure standards. Biomed Pharmacother 62: 104-109, 2008.
78. Starkey SJ: Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation. Rev Environ Health 31: 493-503, 2016.

Radiofrequency radiation at Stockholm Central Railway Station in Sweden and some medical aspects on public exposure to RF fields

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Abstract. The Stockholm Central Railway Station in Sweden was investigated for public radiofrequency (RF) radiation exposure. The exposimeter EME Spy 200 was used to collect the RF exposure data across the railway station. The exposimeter covers 20 different radiofrequency bands from 88 to 5,850 MHz. In total 1,669 data points were recorded. The median value for total exposure was 921 μW/m^2 (or 0.092 μW/cm^2; 1 μW/m^2=0.0001 μW/cm^2) with some outliers over 95,544 μW/m^2 (6 V/m, upper detection limit). The mean total RF radiation level varied between 2,817 to 4,891 μW/m^2 for each walking round. High mean measurements were obtained for GSM + UMTS 900 downlink varying between 1,165 and 2,075 μW/m^2. High levels were also obtained for UMTS 2100 downlink; 442 to 1,632 μW/m^2. Also LTE 800 downlink, GSM 1800 downlink, and LTE 2600 downlink were in the higher range of measurements. Hot spots were identified, for example close to a wall mounted base station yielding over 95,544 μW/m^2 and thus exceeding the exposimeter's detection limit. Almost all of the total measured levels were above the precautionary target level of 3-6 μW/m^2 as proposed by the BioInitiative Working Group in 2012. That target level was one-tenth of the scientific benchmark providing a safety margin either for children, or chronic exposure conditions. We compare the levels of RF radiation exposures identified in the present study to published scientific results reporting adverse biological effects and health harm at levels equivalent to, or below those measured in this Stockholm Central Railway Station project. It should be noted that these RF radiation levels give transient exposure, since people are generally passing through the areas tested, except for subsets of people who are there for hours each day of work.

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Introduction

On 31 May 2011 the WHO International Agency for Research on Cancer (IARC) categorized the radiation fields from mobile phones, and from other devices that emit similar non-ionizing electromagnetic field (EMF) radiation in the frequency range 30 kHz to 300 GHz, as a Group 2B, i.e. a 'possible', human carcinogen (1,2). Nine years earlier IARC had also classified the electromagnetic fields from overhead electric power lines as a Group 2B carcinogen (3).

The IARC decision on mobile phones was based mainly on two sets of case-control human studies: the Hardell group of studies from Sweden (4-6) and the IARC Interphone study (7-9). Both provided complementary and generally mutually supportive evidence of increased risk for brain tumours, i.e. glioma and acoustic neuroma. Later published studies by us (10-13) and the French CERENAT study on glioma and meningioma published in 2014 (14) supported an increased risk for brain tumours and use of mobile phones. These results were further supported by a study on mice showing tumour-promoting effect from radiofrequency (RF) radiation at low to moderate levels (0.04 and 0.4 W/kg SAR), radiation well below exposure limits for users of mobile phones (15). Thus, implications of the study by Tillman *et al* (16) were successfully tested. It should be added that a long-term animal toxicity study at 900 MHz published in 1997 resulted in statistically significant increased lymphoma risk in mice (17).

Recently, a report was released from The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in USA on the largest ever animal study on cell phone RF radiation and cancer (18). An increased incidence of glioma and malignant Schwannoma in the heart was found. Acoustic neuroma or vestibular Schwannoma is the same type of tumour as the one found in the heart, although benign.

The carcinogenicity findings evaluated by IARC in 2011 were related to personal wireless phone use, including mobile phones and DECT phones. The overall exposure including

mobile phone base stations, radio- and TV-transmitters, DECT base stations and wireless local area networks (WLAN) is not very well known. Epidemiological studies of mobile phone base stations indicated health risks for humans, see a review of Khurana *et al* (19), but did not contain enough exposure information.

The exposure guideline by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) was established in 1998 (20) and was based on thermal (heating) effects from RF radiation neglecting non-thermal biological effects. It was updated in 2009 (21) and stated that: 'it is the opinion of ICNIRP that the scientific literature published since the 1998 guidelines has provided no evidence of any adverse effects below the basic restrictions and does not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields. Therefore, ICNIRP reconfirms the 1998 basic restrictions in the frequency range 100 kHz to 300 GHz until further notice'. The guideline provided by ICNIRP still recommends 10 W/m^2 as a reference level for limiting public's exposure to the RF-EMFs (2-300 GHz) (20).

It should be noted that the ICNIRP guideline, although only a recommendation, is nevertheless used in most European countries as well as in many other countries. The guideline is based on short-term (acute) exposures but not chronic, low-intensity cumulative exposures, nor possible health effects. ICNIRP safety limits do not acknowledge effects from long-term exposure and non-thermal biological effects from RF-EMF exposure. According to the philosophy document of ICNIRP (22): 'Some guidelines may still not provide adequate protection for certain sensitive individuals nor for normal individuals exposed concomitantly to other agents'. In practice this means, that if simultaneously exposed to chemicals and RF radiation (15,16), the ICNIRP guideline does not protect. The philosophy document of ICNIRP (22) also states: 'Different groups in a population may have differences in their ability to tolerate a particular NIR (Non-Ionizing Radiation) exposure. For example, children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of NIR exposure than the rest of the population'. However, this is not considered in existing ICNIRP (1998) guideline document (20) and for example Gandhi *et al* (23) provide a historical overview how ICNIRP and the Federal Communications Commission (FCC) standard setting is based on (adult) military recruit head and body models, not children's.

ICNIRP's goal has been to harmonize guidelines worldwide and most countries have adopted the ICNIRP's guidelines into their national legislation. Using wireless internet access is compatible with ICNIRP's guidelines, but may exceed the BioInitiative Report recommendation (24). There is a vast body of literature that shows non-thermal adverse health effects from RF radiation. These, as well as thermal effects, have been evaluated in several reports, e.g. the BioInitiative report from 2007 (25) and in the 2012 update (26). The 2007 Bioinitiative report suggested a precautionary target level of 1,000 μW/m^2 for outdoor pulsed RF radiation that could be applied to sources from cell tower antennas, Wi-Fi, WiMAX and other similar sources (25). The BioInitiative 2012 Report defined the scientific benchmark for possible risks as 30-60 μW/m^2, based in part on post-2007 studies by Thomas *et al* (27,28), Heinrich *et al* (29) and Buchner and Eger (30). Considering also chronic exposure and sensitivity among children the precautionary target level was proposed to one tenth of this, 3-6 μW/m^2, see Chapter 24 of the BioInitiative Report (26). However, the studies by Thomas *et al* (27,28) and Heinrich *et al* (29) used personal dosimetry without differentiating up-and downlink and without presenting actual measurements, but only percentages of the reference levels. Also shielding by the body may preclude any statement about actual exposure.

The BioInitiative report guideline obviously differs from the one proposed by ICNIRP, largely because ICNIRP protects only against acute, thermal injury while the BioInitiative recommendations address chronic exposures to non-thermal, low-intensity exposures for which mounting evidence shows adverse health effects. The ICNIRP level has been vigorously propagated by that organisation in order to harmonize guidelines worldwide. With few exceptions it has been a successful story and most countries have adopted the ICNIRP guideline. This gives a 'green card' to roll out the technology, for example using wireless internet access in schools (24), since the high exposure level by ICNIRP is rarely compromised.

There are few studies in this area on public exposure, other than for example outdoor exposure in urban and rural areas in Sweden (31), in a workplace (32), the metro in Warsaw (33) and a study with body-worn exposimeters in The Netherlands (34).

The aim of the present study was to assess RF radiation exposure in a public transportation hub, Stockholm Central Railway Station in Sweden. Many shops, restaurants and offices are located within this area. The Central Station contains many people, those working there and those commuting, thus, both short- and long-term exposure occurs. There is a lack of exposure studies in public places in Sweden. The previous measurement studies are outdated due to the rapid technology shift (35,36). We selected a place visited by many persons that are exposed to RF radiation. This was a measurement study with no involvement of test persons. Thus, no ethical permission was needed. We discuss also some laboratory studies on RF-radiation that will help the reader to understand the context of the exposer logger measurements. Especially interesting are non-thermal levels of RF radiation and biological effects.

Materials and methods

EME Spy 200 exposimeter. In the present study an EME Spy 200 exposimeter with a valid calibration was used to collect the exposure data. The 20 predefined measured frequency bands are presented in Table I. They cover the frequencies of most public RF-EMF emitting devices currently used in Sweden. This band selective exposimeter covers 88 to 5,850 MHz. For FM, TV3, TETRA, TV4&5, Wi-Fi and 5G the lower detection limit is 0.01 V/m (0.27 μW/m^2); for all other exposures the lower detection limit is 0.005 V/m (0.066 μW/m^2). The upper detection limit is 6 V/m (95,544 μW/m^2). The sampling time used in this study was 4 sec which is the fastest for the given exposimeter. The exposimeter measures different telecommunication protocols: FM (frequency modulation) radio broadcasting; TV (television) broadcasting; TETRA emergency services (police, rescue, etc.); GSM (global system for mobile communications) second generation mobile communications; UMTS (universal

Table I. Predefined measurement frequency bands of EME Spy 200 exposimeter and frequency ranges.

Frequency band	Frequency Min (MHz)	Frequency Max (MHz)
FM	87	107
TV3	174	223
TETRA I	380	400
TETRA II	410	430
TETRA III	450	470
TV4&5	470	770
LTE 800 (DL[a]), 4G	791	821
LTE 800 (UL[b]), 4G	832	862
GSM 900+ UMTS 900 (UL), 3G	880	915
GSM 900 + UMTS 900 (DL), 3G	925	960
GSM 1800 (UL)	1,710	1,785
GSM 1800 (DL)	1,805	1,880
DECT	1,880	1,900
UMTS 2100 (UL), 3G	1,920	1,980
UMTS 2100 (DL), 3G	2,110	2,170
Wi-Fi, 2G	2,400	2,483.5
LTE 2600 (UL), 4G	2,500	2,570
LTE 2600 (DL), 4G	2,620	2,690
WiMax	3,300	3,900
Wi-Fi 5G	5,150	5,850

[a]DL, down link: transmission from base station to mobile phone; [b]UL, up link: transmission from mobile phone to base station.



Figure 1. Stockholm Central Station main level (ground floor).

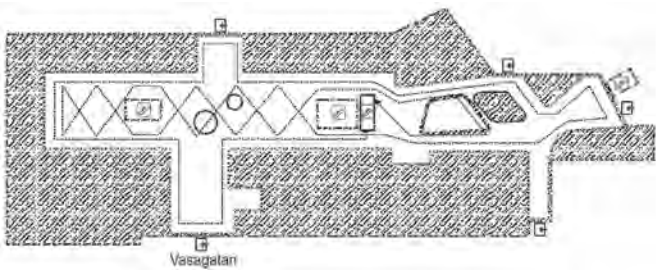


Figure 2. Stockholm Central Station ground floor measurement path.

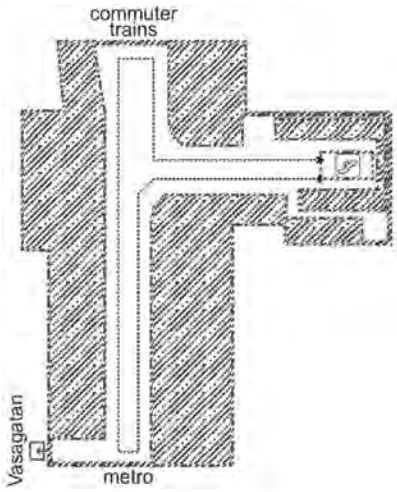


Figure 3. Stockholm Central Station lower level measurement path.

mobile telecommunications systems) third generation mobile communications, 3G; LTE (long-term evolution) fourth generation mobile communications standard, 4G; DECT (digital European cordless telecommunications) cordless telephone systems standard; Wi-Fi wireless local area network protocol; WiMAX (worldwide interoperability for microwave access) wireless communication standard for high speed voice, data and internet.

EME SPY 200 is a sophisticated exposimeter, preferred by the majority of the EMF measurement's community. The unit utilizes 3-axis antennas to capture EMF radiation from all possible directions. The unit reports the exposure in a conservative manner since each reported value is the sampling outcome, where many samples are taken and statistically processed. The amount of the samples is dependent on the measurement band and could reach several hundreds. These samples are analyzed and minimum, mean, median and maximum values are calculated. For each band the sampling period is longer than the pulse length characteristic to that band and signal. This ensures that all the pulses are accounted for in the sampling period. The analysis method of EME SPY 200 allows differentiation of low and high wireless traffic, whereas the peak value might remain the same in both cases. Multiple antennas are of importance to reduce body shielding (37) as well as holding the exposimeter at some distance from the body.

Study design. The present study was performed during daytime November 7, (Saturday; 1 round), November 8 (Sunday; 3 rounds) and November 9, 2015 (Monday; 3 rounds) at the Stockholm Central Station in Sweden. The upper level of the station is displayed in Fig. 1. To the left is the access to the street (Vasagatan) and to the right to commuter trains.

On each measurement round the main and lower floor were walked through with the exposimeter; the same path was always followed. The path was developed to make a clockwise tour of the station's main floor, followed by a zig-zag pattern across the main floor. Due to the narrow area of the lower floor, it was scanned only by a clockwise tour. The walking

Table II. Mean values (μW/m^2) for the seven measurement rounds.

Date	151107 (Saturday)	151108 (Sunday)	151108 (Sunday)	151108 (Sunday)	151109 (Monday)	151109 (Monday)	151109 (Monday)
Time (start)	21:18	11:00	14:45	18:50	9:45	10:50	15:50
No. of readings	195	258	250	235	225	244	262
FM	5.8	9.6	6.7	78.0	10.1	2.0	50.1
TV3	0.0	1.0	0.5	0.3	0.0	0.0	0.1
TETRA I	8.1	2.5	0.4	2.7	1.1	2.7	5.1
TETRA II	0.0	0.0	0.0	0.0	0.0	0.0	1.0
TETRA III	1.3	0.5	0.4	1.3	0.8	1.1	0.8
TV4&5	0.7	0.3	0.2	0.2	0.2	0.3	0.3
LTE 800 (DL[a])	556.8	472.9	421.3	482.9	250.1	363.6	864.4
LTE 800 (UL[b])	0.1	0.7	0.6	0.1	0.3	0.1	0.1
GSM+UMTS 900 (UL)	5.4	4.1	4.3	14.3	8.0	4.8	4.1
GSM+UMTS 900 (DL)	1,561.6	1,453.5	1,409.5	2,074.6	1,337.0	1,165.1	1,314.0
GSM 1800 (UL)	0.4	0.9	1.1	4.1	1.0	0.6	1.1
GSM 1800 (DL)	102.5	354.4	390.0	840.2	495.5	370.5	344.8
DECT	20.8	8.6	19.6	11.2	8.5	12.0	35.4
UMTS 2100 (UL)	0.0	0.1	0.5	0.3	0.5	0.1	0.2
UMTS 2100 (DL)	864.3	964.2	1,631.9	893.3	441.5	557.1	1,239.6
Wi-Fi 2G	1.6	0.9	1.2	2.6	1.2	1.9	2.0
LTE 2600 (UL)	0.1	0.1	0.1	0.2	0.1	0.1	0.1
LTE 2600 (DL)	404.7	309.3	674.5	483.3	372.4	331.0	683.6
WiMax	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wi-Fi 5G	0.7	0.9	1.5	1.6	1.7	3.9	1.4
Total	3,535.0	3,584.4	4,564.2	4,891.2	2,929.9	2,817.0	4,548.1

[a]DL, down link: transmission from base station to mobile phone; [b]UL, up link: transmission from mobile phone to base station.

path is schematically shown in Figs. 2 and 3. The lower level contains businesses and access to the metro, commuter trains and Vasagatan; the main floor has also businesses, access to the trains and exits to the street.

In order to minimize the body's shielding effect to the exposimeter, the unit was held ahead within ~0.4 m from the investigator's body.

Statistical methods. Means in μW/m^2 were calculated for all measured frequency bands and a box plot was constructed to illustrate the distribution of total exposure for all measurement rounds. Values at lower detection limit were treated as no (0) exposure. Total exposure was calculated as the sum of all measured frequency bands. Stata/SE 12.1 (Stata/SE 12.1 for Windows; StataCorp., College Station, TX, USA) was used for all calculations.

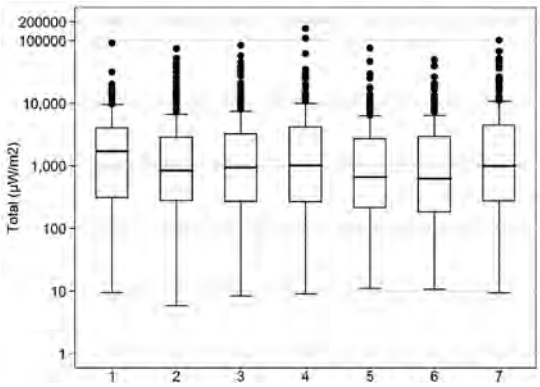


Figure 4. Box plot for total exposure in μW/m^2 for the seven measurement rounds. The median is indicated by a black line inside each box; the bottom and top of the boxes show first and third quartiles; the end of the whiskers are calculated as 1.5xIQR (interquartile range). Points represent outliers.

Results

In total 1,669 readings were collected varying from 195 to 262 during each round (median 244). Thus, the time varied between 13.0 and 17.5 min for different rounds.

The results for each round are displayed in Table II, and for all rounds in Table III. The mean total exposure level varied between 2,817 to 4,891 μW/m^2 (or 0.28 to 0.49 μW/cm^2; 1 μW/m^2=0.0001 μW/cm^2) and the median value for total exposure (all measurement rounds) was 921 μW/m^2. High mean measurements were obtained for GSM and UMTS 900 downlink varying between 1,165 and 2,075 μW/m^2. High mean levels were also obtained for UMTS 2100 downlink; 442 to 1,632 μW/m^2. Also LTE 800 downlink, GSM 1800 downlink, and LTE 2600 downlink were in the higher range of measurements. Notably lower mean levels were seen for DECT varying between 8.5 to 35.4 μW/m^2. The mean level results for FM

Table III. Mean, median, minimum and maximum values (μW/m^2) for all measurement rounds (n=1,669 measurement points).

Frequency band	Mean	Median	Min	Max
FM	23.7	0.0	0.0	9,206.3
TV3	0.3	0.0	0.0	176.6
TETRA I	3.1	0.0	0.0	834.8
TETRA II	0.2	0.0	0.0	78.5
TETRA III	0.9	0.0	0.0	100.9
TV4&5	0.3	0.0	0.0	41.4
LTE 800 (DL[a])	491.8	55.8	0.0	41,281.2
LTE 800 (UL[b])	0.3	0.0	0.0	142.8
GSM+UMTS 900 (UL)	6.3	0.6	0.0	561.3
GSM+UMTS 900 (DL)	1,467.2	254.9	0.0	95,522.5
GSM 1800 (UL)	1.3	0.1	0.0	243.5
GSM 1800 (DL)	418.6	22.9	0.0	58,843.8
DECT	16.7	0.3	0.0	3,637.2
UMTS 2100 (UL)	0.2	0.0	0.0	94.8
UMTS 2100 (DL)	955.8	127.2	0.9	59,847.5
Wi-Fi 2G	1.6	0.2	0.0	186.3
LTE 2600 (UL)	0.1	0.0	0.0	13.4
LTE 2600 (DL)	470.1	64.6	0.0	40,158.8
WiMax	0.0	0.0	0.0	1.3
Wi-Fi 5G	1.7	0.4	0.0	301.2
Total	3,860.2	920.6	5.8	155,263.4

[a]DL, down link: transmission from base station to mobile phone; [b]UL, up link: transmission from mobile phone to base station.

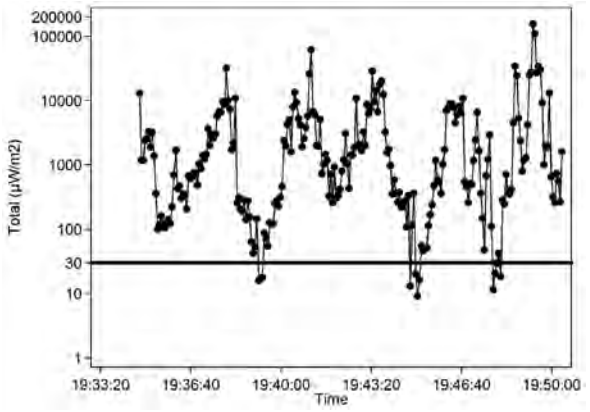


Figure 5. Total radiofrequency field exposure (μW/m^2) of the highest exposure round (151108, 18:50; mean exposure 4,891.2 μW/m^2) by walking across the station. The horizontal line represents the exposure limit of 30 μW/m^2 suggested by the BioInitiative Report (29).

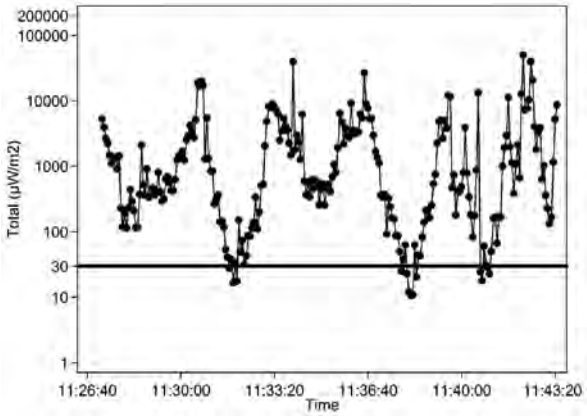


Figure 6. Total radiofrequency field exposure (μW/m^2) of the lowest exposure round (151109, 10:50; mean exposure 2,817.0 μW/m^2) by walking across the station. The horizontal line represents the exposure limit of 30 μW/m^2 suggested by the BioInitiative Report (29).

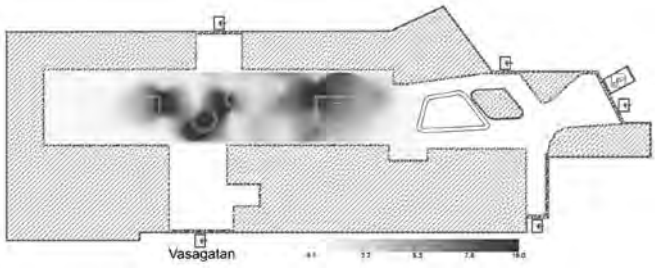


Figure 7. Stockholm Central Station ground floor with total field intensity map (151108, 19:20) scale in mW/m^2.



Figure 8. An example of highest exposure area. A man is standing with his smartphone just a couple of meters below a base station (see arrow). In that area maximum measured power density in the GSM +UMTS 900 downlink band was 95,544 μW/m^2, which is the upper limit of measurement for EME Spy 200.

radio varied between 2.0 to 78.0 μW/m^2. Some of the results showed 0.0 μW/m^2 since readings registered as lower detection limit were considered as 0 in the analysis.

In Fig. 4 the box plot shows total exposure in μW/m^2 for the seven measurement rounds. The overall median value was 921 μW/m^2 with some outliers of >150,000 μW/m^2. Fig. 5 displays the variation over time for the highest exposure round. It should be noted that most measurements were >100 μW/m^2. In Fig. 6 similar results as in Fig. 5 are shown for lowest exposure round.

Fig. 7 shows total field intensity map on the Central Station main level. Clearly there were several hot spots, for example at

places where people use to sit or stand waiting for their train or meeting with other persons.

One example of highest exposure area is shown in Fig. 8. In that area maximum measured power density in the GSM + UMTS 900 downlink band was 95,544 μW/m^2, which is the upper limit of measurement in each frequency band for EME Spy 200. Note that the photo was not taken simultaneously with the measurement rounds.

Discussion

EME Spy 200 is a band specific exposimeter and gives the possibility to identify and measure most RF radiation bands currently used in Sweden. We selected Stockholm Central Station in Sweden since it is a place for communication with lots of daily visiting persons. It may be persons that transfer between the metro and train (or opposite), but also people that meet each other or are waiting during a considerable time for a transfer train. There are also lots of shops in that area with employees. We did not make any measurements in shops since the aim was to restrict the study to transfer areas. Anyhow, there is a possibility for many persons to be exposed to high RF radiation for shorter or longer time periods.

Major results. The major finding of the present study was that total RF radiation mean exposure for a walking round, see Figs. 2 and 3, varied between 2,817 to 4,891 μW/m^2. GSM and UMTS 900 downlink contributed to most of the radiation dose. In fact, this together with UMTS 2100 downlink contributed to almost half of total exposure. Other major sources were LTE 800 downlink, GSM 1800 downlink and LTE 2600 downlink. Other sources were comparatively low. According to Table II, the vast majority of the mobile telephone exposure is from the downlink bands, i.e. the sources are the base station antennas placed around the railway station. Exposure from uplink levels was an insignificant percentage of the downlink exposure: LTE 800 0.06%, GSM 900 0.44%, GSM 1800 0.32%, UMTS 2100 0.03% and LTE 2600 0.21%.

All measured mean and median levels were well below ICNIRP's exposure guidelines at 2-10 W/m^2 (see below), but most of the measured levels were above the scientific benchmark of 30-60 μW/m^2 as proposed by the BioInitiative Report (26). Obviously few total measurements were below 30 μW/m^2, see Figs. 5 and 6.

There were also some hot spots for exposure. This is exemplified in Fig. 8 with a man standing close to a base station on the wall just below the roof. The measured exposure was 95,544 μW/m^2, which is the upper detection limit for each frequency band for the exposimeter. Thus, it was not possible to get the exact value. People in general are not aware of this kind of exposure that may be considerable. Moreover, this is an example of an inappropriate placement of a base station with high downlink exposure. Note that the photo was taken separate from measurement rounds.

The exposure guidelines by ICNIRP. The reference values for radiofrequency electromagnetic fields were recommended in 1998 by ICNIRP to 2-10 W/m^2 for frequencies between 10 MHz to 300 GHz. Up to 400 MHz the recommendation is 2 W/m^2. The formula: frequency/(2x10^8) is used for frequencies between 400 and 2,000 MHz. Above 2,000 MHz up to 300 GHz the recommended reference value is 10 W/m^2 (20).

The basic restrictions for time varying electric and magnetic fields for frequencies from 10 MHz up to 10 GHz for the specific energy absorption rate (SAR) is over 10 g of tissue for whole-body average set to 80 mW/kg, for localized head and trunk 2 W/kg and for localized limbs 4 W/kg. FCC/Institute of Electrical and Electronics Engineers (IEEE) public safety limits use a 1 g rather than 10 g volume of tissue and the SAR limit for ICNIRP is 2 W/kg in comparison to the FCC/IEEE 1.6 W/Kg SAR allowance.

These reference values and basic restrictions protect against injuries caused by a heating effect over 1˚C after an exposure of 30 min, and with a safety factor of 50 for general public (20). Injuries caused by other biological mechanisms than heating or from chronic effects are not considered in the above mentioned limit values.

Limitations due to method of measurements. The present study describes measurements mostly from far-field RF radiation. It describes the exposure that the citizen may be exposed to without himself/herself using personal wireless devices. Near-field exposure from people's own mobile phones held near the ear or in the hand when surfing on the internet may be a considerable contribution to the individual's total exposure.

We measured during seven rounds during three days yielding 1,669 readings in total. The exposure levels did somewhat vary between the different walking rounds but did not exceed 2-fold. However, the data does not show that either weekends or weekdays would exhibit higher exposure level. Many people pass through the station in rush hours, but also in weekends when traveling away and into the city. It should be noted that this is a conservative estimate of exposure. The results do not reflect personal wireless devices being carried around or used by individuals, just the 'ambient' RF levels of people not using devices.

The present study used an exposimeter for measurements. Because samples were taken every 4 sec, technologies with large differences between average and peak might not have been exactly evaluated, an inherent limitation of the exposimeter. For example the DECT-base stations and Wi-Fi router exposures may have been undervalued with the used exposimeter. Generally, peak signal level measurement data is interesting when discussing the non-thermal effects of radiofrequency radiation.

The shielding effect from the body of a person carrying an exposimeter can be considerable as shown by Bolte *et al* (38) when comparing a body worn exposimeter with an exposimeter mounted on a car roof. This was partly compensated in the present study by holding the exposimeter at some distance from the body. Bhatt *et al* (37) concluded that using an exposimeter with three antennas, as in the present study, may minimize body shielding.

Laboratory studies and medical aspects. The mean measurements in the Stockholm Central Station showed a total RF radiation between 2,817 to 4,891 μW/m^2. Studies with laboratory animals exposed to RF radiation at or below these levels have shown influence on several physiological parameters in

the body of mammals. Influence on the blood-brain barrier, proteins and microRNA in the brain, testicular function, oxidative stress in the cells and DNA damage have been shown. Also neurotransmitters in people living in a village were changed after activation of a GSM mobile phone base station. These are non-thermal effects and are discussed briefly in the following.

The blood brain barrier (BBB) may open by exposure to RF radiation and lead to leakage into the brain of large molecules, like albumin and different toxins. As a result of opening of the protective BBB layer that separates the brain from the blood, this pathological leakage of the BBB has been shown to be toxic to brain tissues and can cause damage to, and death of neurons (39,40). Condensed dark neurons in the rats' brains are a sign of damage, and have been seen after 2 h of exposure to a GSM mobile phone both at 28 and 50 days after exposure (39,40). Several studies on rats have shown opened BBB after RF radiation from a GSM mobile phone with peak power output down to 1,000 μW and with an average whole body SAR-value down to 120 μW/kg (41). A U-shaped response curve has also been seen with stronger health effects by RF radiation at lower exposure levels than at higher exposure (39,41).

Difference between genders after exposure to RF radiation has been found, where male rats got an increased BBB permeability for both GSM 900 and 1,800 MHz pulsed modulated RF radiation while female rats only got increased BBB permeability for the 900 MHz frequency (42).

The hippocampus is a center for memory and learning in the brain, and in particular appears to be a primary target for neuronal damage from RF radiation and opened BBB. Exposure to 900 MHz RF radiation during 3 h per day for 28 days showed extravasation of albumin in the hippocampus and cortex and impaired spatial memory in exposed rats (43). Also exposure for 2 h per day for 55 weeks showed impaired memory in GSM 900 MHz exposed rats, but no statistically significant alterations of histopathological parameters (44,45).

RF radiation has been shown to increase protein synthesis in proliferating human cells after 8 h of exposure, but not in quiescent white blood cells. This indicates a higher sensitivity of growing organisms (46). Also the capacity to repair DNA double-strand breaks was more effected by RF radiation in stem cells compared to differentiated cells like fibroblasts (47).

In a long-term study mice were exposed to a GSM 900 MHz mobile phone at SAR-level 370,000 μW/kg for 3 h a day or to a DECT base station at a SAR-level of 12,000-28,000 μW/kg for 8 h a day. After 8 months of exposure the two exposed groups of mice were compared with a sham exposed control group regarding 432 proteins from the cerebellum, hippocampus and frontal lobes of the brains. Comparative proteomics analyses revealed that 143 of the proteins had a statistically significant downregulation or an overexpression. Several neural function related proteins, like apolipoprotein E, heat shock proteins and cytoskeletal proteins as well as proteins of the brain metabolism were altered (48).

In two long-term studies rats were exposed to RF radiation emitted from a Wi-Fi system of 2.4 GHz for 24 h a day for 12 months. The peak power from the Wi-Fi was 100,000 μW with the antenna 50 cm above the cage. The SAR value over 10 g of brain tissue was 1,030 μW/kg. In one of the studies micro-RNAs (miRNA) in the rat brains were examined. Two of the five examined miRNA, 107 and 106b-5p, decreased 3.3 and 3.6 times, respectively. miRNA plays an important role in the proliferation, differentiation, function and maintenance of neuronal cells. Dysfunction of miRNA pathways may be a potential contribution to pathogenesis of neurodegenerative disorders and also a key indicator of epigenetic changes and cancer risk (49).

In the other study the rat testes and prostate were examined. The SAR value in the exposed rat testes and prostate was 1,020 μW/kg over 10 gram tissue. Compared to the sham exposed rats the Wi-Fi exposed rats showed statistically significant more head defects of the sperms and effects on testicular function and histology (50). Other Wi-Fi exposure studies have indicated damage to DNA in sperms (51-53).

Yakymenko *et al* (54) showed in a review of 100 studies investigating oxidative effects of low-intensity RF radiation in living cells, that exposure down to 2,500 μW/m^2 (55) and with SAR values down to 600 μW/kg (56,57) could increase oxidative stress in the cells. Long-term RF radiation exposure at the frequencies 900, 1,800 and 2,450 MHz for 2 h per day 5 days per week for 30-180 days at SAR 595-667 μW/kg have shown induced oxidative stress, reduced levels of neurotransmitters and downregulation of mRNA, increase in pro-inflammatory cytokines and DNA damage with single strand breaks in the hippocampus in the brain in the exposed rats (57-59). Cognitive impairments in learning and memory were also shown (59). Increase in frequency seems to have more deleterious effect on several of the parameters; 1,800 and 2,450 MHz had a statistically significant effect not only compared to sham exposed animals but also in some cases compared to 900 MHz exposure.

Even lower exposure levels in rats, down to SAR 85 μW/kg, for 900 MHz during 2 h/day, 5 days/week for 30 days showed increase in oxidative stress parameters in lipid peroxidation and protein oxidation. Also cognitive function showed a statistically significant impairment in spatial memory in the rats (60).

Buchner and Eger (30) performed a study with 60 participants out of the 2,000 inhabitants, who lived in the village Rimbach in Germany, when a GSM mobile base station was built in the spring of 2004. The neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (PEA) were measured in second morning urine samples before the base station was activated and 6, 12 and 18 months after. The RF radiation was measured outside each participant's house in peak value of the power density after the activation of the base station. The 60 study participants were divided into three exposure groups, <60, 60-100 and >100 μW/m^2.

After the activation of the GSM base station the levels of the stress hormones adrenaline and noradrenaline showed a statistically significant increase during the first six months and then decreased but were not restored to initial level after 18 months. This was seen especially for the children and the chronically ill adults. A statistically significant decrease was seen for dopamine levels during the first six months ($P<0.0002$), then dopamine levels increased but were not restored to the initial level. These three neurotransmitters showed a dose-response relationship with highest influence for the participants with exposure >100 μW/m^2 at home. PEA levels decreased for the

highest exposed group first, but after 18 months all three exposure groups had a statistically significant decrease (P<0.0001). Wireless devices like DECT, Wi-Fi and bluetooth at home seemed to amplify the effect of GSM radiation. Even the lowest exposed group, <60 μW/m^2, had decreased dopamine and PEA levels after 18 months. Chronic dysregulation of the catecholamine system and PEA may contribute to health problems and chronic illnesses (30).

The NTP animal study (18) confirms findings in epidemiological studies of an increased risk for glioma and acoustic neuroma among people that use wireless phones, both mobile phones and cordless phones (DECT). In 2013, accumulating evidence from brain cancer studies resulted in a recommendation to upgrade IARC's 2011 classification of RF from a Group 2B - Possible Human Carcinogen to Group 1 - Known Carcinogen (61). The NTP study has greatly strengthened the evidence of risk, and reaffirms that it is sufficient to reclassify wireless phone radiation as a known cancer causing agent, and confirms the inadequacy of existing public safety limits.

Environmental RF radiation exposure. There are no other published studies in Sweden on RF radiation exposure in public places like this one at the Stockholm Central Station. The study by Hamnerius *et al* (35) from 2000 has merit as an RF radiation baseline, and may establish how much exposure has changed over time. Estenberg and Augustsson (31) measured with a car-mounted device the frequency range 30-3,000 MHz in some public places; rural, urban and city. The arithmetic mean measured exposure was in Stockholm city 6,700 μW/m^2, in urban areas (4 towns) 1,500 μW/m^2, and in rural areas (2 places) 230 μW/m^2. Similarly as in present study the major sources were GSM and UMTS downlinks.

Within one year, from 2011 to 2012, total RF radiation levels in all studied European outdoor city areas in combination increased by 57.1% (62). Over the past decade or so, RF radiation levels have significantly increased in our environment. Frei *et al* (63) estimated that the introduction of mobile phone technology has resulted in a 10-fold increase of RF radiation at outdoor areas compared to the time period before when broadcast transmitting was the most relevant source. Urbinello *et al* (62) measured 3 European cities, including train stations. The RF radiation measurement values in train stations ranged from 0.32 (272 μW/m^2) to 0.57 V/m (862 μW/m^2). Authors comment: 'Interestingly, across all indoor areas in all cities, mobile phone base station exposure showed a stronger temporal increase than mobile phone handset exposure' (62).

In a study by Bolte *et al* (64) 98 persons in The Netherlands carried a body-worn EME-Spy 121 for 24 h. Passing time at a railway station or going by train and metro showed high exposure, mean power density 304-354 μW/m^2, although visiting pubs or cafés showed even higher exposure, mean 526 μW/m^2. These are places where many people gather together and use mobile phones and laptops. During 2010 and 2011 when the study was done exposure from UMTS, both downlink and uplink, was low and few owned and used smartphones.

Grytz and Karpowicz (33) measured RF radiation inside the metro in Warsaw. The major source of exposure was the 900 GSM system. In another publication the mean exposure based on 173,323 measurements in 23 countries worldwide was reported to be 730 μW/m^2 (65). However, these measurements covered a different time period and not the same frequency range as in this study. Furthermore, the study methods were not clearly described. Markakis and Samaras (66) made a measurement campaign in Greece from 2010 to 2012 and concluded that signals from mobile base stations were dominant in workplaces and schools, whereas in home environment the dominant exposure was from wireless phones and computer networks. Viel *et al* (67) used exposimeters to investigate the participants' exposure budget across the week. They concluded the highest exposure to reside during Sundays, with main contributions from UMTS Tx (transmitting, upload) and DECT.

The present study is unique and different from those published previously since it covers 20 different frequency bands including most currently used frequency bands. Thus, in addition to the changing technology, our results are not comparable with previous ones such as the one from 2010 by Joseph *et al* (68) or even the results by Tell and Kavet (69) from 2014 stating that the FM band was a major contributor to overall power density. These results are less reliable comparing with our findings. Mean values for the FM band was orders of magnitude lower than e.g. for GSM+UMTS 900 (DL) and UMTS 2100 (DL) in this study, see Table II.

In conclusion, the aim of the present study was to assess the exposure to RF radiation in a public place in Sweden visited daily by many persons. We compare our results with non-thermal effects in laboratory investigations and also discuss results in animal studies on the carcinogenic risk. In epidemiological studies an increased risk of glioma and acoustic neuroma has been found in persons exposed to RF radiation from wireless phones. In animal studies RF radiation has been shown to promote tumours but also cause glioma and acoustic neuroma. There are also by now mechanistic studies such as oxidative effects from low-intensity RF radiation. We call for upgrading the carcinogenic potential to IARC Group 1, the agent causes cancer in humans.

In this study, real-time band specific exposure measurements at a public place showed comparatively high exposure from all mobile telephone and networking bands. The highest contributors to the exposure were download frequencies from the base stations at GSM+UMTS 900, UMTS 2100, LTE800, LTE 2600 and GSM 1800 bands. However, these RF exposure levels in this study are transient, since people are generally passing through the areas tested, except for subsets of people, i.e., security and police staff, cafe workers, shop workers, janitors, information counter people, who are there for hours each day of work.

Due to the rapid development of the telecommunications technology and the evolution of the wireless infrastructure, it is imperative to measure public's exposure. Yearly monitoring measurements would allow an overview of the public's exposure budget, since nowadays, rapid deployment of new RF radiation sources take place. The information obtained by the exposure studies allows assessing public's exposure to RF radiation today and in the years to come, when future epidemiologic studies seek for information in assessing the historic exposure levels to which the public was commonly exposed. Unfortunately studies on human risk from long-term environmental RF radiation based on personal exposure monitoring

do not exist to our knowledge. Given the lack of good historic RF radiation exposure information to date, it is imperative that better efforts be directed to periodic collection of RF radiation exposures in daily life for use in epidemiological studies of cancer as well as of neurological diseases and other adverse health effects attributed to RF radiation exposures.

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References

1. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
2. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 102. Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields. International Agency for Research on Cancer: Lyon, France, 2013. Available online: http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf (accessed on 1 June 2016).
3. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 80. Non-Ionizing Radiation, Part I: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields. IARC Press, Lyon, France, 2002. Available online: http://monographs.iarc.fr/ENG/Monographs/vol80/mono80.pdf (accessed on 1 June 2016).
4. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of two case-control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997-2003. Int Arch Occup Environ Health 79: 630-639, 2006.
5. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of two case-control studies on the use of cellular and cordless telephones and the risk of benign brain tumours diagnosed during 1997-2003. Int J Oncol 28: 509-518, 2006.
6. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 38: 1465-1474, 2011.
7. INTERPHONE Study Group: Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.
8. INTERPHONE Study Group: Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Cancer Epidemiol 35: 453-464, 2011.
9. Cardis E, Armstrong BK, Bowman JD, Giles GG, Hours M, Krewski D, McBride M, Parent ME, Sadetzki S, Woodward A, *et al*: Risk of brain tumours in relation to estimated RF dose from mobile phones: Results from five Interphone countries. Occup Environ Med 68: 631-640, 2011.
10. Hardell L, Carlberg M, Söderqvist F and Mild KH: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.
11. Hardell L, Carlberg M, Söderqvist F and Mild KH: Case-control study of the association between malignant brain tumours diagnosed between 2007 and 2009 and mobile and cordless phone use. Int J Oncol 43: 1833-1845, 2013.
12. Hardell L, Carlberg M and Hansson Mild K: Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. Pathophysiology 20: 85-110, 2013.
13. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22: 1-13, 2015.
14. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R, *et al*: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
15. Lerchl A, Klose M, Grote K, Wilhelm AF, Spathmann O, Fiedler T, Streckert J, Hansen V and Clemens M: Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem Biophys Res Commun 459: 585-590, 2015.
16. Tillmann T, Ernst H, Streckert J, Zhou Y, Taugner F, Hansen V and Dasenbrock C: Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. Int J Radiat Biol 86: 529-541, 2010.
17. Repacholi MH, Basten A, Gebski V, Noonan D, Finnie J and Harris AW: Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. Radiat Res 147: 631-640, 1997.
18. Wyde M, Cesta M, Blystone C, Elmore S, Foster P, Hooth M, Kissling G, Malarkey D, Sills R, Stout M, *et al*: Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposures). Draft 5-19-2016. US National Toxicology Program (NTP), 2016. doi: http://dx.doi.org/http://dx.doi.org/10.1101/055699. Available online: http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf (accessed on 1 June 2016).
19. Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M and Ahonen M: Epidemiological evidence for a health risk from mobile phone base stations. Int J Occup Environ Health 16: 263-267, 2010.
20. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.
21. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
22. International Commission on Non-Ionizing Radiation Protection: General approach to protection against non-ionizing radiation. Health Phys 82: 540-548, 2002.
23. Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB and Davis DL: Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 31: 34-51, 2012.
24. Hedendahl L, Carlberg M and Hardell L: Electromagnetic hypersensitivity - an increasing challenge to the medical profession. Rev Environ Health 30: 209-215, 2015.
25. BioInitiative Working Group: BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds.). Bioinitiative, 2007. Available online: http://www.bioinitiative.org/table-of-contents/ (accessed on 1 June 2016).
26. BioInitiative Working Group: BioInitiative 2012. A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds.). Bioinitiative, 2012. Available online: http://www.bioinitiative.org/table-of-contents/ (accessed on 1 June 2016).
27. Thomas S, Kühnlein A, Heinrich S, Praml G, Nowak D, von Kries R and Radon K: Personal exposure to mobile phone frequencies and well-being in adults: A cross-sectional study based on dosimetry. Bioelectromagnetics 29: 463-470, 2008.
28. Thomas S, Heinrich S, von Kries R and Radon K: Exposure to radio-frequency electromagnetic fields and behavioural problems in Bavarian children and adolescents. Eur J Epidemiol 25: 135-141, 2010.
29. Heinrich S, Thomas S, Heumann C, von Kries R and Radon K: Association between exposure to radiofrequency electromagnetic fields assessed by dosimetry and acute symptoms in children and adolescents: A population based cross-sectional study. Environ Health 9: 75, 2010.
30. Buchner K and Eger H: Changes of clinically important neurotransmitters under the influence of modulated RF fields: A long-term study under real-life conditions. Umwelt-Medizin-Gesellschaft 24: 44-57, 2011 (In German).
31. Estenberg J and Augustsson T: Extensive frequency selective measurements of radiofrequency fields in outdoor environments performed with a novel mobile monitoring system. Bioelectromagnetics 35: 227-230, 2014.

32. Gryz K, Karpowicz J, Leszko W and Zradziński P: Evaluation of exposure to electromagnetic radiofrequency radiation in the indoor workplace accessible to the public by the use of frequency-selective exposimeters. Int J Occup Med Environ Health 27: 1043-1054, 2014.
33. Gryz K and Karpowicz J: Radiofrequency electromagnetic radiation exposure inside the metro tube infrastructure in Warszawa. Electromagn Biol Med 34: 265-273, 2015.
34. Bolte JF and Eikelboom T: Personal radiofrequency electromagnetic field measurements in The Netherlands: Exposure level and variability for everyday activities, times of day and types of area. Environ Int 48: 133-142, 2012.
35. Hamnerius Y and Uddmar T: Microwave exposure from mobile phones and base stations in Sweden. Proceedings of the International Conference on Cell Tower Sitting 52-63, 2000. Available online: https://www.salzburg.gv.at/gesundheit_/Documents/proceedings_(08)_hamnerius.pdf (accessed on 1 June 2016).
36. Foster KR: Radiofrequency exposure from wireless LANs utilizing Wi-Fi technology. Health Phys 92: 280-289, 2007.
37. Bhatt CR, Thielens A, Redmayne M, Abramson MJ, Billah B, Sim MR, Vermeulen R, Martens L, Joseph W and Benke G: Measuring personal exposure from 900MHz mobile phone base stations in Australia and Belgium using a novel personal distributed exposimeter. Environ Int 92-93: 388-397, 2016.
38. Bolte JF, Maslanyj M, Addison D, Mee T, Kamer J and Colussi L: Do car-mounted mobile measurements used for radio-frequency spectrum regulation have an application for exposure assessments in epidemiological studies? Environ Int 86: 75-83, 2016.
39. Eberhardt JL, Persson BR, Brun AE, Salford LG and Malmgren LO: Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. Electromagn Biol Med 27: 215-229, 2008.
40. Salford LG, Brun AE, Eberhardt JL, Malmgren L and Persson BR: Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ Health Perspect 111: 881-883, discussion A408, 2003.
41. Nittby H, Brun A, Eberhardt J, Malmgren L, Persson BR and Salford LG: Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. Pathophysiology16: 103-112, 2009.
42. Sırav B and Seyhan N: Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood-brain barrier in male & female rats. J Chem Neuroanat: Dec 23, 2015. pii: S0891-0618(15)00106-4. doi: 10.1016/j.jchemneu.2015.12.010. (Epub ahead of print).
43. Tang J, Zhang Y, Yang L, Chen Q, Tan L, Zuo S, Feng H, Chen Z and Zhu G: Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. Brain Res 1601: 92-101, 2015.
44. Nittby H, Grafström G, Tian DP, Malmgren L, Brun A, Persson BR, Salford LG and Eberhardt J: Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation. Bioelectromagnetics 29: 219-232, 2008.
45. Grafström G, Nittby H, Brun A, Malmgren L, Persson BR, Salford LG and Eberhardt J: Histopathological examinations of rat brains after long-term exposure to GSM-900 mobile phone radiation. Brain Res Bull 77: 257-263, 2008.
46. Gerner C, Haudek V, Schandl U, Bayer E, Gundacker N, Hutter HP and Mosgoeller W: Increased protein synthesis by cells exposed to a 1,800-MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling. Int Arch Occup Environ Health 83: 691-702, 2010.
47. Markovà E, Malmgren LO and Belyaev IY: Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: Possible mechanistic link to cancer risk. Environ Health Perspect 118: 394-399, 2010.
48. Fragopoulou AF, Samara A, Antonelou MH, Xanthopoulou A, Papadopoulou A, Vougas K, Koutsogiannopoulou E, Anastasiadou E, Stravopodis DJ, Tsangaris GT, *et al*: Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. Electromagn Biol Med 31: 250-274, 2012.
49. Dasdag S, Akdag MZ, Erdal ME, Erdal N, Ay OI, Ay ME, Yilmaz SG, Tasdelen B and Yegin K: Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue. Int J Radiat Biol 91: 555-561, 2015.
50. Dasdag S, Taş M, Akdag MZ and Yegin K: Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. Electromagn Biol Med 34: 37-42, 2015.
51. Avendaño C, Mata A, Sanchez Sarmiento CA and Doncel GF: Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril 97: 39-45.e2, 2012.
52. Atasoy HI, Gunal MY, Atasoy P, Elgun S and Bugdayci G: Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. J Pediatr Urol 9: 223-229, 2013.
53. Akdag MZ, Dasdag S, Canturk F, Karabulut D, Caner Y and Adalier N: Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats? J Chem Neuroanat: Jan 8, 2016. pii: S0891-0618(16)00005-3. doi: 10.1016/j.jchemneu.2016.01.003 (Epub ahead of print).
54. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 19: 1-17, 2015.
55. Burlaka A, Tsybulin O, Sidorik E, Lukin S, Polishuk V, Tsehmistrenko S and Yakymenko I: Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation. Exp Oncol 35: 219-225, 2013.
56. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK and Abegaonkar MP: Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. Indian J Exp Biol 50: 889-896, 2012.
57. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R and Abegaonkar MP: Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology 51: 158-165, 2015.
58. Deshmukh PS, Nasare N, Megha K, Banerjee BD, Ahmed RS, Singh D, Abegaonkar MP, Tripathi AK and Mediratta PK: Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation. Int J Toxicol 34: 284-290, 2015.
59. Megha K, Deshmukh PS, Ravi AK, Tripathi AK, Abegaonkar MP and Banerjee BD: Effect of low-intensity microwave radiation on monoamine neurotransmitters and their key regulating enzymes in rat brain. Cell Biochem Biophys 73: 93-100, 2015.
60. Deshmukh PS, Banerjee BD, Abegaonkar MP, Megha K, Ahmed RS, Tripathi AK and Mediratta PK: Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats. Indian J Biochem Biophys 50: 114-119, 2013.
61. Hardell L and Carlberg M: Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones. Rev Environ Health 28: 97-106, 2013.
62. Urbinello D, Joseph W, Verloock L, Martens L and Röösli M: Temporal trends of radio-frequency electromagnetic field (RF-EMF) exposure in everyday environments across European cities. Environ Res 134: 134-142, 2014.
63. Frei P, Mohler E, Neubauer G, Theis G, Bürgi A, Fröhlich J, Braun-Fahrländer C, Bolte J, Egger M and Röösli M: Temporal and spatial variability of personal exposure to radio frequency electromagnetic fields. Environ Res 109: 779-785, 2009.
64. Bolte JF, van der Zande G and Kamer J: Calibration and uncertainties in personal exposure measurements of radiofrequency electromagnetic fields. Bioelectromagnetics 32: 652-663, 2011.
65. Rowley JT and Joyner KH: Comparative international analysis of radiofrequency exposure surveys of mobile communication radio base stations. J Expo Sci Environ Epidemiol 22: 304-315, 2012.
66. Markakis I and Samaras T: Radiofrequency exposure in Greek indoor environments. Health Phys 104: 293-301, 2013.
67. Viel JF, Tiv M, Moissonnier M, Cardis E and Hours M: Variability of radiofrequency exposure across days of the week: A population-based study. Environ Res 111: 510-513, 2011.
68. Joseph W, Frei P, Roösli M, Thuróczy G, Gajsek P, Trcek T, Bolte J, Vermeeren G, Mohler E, Juhász P, *et al*: Comparison of personal radio frequency electromagnetic field exposure in different urban areas across Europe. Environ Res 110: 658-663, 2010.
69. Tell RA and Kavet R: A survey of the urban radiofrequency (RF) environment. Radiat Prot Dosimetry 162: 499-507, 2014.

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Commentary

Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 Guidelines on Radiofrequency Radiation

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Abstract

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published 2020 updated guidelines on radiofrequency (RF) radiation in the frequency range 100 kHz to 300 GHz. Harmful effects on human health and the environment at levels below the guidelines are downplayed although evidence is steadily increasing. Only thermal (heating) effects are acknowledged and therefore form the basis for the guidelines. Despite the increasing scientific evidence of non-thermal effects, the new ICNIRP guidelines are not lower compared with the previous levels. Expert groups from the WHO, the EU Commission and Sweden are to a large extent made up of members from ICNIRP, with no representative from the many scientists who are critical of the ICNIRP standpoint.

Keywords: EU; WHO; ICNIRP; 5G; Microwave radiation

1. Introduction

Wireless technologies, such as mobile phones, cordless phones, base stations, WiFi, 2G, 3G, 4G and 5G emit radiofrequency (RF) radiation, also called microwave radiation. For a long time there has been concern among laymen and a large part of the scientific community that such radiation may be a health hazard and also have a negative effect on the environment including birds [1], insects [2] and plants [3,4].

The seminal first early warning on brain tumor risk associated with exposure to RF radiation from mobile phones was published some 20 years ago [5, 6]. In the following case-control studies by the Hardell group, in addition to mobile phones, also use of cordless phones (DECT) was assessed. These studies confirmed an increased risk for brain tumors, i.e. glioma, for both types of wireless phones [7]. Similar findings were reported for acoustic neuroma [8].

In May 2011 the International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) evaluated RF radiation in the frequency range 30 kHz–300 GHz to be a possible human carcinogen, Group 2B [9, 10].The IARC decision on mobile phones was based mainly on two sets of case-control human studies: the Hardell group studies from Sweden [11-13] and the IARC Interphone study [14, 15]. Both provided supportive evidence of increased risk for brain and head tumors, i.e. glioma and acoustic neuroma. Later published studies by the Hardell group [7, 8] and the French CERENAT (CEREbral tumors: a NATional study) study on glioma and meningioma [16] supported an increased risk for brain tumors and use of mobile and cordless phones. However, risks associated with the use of cordless phones was assessed only by the Hardell group, although cordless phones emit RF radiation of similar type as mobile phones.

The increasing scientific evidence on cancer risks from RF radiation, as well as other health effects, has had little or mostly no effect on preventive measurements. This is due to scientific disagreements and controversies. Some influential organizations are downplaying the health risks, i.e. the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the World Health Organization (WHO), the European Union (EU) and the Swedish Radiation Safety Authority (SSM), see next section. It has been discussed that by now such exposure might be classified as carcinogenic to humans, Group 1, according to the IARC classification [17-19]. However, only an IARC evaluation can make that classification.

Because of the controversies and the lobbying by influential organizations, including the telecom industry, precautionary measures are not taken and the public is not informed about health risks [20, 21]. People in general are, as a consequence, not taking preventive measures when using the handheld wireless phone, WiFi, or when exposed to RF radiation from base stations. Increasing ambient RF radiation gives higher total human exposure [22, 23] in addition to the widespread use of mobile and cordless phones.

During the last decades, the scientific evidence on other health effects than cancer has also increased. By January 2021, 255 scientists from 44 nations and 15 supporting scientists from 11 nations concluded that these effects occur well below most international and national guidelines recommended by ICNIRP, (see next section).

"Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life." [24].

The scientific evidence on the carcinogenic potential of RF radiation in laboratory studies has long been accumulating, but has mostly been ignored or dismissed by e.g., ICNIRP, the WHO, the EU and the SSM. The increased cancer risk in humans for RF radiation is clearly supported by recent animal studies [25-27] and mechanistic studies, both induction of reactive oxygen species (ROS) [28], and DNA damage [29-31]. The history on carcinogenic effects in laboratory studies started several decades ago.

Co-carcinogenic effects of RF radiation exposure and benzopyrene in mice were published already in 1982 [32]. The study showed that 2,450 MHz of RF radiation at either 50 or 150 W/m^2 promoted carcinogenesis. These levels exceed the ICNIRP guidelines, see below. The authors concluded that the resulting acceleration of development of spontaneous and chemically induced cancers indicated the carcinogenic potential of RF radiation.

Two studies published in 1990 demonstrated that 2,450 MHz continuous-wave RF radiation exerted a biphasic effect on glioma cells [33] and lymphocytes [34]. Cell proliferation was found at a specific absorption rate (SAR) of ≤50 W/kg, whereas a higher SAR suppressed DNA and RNA synthesis. These effects were reported to be non-thermal, i.e. not caused by heating.

A statistically significant increased incidence of primary malignant diseases was found in exposed animals compared with sham exposure in a study on 200 rats exposed to 2,450 MHz pulsed RF radiation for 21.5 h/day for 25 months compared with 200 controls. SAR ranged between 0.144 and 0.4 W/kg, depending on the rat's weight [35]. This was one of the first large scale studies to be conducted. Consequently the results in the U.S. National Toxicology Program (NTP) [25-26] and the Ramazzini Institute [27] studies are in line with these findings.

A study on mice carrying a lymphomagenic oncogene exposed to RF radiation showed a statistically significant increased risk for malignant lymphoma [36]. A total of 100 mice were sham-exposed and 101 were exposed for two 30-min periods per day for up to eighteen months to 900 MHz pulsed RF radiation with power densities of 2.6-13 W/m^2 (SAR 0.008-4.2 W/kg; mean, 0.13-1.4 W/kg). These results were not confirmed in the study by Utteridge et al. [37] which has been noted not to be a replication study [10, 38].

A co-carcinogenic effect was found in a study on mice exposed to a Universal Mobile Telecommunications System (UMTS) test signal from the fetal period for up to 24 months [39]. Animals were exposed to UMTS fields with intensities of 0 (sham), 4.8 and 48 W/m^2. The low-dose group was subjected to additional prenatal ethylnitrosourea (ENU) treatment. The group that was ENU-treated and UMTS-exposed at 4.8 W/m^2 exhibited an increased rate of lung tumors and an increased incidence of lung carcinomas as compared with the controls treated with ENU alone.

A tumor promoting effect was studied in another study on ENU-treated mice. The exposure levels were 0 (sham), 0.04, 0.4 and 2 W/kg SAR. The numbers of lung and liver tumors

in exposed animals were statistically significant higher compared with those in sham-exposed controls, as were the numbers of malignant lymphoma. A tumor-promoting effect of RF radiation was found at low to moderate levels (0.04 and 0.4 W/kg SAR), which were well below the exposure limits for users of mobile phones, 2 W/kg (of tissue) to the head [40].

Numerous published studies report effects or damage in terms of oxidative stress, damage to DNA, gene and protein expression, breakdown of the blood-brain barrier and damage to the brain and other organs of the body [41, 42]. There is also increasing evidence of adverse (chronic) health effects from long-term exposure. This was already reported as the "microwave syndrome" or "radiofrequency sickness" some fifty years ago. Reported health effects in scientific studies during the last decades from exposure to mobile phone towers, WiFi and mobile phones are consistent with the reported effects from RF radiation (microwaves) half a century ago [43, 44]. Furthermore, repeated studies show harmful effects from prenatal exposure, both in animal studies and in humans [45, 46].

Many countries around the world rely on guidelines for maximum allowed exposure from ICNIRP, supported and recommended by the WHO [47]. In Europe, most countries also follow the recommendations from the EU Commission that are based on ICNIRP and the EU expert group Scientific Committee on Emerging and Newly Identified Health Risk (SCENIHR). In 2020 ICNIRP published updated guidelines [48] based on the reviews and opinions from the WHO 2014 environmental health criteria public consultation report, SCENIHR 2015 [49] and the Scientific Council on Electromagnetic Fields at the Swedish Radiation Safety Authority (SSM) 2015, 2016, 2018 [50-52].

In this article we discuss how these organizations have evaluated the increasing evidence of harmful effects of RF radiation at levels below most national guidelines and limits for RF radiation exposure. The same individuals reappear in several of these organizations' expert groups, see Table 1, and there are no representatives in these groups from the many scientists that disagree with their conclusions [24]. We discuss primarily cancer risks in Appendix B of the ICNIRP updated guidelines [48].

WHO 2014 core group	**ICNIRP**	**IEEE**	**EU**	**SSM**	**EMF Scientist Appeal**	**The 5G Appeal EU**
Emilie van Deventer, project leader	X	X	-	X	-	-
Simon Mann	X	-	-	-	-	-
Maria Feychting	X	-	-	X	-	-
Gunnhild Oftedal	X	-	-	-	-	-
Eric van Rongen	X	X	X	X	-	-
Maria Rosaria Scarfi	X	-	X	X	-	-
Denis Zmirou	-	-	-	-	-	

SCENIHR 2015	ICNIRP	IEEE	WHO	SSM	EMF Scientist	5G Appeal EU
Theodoros Samaras	-	X	-	-	-	-
Norbert Leitgeb	-	-	-	-	-	-
Anssi Auvinen	X	-	-	-	-	-
Heidi Danker Hopfe	-	-	-	X	-	-
Kjell Hansson Mild	-	-	-	-	-	-
Mats Olof Mattsson	X	X	-	-	-	-
Hannu Norppa	-	-	-	-	-	-
James Rubin	-	-	X	-	-	-
Maria Rosaria Scarfi	X	-	X	X	-	-
Joachim Schüz	-	-	-	-	-	-
Zenon Sienkiewicz	X	-	-	-	-	-
Olga Zeni	-	-	X	-	-	-
SSM 2016	ICNIRP	IEEE	WHO	EU	EMF Scientist	5G Appeal EU
Anke Huss	From 2020	-	-	-	-	-
Clemens Dasenbrock	X	-	-	-	-	-
Emilie van Deventer	X	X	X	-	-	-
Eric van Rongen	X	X	X	X	-	-
Heidi Danker-Hopfe	-	-	-	X	-	-
Lars Klaeboe	-	-	-	-	-	-
Maria Rosaria Scarfi	X	-	X	X	-	-
Martin Röösli	X	-	X	-	-	-

Table 1: Many persons in expert groups at the WHO, the EU commission and in Sweden are current or former members in ICNIRP, and other expert groups, with no representative from the scientific community with opinions as expressed in EMF Scientist Appeal or 5G Appeal. For further details see ICNIRP [72,135,136,140,141,143-146], IEEE [137,145], EU [86,138,145], SSM [71,142], EMF Scientist Appeal [24], the 5G Appeal EU [139].

2. Evaluating Organizations

2.1. ICNIRP

ICNIRP is a non-governmental organization (NGO) based in Germany that has obtained major influence world-wide on health risks from RF radiation through its recommended guidelines for limiting RF radiation exposure [48, 53, 54]. These guidelines are recommended by the EU Commission, the WHO and are adopted by the majority of the countries around the globe.

ICNIRP was started in 1992 as an "independent commission". It is registered in Germany and located in Munich at the same address as the German Federal Office for Radiation Protection [55].

ICNIRP maintains the same attitude to health effects from RF-radiation as the Institute of Electrical and Electronics Engineers (IEEE) and its standards setting committee, the International Committee on Electromagnetic Safety (ICES). This committee and ICNIRP, are both standard setting organizations for frequencies between 0 Hz to 300 GHz.

ICES have many industry and military representatives among its members [56]. ICES within IEEE also sets limits for RF exposure which are in line with the ICNIRP opinion that there are only immediate thermal effects and no effects below those that cause immediate effects due to increased temperature. This perception was established in the 1950's and a decade later used when the first thermal based standard for radiofrequency radiation was set in the USA in 1966 [57]. Several members of ICNIRP are also present or former members of IEEE/ICES [58].

The biophysicist Michael Repacholi from Australia was ICNIRP's first chairman and he is since 1996 an emeritus member [59]. Experts from various countries constitute the "main commission" of ICNIRP; a chair, a vice chair and 11 other members. Further scientists are elected by this commission to the scientific expert group (SEG). New and continuing members to the commission are elected by the members of the main commission. Nominations can be submitted by the members of the Commission itself, the Executive Council of IRPA (the International Radiation Protection Association) or the IRPA Associate Societies. It seems as if no scientist that is critical to the thermal paradigm on RF radiation risks, advocated by ICNIRP, is elected as a member of the Commission.

ICNIRP published its first guidelines on RF radiation in 1998 [53]. These were updated in 2009 with no changes [54]. Only short-term thermal (heating) effects were acknowledged to form the basis for the exposure guidelines. Long-term exposure and non-thermal effects were considered not to be established, thus excluding a large number of peer-reviewed scientific studies on negative health and biological effects from RF-radiation below the ICNIRP guidelines. In 2020 ICNIRP [48] published new guidelines on health risks based on documents from: the WHO 2014 draft, the EU SCENIHR 2015 report and the Swedish SSM reports 2015, 2016 and 2018.

It should be noted that not one of these five reviews has been published after peer-review in a scientific journal. Critique from the scientific community has been expressed against several of these reviews but has been ignored. Furthermore, these older documents do not cover the most recent research. In the following comments are given to these three reviews

since the ICNIRP 2020 is based on these older evaluations with no new and further evaluation of its own [48].

2.2 The WHO Public Consultation Environmental Health Criteria Document, 2014

The WHO EMF Project, responsible for the 2014 document, was established in 1996. ICNIRP's chairman Michael Repacholi suggested in 1995 that WHO should start the EMF Project [60]. In 1995, while Repacholi still was chairman of ICNIRP, he became the head of the WHO International Electromagnetic Fields Project, and then head of the WHO EMF Project in 1996 [61], where he remained until 2006 [62]. A close colloboration between WHO and ICNIRP was initiated. In November 1998 the WHO EMF Project commenced a process aimed at the harmonization of EMF standards worldwide according to the ICNIRP guidelines [63]. Benefits to trade was given as one main argument to this specific project. The 100 times lower limits (compared to ICNIRP) in Eastern Europe were described as problematic [63].

The possibility of industry funding to the project was arranged already before the start of the project: "In 1995 WHO reached agreement consistent with these policies with Royal Adelaide Hospital (RAH), Australia to collect funds on behalf of the EMF Project. A memorandum of understanding allowed RAH to collect funds from government, professional associations and industry." [64]. This financial situation was ended in 2006 after disclosure by investigating journalists that showed that approximately half of the funding for the WHO EMF Project came from telecom industry organizations; GSM Association, Mobile Manufacturers Forum (MMF) and Forschungsgemeinschaft Funk e.V. (FGF) [65, 66].

Since 2006 the project leader of the WHO EMF project is Emilie van Deventer, an electrical engineer and longtime member of the industry organization IEEE [67]. She is the founder and former chairperson of the IEEE Joint Chapter on Electromagnetics and Radiation [68]. Her background is in "electromagnetic characterization of high-speed circuits for telecommunications applications, computationa electromagnetics (RF frequency and time domain techniques), electromagnetic compatibility, antenna modelling and design" and does not include medical training [69, 70]. She is the WHO EMF Project observer at the ICNIRP's main commission as well as a member of the SSM expert group from 2010 to 2017 [60, 71, 72].

The WHO EMF Project is in principle synonymous with ICNIRP. The same individuals that propose the ICNIRP guidelines are also acting as experts evaluating hazards from RF radiation on behalf of the WHO. This kind of double position situation is a potential conflict of interest according to the Ethical Board of the Karolinska Institute, Stockholm, Sweden 2008 (Dnr 3753-2008-609).

In 2005-2006 the personnel at the WHO EMF Project were Michael Repacholi, Emilie van Deventer, Chiyoi Ohkubo [62], Richard Saunders [73], Eric van Rongen and Lisa Ravenscroft [60]. All except Ravenscroft are current or former members of ICNIRP. In fact, at a meeting at WHO, Geneva in March 2017, Dr Maria Neira, at that time Director for Public Health and Environment at WHO, stated that ICNIRP is an Non-Governmental organization (NGO) with an official relationship with WHO that "helps us a lot in our analyses" and their members work as WHO's experts [74]. The WHO EMF Project has for many years been criticized for its collaboration with the industry; electrical, military and telecom [75].

A draft of a Monograph on health effects of electromagnetic field (EMF) exposure was released by WHO in 2014 [76]. It was open for public consultation until December 31, 2014, but has never been published as a final version and it is unclear why it was never finalized.

Out of the six experts in the WHO core group responsible for the draft, four were active members and one was a former member of ICNIRP [74], a fact that illustrates that WHO continues to be almost identical with ICNIRP, see Table 1. Many critical comments were sent to the WHO. One example is the "No confidence" letter sent by The BioInitiative Working Group in December 2016 to the WHO EMF Program Manager that concluded that the experts writing the WHO draft were to a large extent ICNIRP members.

"The BioInitiative Working Group urges the World Health Organization to make changes to the WHO RF EHC [Environmental Health Criteria] Core Group membership to more fairly reflect membership and expertise of the 2011 IARC RF Working Group. At present the WHO RF EHC Core Group is indistinguishable from ICNIRP (1, 2) undermining credibility of the process and ensuring doubt about conclusions." [77].

This letter was followed by another letter from the BioInitiative Working Group in January 2017 including suggestion of experts to replace present persons in the Core Group as well as Additional Experts [78].

A call for Protection from Non-ionizing Electromagnetic Field Exposure was made by the International EMF Scientist Appeal.

"By not taking action, the WHO is failing to fulfil its role as the preeminent international public health agency…. The WHO is calling for all nations to adopt the ICNIRP guidelines to encourage international harmonization of standards… It is our opinion that, because the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, they are insufficient to protect public health." [24].

In total forty-seven NGOs also submitted a critical statement regarding the WHO draft on December 15, 2014. The WHO draft was criticized for the absence of pluralism among the selected experts, for biased reporting of scientific results and the "promiscuity between the WHO and ICNIRP." [79].

A press release was furthermore issued on February 24, 2017 by the European coordination of organizations for an EMF exposure regulation which truly protects public health. They stated that "The Conflict of Interest Scandal is repeating itself in the WHO" [80].

In a letter of concern dated March 1, 2017 the Russian National Committee on Non-Ionizing Radiation Protection wrote to the WHO: "It has just come to our attention that the WHO RF Working group consists mainly from present and past ICNIRP members…..the private self-elected organization ICNIRP, similar as majority of the current WHO RF WG [Working Group] members, does not recognize the non-thermal RF effects,…" [81].

In 2016 at a seminar at SSM in Stockholm Emilie van Deventer said that they had received 700 comments on the draft including references to "at least 300 papers that we had missed" [82].

It is unclear how WHO reacted to the critique. The Monograph is still unfinished. Instead the WHO has called for a new systematic review of this topic.

It should be noted that WHO in 2014 issued the following statement: "THIS IS A DRAFT DOCUMENT FOR PUBLIC CONSULTATION. PLEASE DO NOT QUOTE OR CITE." Nevertheless, this WHO Monograph draft from 2014, issued by a group dominated by ICNIRP members, was used as a basis for the ICNIRP guidelines 2020.

2.3. The European Commission SCENIHR opinion 2015

In 2015 the European Commission's expert group on electromagnetic fields, SCENIHR, released its report "Opinion on potential health effects of exposure to electromagnetic fields (EMF)" [49]. It was an update of the previous SCENIHR Opinions of 19 January 2009 "Health effects of exposure to EMF" and 6 July 2009 "Research needs and methodology to address the remaining knowledge gaps on the potential health effects of EMF" [83].

SCENIHR is one of three "Independent Scientific Committees" that provide the EU Commission, and through the Commission the other European institutions, with scientific advice regarding consumer safety, public health and the environment [84]. The Committee is also supposed to "…draw the Commission's attention to the new or emerging problems which may pose an actual or potential threat".

According to the Commission decision 2008, article 15 [85], the experts "…shall undertake to act independently of any external influence" and "shall make a declaration of commitment to act in the public interest and a declaration of interests indicating either the absence or existence of any direct or indirect interest which might be considered prejudicial to their independence". However, this committee has a history of being unbalanced in terms of representation from both sides of the scientific controversy on RF radiation. No representatives from the scientific community that are of the opinion that there is increasing evidence of harmful effects have participated; at least no person has declared other opinion than the ICNIRP view.

The 2007 SCENIHR [86] working group's chair was Anders Ahlbom from Sweden, ICNIRP commission member 1996-2008 and contributing to the ICNIRP guidelines 1998. Mats-Olof Mattsson, from Sweden, was one of the groups' three experts.

The 2009 SCENIHR [87] working group was identical to the 2007 group, but Mats-Olof Mattsson, from 2013 member of ICNIRP SEG, replaced Ahlbom as chair [88]. Eric van Rongen, member of ICNIRP and ICES as well as working with the WHO EMF Project, was now among the external experts [87].

The 2015 SCENIHR working group was made up of Theodoros Samaras and Norbert Leitgeb (retired) and ten additional external experts [89]. Of the ten external experts, four are former or present members of ICNIRP main commission or SEG (Anssi Auvinen, Mats-Olof Mattsson, Maria Rosaria Scarfi and Zenon Sienkiewicz). Both Mattsson and Samaras are members of ICES/ IEEE [56].

2.3.1 Main conclusions 2015

The quotes in this section are from the SCENIHR report 2015 [49]:

"Overall, the epidemiological studies on mobile phone RF EMF exposure do not show an increased risk of brain tumours. Furthermore, they do not indicate an increased risk for other cancers of the head and neck region.…The results of cohort and incidence time trend studies do not support an increased risk for glioma while the possibility of an association with acoustic neuroma remains open."

Other effects from RF-radiation such as different health symptoms, also known as the microwave syndrome [43], neurological diseases and other health outcomes, were also dismissed with various arguments. The conclusion of no brain tumor risks from RF radiation relied upon several studies with methodological shortcomings resulting in underestimated risks, for instance the Danish cohort study [90, 91], the UK Benson study [92] as well as the Cefalo study [93], see below. Joachim Schüz, who was a member of SCENIHR 2015 working group that drafted SCENIHR 2015, was also coauthor of these three studies [94].

Increased cancer risks in other epidemiological studies [7, 8, 14, 15, 16] were downplayed by SCENIHR [49] with reference to a few brain tumor incidence trend reports, the Danish cohort and a UK cohort:

"The fact that incidence rates of glioma and meningioma do not rise in the age groups of highest mobile phone prevalence provides evidence that common use of mobile phones is unlikely to be associated with an increased risk of those brain tumours. This is confirmed by the Danish cohort study that rules out risks that would affect large segments of the population. Evidence against an association also arises from the large-scale UK million women study."

2.3.2. Methodological issues

2.3.2.1. The Danish Cohort (2001, 2006, 2011): This study, funded by Danish telecom operators, first published in 2001 [90] and last updated in 2011 [91], reported no increased risks of tumors in the central nervous system. It was based on 420,095 mobile phone private subscribers. This group's incidence of brain tumors was compared with the incidence within the rest of the Danish population (control group). However, there are severe methodological faults that led to erroneous results:

- Inclusion only of mobile phone private subscribers in Denmark between 1982 and 1995 in the exposure group.
- Exclusion of the most exposed group, consisting of 200,507 corporate users of mobile phones [90]. They were instead included in the unexposed control group if not private subscribers.
- Users with mobile phone subscription after 1995 were not included in the exposed group and were thus treated as unexposed: "individuals with a subscription in 1996 or later were classified as non-users" [91].
- Actual exposure data is unknown and no analysis by laterality (the side were the phone is hold in relation to the position of the tumor) was performed.
- All users of cordless (DECT) phones were treated as unexposed for that exposure although they were also exposed to the same kind of RF radiation as from mobile phone use. The Hardell group has shown that use of cordless phones increases risk of glioma and acoustic neuroma tumors [7, 8].

Professor Michael Kundi of the Medical University of Vienna expressed the opinion that the Danish study is "the

most severely biased study among all studies published so far" [95]. Certainly, there were severe methodological flaws. The study [90, 91, 96] was regarded by IARC in the 2011 evaluation [9, 10] to be uninformative regarding cancer risks due to serious exposure misclassification. However, it is included by SCENIHR [49], WHO [76], SSM [97] and ICNIRP as evidence of no risk [98, 99]. The statement by SSM 2013 [97] that: "The Danish cohort studies make an important contribution to the total assessment in the field." is remarkable taking the critique of the study that should have been well known to the SSM expert panel. The many shortcomings in the study were discussed in a peer-reviewed article [100] concluding that: "After reviewing the four publications on the Danish cohort study, one might rightly wonder whether this cohort was initially set up to show no increased risk."

2.3.2.2. The Benson UK study (2013): This cohort study of 791,710 women in the Million Women Study was started during 1996-2001 [92]. Data on mobile phone use was collected at one time between 1999 and 2005, without questions separating heavy users from light users. Mobile phone use was based on the answers to a few questions posed at the time when the women were recruited to the study: "About how often do you use a mobile phone?", "Never, less than once a day, or every day?" Those who did use a mobile phone were also asked "for how long?". At the end of the study in 2009, a random sample of participants were asked two more questions about their mobile phone use, but these answers were never used in the analyses. Use of cordless (DECT) phone was not assessed. Due to limitations in the study design, such as no comprehensive assessment of life-time mobile phone use, the study is uninformative and should not be used as scientific evidence of lack of cancer risk. In fact the authors concluded that:

"The main limitation of the study is that mobile phone use was reported at baseline and may have changed subsequently. Almost all women who reported daily use of mobile phones at baseline were still using a mobile phone at least once a week when asked again 8.8 years later. However, some women who reported not using a mobile phone at baseline began use subsequently; and this might dilute our estimates of relative risk towards the null" [92].

2.3.2.3. The CEFALO Study (2011): The CEFALO study on brain tumor risk for children aged 7-19 using mobile phones [93] is claimed in the SCENIHR 2015 report [49] to have found no increased risk. The children in the study were diagnosed with a brain tumor during 2004-2008. The study showed several statistically non-significant increased odds ratios (ORs). However, a press release issued by one of the authors, Maria Feychting at the Karolinska Institute in Stockholm, stated that "Reassuring results from first study on young mobile users and cancer risk…The so called CEFALO study does not show an increased brain tumor risk for young mobile users." [101]. She was vice chair of ICNIRP 2012-2020, member of ICNIRP SEG 2000-2012, and is currently SEG member since 2020. Maria Feychting was also member of the WHO core group responsible for the WHO 2014 draft. Martin Röösli, member of ICNIRP Commission since 2016, the SSM expert group since 2010, as well as member of the WHO 2014 external expert group, was also coauthor of this study (corresponding author). Martin Röösli also claimed in a press-release that the results were reassuring of no risk [102].

The study has several shortcomings and one major shortcoming is the assessment of RF exposure from cordless phones that was not included in the total RF radiation exposure. Furthermore, the scientists did not assess total

exposure from cordless phones (DECT). Instead the authors analyzed "…ever used cordless phones, and the cumulative duration and number of calls with cordless phones in the first 3 years of use." This is a scientifically invalid method to study risk associated with an agent [103]. Thereby four to sixteen years of potential exposure were disregarded in the study age group 7-19 years. It is most questionable since use of the cordless phone increases by age.

This is more startling since no such time limit was made in the questionnaire sent to the Ethical Board at Karolinska Institute, Stockholm (DNR2005/1562-3). There were four questions on use of a cordless phone (summary): 1. When did you first start using a cordless phone? 2. How often did [child] answer the cordless phone? 3. How often does [child] speak on the cordless phone? 4. When [child] talks on the cordless phone, which phrase fits the best? (about 1 min, about 3 min, about 6 min, about 10 min or more).

No doubt even with these few questions it would have been possible to assess lifetime cumulative use of the cordless phones. According to the questions there is no reason or possibility to limit to only the first three years of use. Furthermore, it is not probable that a child would only use the cordless phone for three years and then stop the habit. To note is also an e-mail (personal communication) from Martin Röösli to one of the authors (MN) on August 17, 2011 in which he regarding cordless phones stated that "We also asked about ever using it and we requested the age range that they have used the phone". No doubt with that information, which was not given in the article, it would have been possible to calculate whole lifetime cumulative exposure.
Thus, it is evident that limiting use to only first three years would bias the results towards unity, particularly as children tend to increase their phone use with increasing age, which is also shown in the CEFALO study. In spite of this, SCENIHR [49] gave the impression that all cordless phone use was included by claiming that "Use of cordless phones showed no increased OR (1.09; CI 0.81-1.45), not even in the group of highest cumulative use." This claim is most misleading. Highest group for cumulative use available in the study was only 70+ hours. Further, the authors intentionally omitted the real highest users by limiting the exposure to the first three years of use. It is remarkable that this misleading claim in the SCENIHR report was written by one of the authors of CEFALO (Joachim Schüz), who also was coauthor of the Danish cohort and the Benson study.

In a comment, the Hardell group wrote [103]:

"Further support of a true association was found in the results based on operator-recorded use [of mobile phones] for 62 cases and 101 controls, which for time since first subscription > 2.8 years yielded [odds ratio] OR 2.15 (95% [confidence interval] CI 1.07-4.29) with a statistically significant trend (P = 0.001)….. We consider that the data contain several indications of increased risk, despite low exposure, short latency period, and limitations in the study design, analyses and interpretation".

In fact, all ORs on mobile phone use were >1.0 according to Table 2 in the article [93]. For both ipsilateral and contralateral mobile phone use statistically significant increased risks were obtained for highest group of cumulative numbers of calls; OR = 2.91, 95% CI = 1.09-7.76 and OR = 4.82, 95 % CI = 1.21-19.24, respectively. For central or unknown location a statistically significant decreased risk was found based on low numbers. It should be noted that there are missing numbers of cases and controls in different strata in e.g. Table 5 in the article [93], no

explanation is given as we have discussed [103]. The anatomical distribution for brain tumors in children differs from adults [104]. Thus, there are more central and brain stem tumors, facts not considered by Aydin et al. [93] In children the distribution of RF radiation differs from adults with larger part of the brain more exposed due to e.g. smaller head and thinner bone [105]. Thus, the laterality analysis should be interpreted with caution.

2.3.3. Critical comments on SCENIHR [49]

There were in total 186 critical comments submitted to EU by different persons and organizations [106]. Less than 30 percent of these comments were taken into account, a few yielding minor clarifications in the text but without changes of the SCENIHR major conclusions. The BioInitiative Group was among many others that expressed critical comments to the SCENIHR: "In summary, the preliminary SCENIHR conclusion that glioma risk is weaker now is not scientifically justified. The only way that conclusion could be reached by SCENIHR is to exclude critical studies that present evidence to the contrary, i.e. studies that report the risk of glioma (and acoustic neuroma) is stronger now than in 2009" [107].

2.4. The reports from the Swedish Radiation Safety Authority (SSM) 2015, 2016 and 2018 [50-52]

The expert group on electromagnetic fields at SSM was created in June 2002. Between 2003 and 2010 it was called the "Independent Expert Group on Electromagnetic Fields". During that period Anders Ahlbom, member of ICNIRP main commission 1996-2008, and SCENIHR member 2007-2009, was the head of the expert group and his colleague Maria Feychting, longtime member of ICNIRP and member of the WHO 2014 core group, was the group's secretary. From 2013 and until today, the expert group was renamed as the "Scientific Council on Electromagnetic Fields".

Between 2003 and 2019 the SSM group has published thirteen reports in English on its webpage [71]. All reports since 2003 have consistently refuted or ignored evidence of health risks from non-thermal exposure in line with the views by ICNIRP, the WHO and the SCENIHR.

Since the first report in 2003 until today around half of the group's members have also been present or previous ICNIRP members. In consequence the conclusions have generally been that there are no health risks below the limits recommended by ICNIRP. No scientist critical to the ICNIRP view has ever been part of this group. Here are some examples of conclusions from the SSM reports (2015 – 2018) that are included as basis for the present ICNIRP guidelines.

2.4.1. SSM 2015

"In terms of exposure from mobile phone base stations or other RF-EMF transmitters, no new evidence has become available indicating a causal link between exposure and symptoms or Electromagnetic Hypersensitivity (EHS)…. New studies on mobile phone use and tumours in the brain using retrospective exposure assessment are in line with previous research, which means that increased risks were observed in some of the most extreme exposure categories. However, it is not clear to what extent these risk estimates are affected by recall bias… New studies on associations between sperm quality and mobile phone use are of low quality and cannot be used to evaluate a potential association with RF-EMF exposure" [50].

The 2015 SSM report raised the issue that recall bias might have affected brain cancer risk estimates. However the study by Momoli et al. [108] showed that recall bias did not affect the risk of glioma in the Canadian component of the Interphone study [14]. In addition, it should be noted that the 2020 ICNIRP guidelines [48] refer to recall bias in the case-control studies of the Interphone study but do not mention the analysis by Momoli et al. Also, as displayed below, recall bias cannot explain the results in the Hardell group studies.

2.4.2. SSM 2016

"Most research in the past decade has been done into a possible relation between mobile phone use and brain tumours. Epidemiological studies have provided weak indications for an association between frequent and long-term use of a mobile phone and gliomas (malign tumours of the brain tissue) and vestibular schwannomas (also called acoustic neuromas, a benign tumour of the vestibulocochlear nerve that connects the ear to the inner brain). The evidence is not very clear and unequivocal, however. Altogether it provides no or at most little indications for a risk for up to approximately 15 years of mobile phone use" [51].

In a press release, at the time of the publication of the 2016 report, this Swedish authority claimed that the suspicion that mobile phones or wireless networks could be a health risk to humans or to the environment had become weaker during the past 13 years since the first of the group's report [109]. This contrasted with the increasing scientific evidence of the opposite [24]. In Table 2 results for meta-analysis of highest cumulative use in hours of mobile phone use in case-control studies is given and the results for acoustic neuroma are given in Table 3. Clearly these results from the different studies available in 2016 are in contrast to the statement by SSM.

	All			Ipsilateral		
	Ca/Co	OR	95 % CI	Ca/Co	OR	95 % CI
Interphone 2010 [14]						
Cumulative use ≥1,640 h	210/154	1.40	1.03 – 1.89	100/62	1.96	1.22 – 3.16
Coureau et al 2014 [16]						
Cumulative use ≥896 h	24/22	2.89	1.41 – 5.93	9/7	2.11	0.73 – 6.08
Hardell, Carlberg 2015 [7]						
Cumulative use ≥1,640 h	211/301	2.13	1.61 – 2.82	138/133	3.11	2.18 – 4.44
Meta-analysis						
Cumulative use ≥1,640 h*	445/477	1.90	1.31 – 2.76	247/202	2.54	1.83 – 3.52

*≥896 h used for Coureau et al.

Table 2: Numbers of exposed cases (Ca) and controls (Co) and odds ratio (OR) with 95 % confidence interval (CI) for glioma in case-control studies in the highest category of cumulative use in hours for mobile phone use, for further details see [42].

	All			Ipsilateral		
	Ca/Co	OR	95 % CI	Ca/Co	OR	95 % CI
Interphone 2010 [15]						
Cumulative use ≥1,640 h	77/107	1.32	0.88 – 1.97	47/46	2.33	1.23 – 4.40
Hardell et al. 2013 [8]						
Cumulative use ≥1,640 h	27/301	2.40	1.39 – 4.16	19/133	3.18	1.65 – 6.12
Meta-analysis						
Cumulative use ≥1,640 h	104/408	1.73	0.96 – 3.09	66/179	2.71	1.72 – 4.28

Table 3: Numbers of exposed cases (Ca) and controls (Co) and odds ratio (OR) with 95 % confidence interval (CI) for acoustic neuroma in case-control studies in the highest category of cumulative use in hours for mobile phone use, for further details see [42].

2.4.3. SSM 2018

This annual report was the twelfth in this series and covered studies published from October 2015 up to and including March 2017. Oxidative stress effects reported below ICNIRP guidelines was discussed but the relevance for human "direct health effects" was claimed to be "unclear". The conclusion was that "No new health risks have been identified." [52].

It is clear that the SSM expert group has not made a sound and objective scientific evaluation of health risks associated with RF radiation exposure. We note that SSM in April 2020 published a new report from the SSM expert group which concluded: "The results of the research review give no reason to change any reference levels [ICNIRP's] or recommendations in the field". Of the ten members in the scientific group five were present or past members of ICNIRP [110].

3. ICNIRP 2020 Evaluation

Eric van Rongen, chair of the ICNIRP Commission 2016-2020, claimed in a press release regarding the new ICNIRP guidelines 2020 that the 1998 version was "conservative in most cases" and "still provide adequate protection for current technologies". He also argued that: "The most important thing for people to remember is that 5G technologies will not be able to cause harm when these new guidelines are adhered to" [111].

Many other incorrect statements were made in the recent ICNIRP paper [48] contrary to an objective evaluation of the available scientific evidence. In the following the section on cancer is reviewed. That section claims:

"There is a large body of literature concerning cellular and molecular processes that are of particular relevance to cancer. Although there are reports of effects of radiofrequency EMFs on a number of these endpoints, there is no substantiated evidence of health-relevant effects (Vijayalaxmi and Prihoda 2019)".

Already in the first paragraph in the report evidence on biological effects from RF radiation is dismissed without

scientific foundation. This continues regarding cancer risks. Mostly not even references are given to the discussed studies, or with erroneous references. The uninformed reader may take the statements at face value and not understand that they are, in fact, not correct.

3.1. Animal studies

Regarding animal studies yielding a promoting effect from RF radiation [39, 40] ICNIRP states that "…interpretation of these results and their applicability to human health [is] difficult, and, therefore, there is a need for further research to better understand these results". In the next paragraph the recent animal NTP studies [25, 26] and Ramazzini Institute results [27] are disregarded, stating that "…no consistency was seen across these two studies" and "within the context of other animal and human carcinogenicity research (HCN 2014, 2016), their findings do not provide evidence that radiofrequency EMFs are carcinogenic".

On the contrary, as discussed above, animal studies indicate that RF radiation may both promote and initiate cancer. In a review, the Hardell group concluded that:

"There is clear evidence that RF radiation causes cancer/tumor at multiple sites, primarily in the brain (glioma) and head (acoustic neuroma). There is also evidence of an increased risk of developing other tumor types. The results are similar in both the NTP studies (19, 20) and the Ramazzini Institute findings (34). Based on the IARC preamble to the monographs, RF radiation should be classified as Group 1: The agent is carcinogenic to humans" [19].

In a note published by ICNIRP in 2018 it was claimed that the histopathological evaluation in the NTP study was not blinded as to exposure status [112]. This was rebutted by one of those responsible for the NTP study [113]. However, it seems to have had no impact on the ICNIRP evaluation [48]. ICNIRP claims that the animal studies "do not provide evidence that radiofrequency EMFs are carcinogenic," while an independent peer review of the NTP data concluded that this study provided 'clear evidence of carcinogenic activity', see Table 4 in a comment on the NTP study [19]. A comprehensive discussion of the ICNIRP evaluation was published by Melnick as a correspondence with "focuses on ICNIRP's false claims about the methodology, interpretation, and relevance of the National Toxicology Program studies on cell phone radiation" [114]. This included misleading statements by ICNIRP on e.g., the pathology review procedure, rat survival rates, multiple comparisons, but also excluding discussion of other end points such as DNA strand breaks in the brain cells, and increased incidence of cardiomyopathy. Melnick concluded that "ICNIRP should promote precautionary advice for the general public rather than trying to justify their decision to dismiss findings of adverse health effects caused by RF-EMFs and thereby retain their 20+ y-old exposure guidelines that are based on protection against thermal effects from acute exposure". In the response, ICNIRP seemed not to make a serious scientific rebuttal of the statements by Melnick "except for one minor issue", i.e., the description of the NTP study as "whole of life" rather than "most of life" [115].

3.2. Brain tumor risks from mobile phone use

Regarding epidemiological studies first a study by Martin Röösli et al. [116] is cited by ICNIRP. Röösli is, as mentioned earlier, both member of the ICNIRP commission, the WHO 2014 external experts and the SSM experts. The

article has several limitations. The results on use of cordless phones as risk factor for brain tumors are not discussed. Regarding glioma risk all results on cumulative use of wireless phones were not discussed and ipsilateral or contralateral use in relation to tumor localization in the brain were omitted from the meta-analyses. These results are important and have shown a consistent pattern of increased risk.

There were several other limitations in the article [116], such as including the Danish cohort study [90] in the meta-analyses. As discussed above, the study has severe errors of exposure classification and was therefore evaluated to be uninformative regarding carcinogenesis in the IARC 2011 evaluation [10] including Martin Röösli as one participating member.

Regarding the thirteen country Interphone study on glioma [14] and acoustic neuroma [15] ICNIRP concludes that the studies do "…not provide evidence of an increased risk", which is not correct [48]. On the contrary regarding glioma cumulative call-time of mobile phones ≥1,640 h resulted in OR = 1.40, 95 % CI = 1.03–1.89, increasing to OR = 1.87, 95% CI = 1.09–3.22 for glioma in the temporal lobe, the most exposed part of the brain. Ipsilateral mobile phone use yielded OR = 1.96, 95% CI = 1.22–3.16 for all glioma, cumulative use ≥1,640 h. Furthermore, a statistically significant increased risk for glioma was seen in the group 2–4 years for regular use, with 1–1.9 years use as reference category, OR = 1.68, 95% CI = 1.16–2.41, see Appendix 2 [14]. The highest OR was seen in the 10+ years category for regular use, OR = 2.18, 95% CI = 1.43–3.31.

In parts of Interphone, RF radiation dose was estimated as total cumulative specific energy (TCSE; J/kg) absorbed at the tumor's estimated center [117]. The risk increased with increasing TCSE 7+ years before diagnosis, OR = 1.91, 95% CI = 1.05 - 3.47 (p-trend = 0.01) in the highest quintile. Comparing with glioma in other parts of the brain, increased ORs were found for tumors in the most exposed part of the brain in those with 10+ years of mobile phone use, OR = 2.80, 95% CI = 1.13 - 6.94.

Similar results were reported by Grell et al. [118]:

"we found a statistically significant association between the intracranial distribution of gliomas and the self-reported location of the phone…Taken together, our results suggest that ever using a mobile phone regularly is associated with glioma localization in the sense that more gliomas occurred closer to the ear on the side of the head where the mobile phone was reported to have been used the most".

Canadian data from the Interphone Study were evaluated separately [108]. For glioma, when comparing those in the highest quartile of use (>558 lifetime hours) to those who were no regular users, the OR was 2.0, 95% CI = 1.2 - 3.4. After adjustment for selection and recall biases somewhat higher OR was found, 2.2, 95 % CI = 95% CI = 1.3 - 4.1, indicating that such bias did not cause the results.

Also for acoustic neuroma, the Interphone study yielded statistically significant increased risk. Thus, ipsilateral cumulative mobile phone use > 1,640 hours gave OR = 2.33, 95 % CI = 1.23-4.40 [15].

Regarding the Hardell group studies ICNIRP [48] writes: "…a set of case-control studies from the Hardell group in Sweden report significantly increased risks of both acoustic neuroma and malignant brain tumors already after less than

five years since the start of mobile phone use, and at quite low levels of cumulative call time." No reference is given to the studies, indicating they have not been seriously evaluated. ICNIRP's writing is not consistent with what the studies reported. In the shortest latency time >1- 5 years period overall mobile phone use yielded for glioma OR = 1.2, 95 % CI = 0.98-1.5 increasing to OR = 2.3, 95 % CI = 1.6-3.4 in the latency period > 20 years (p trend = 0.01). Similar results were found for cordless phones although based on low numbers in the longest latency period. The lowest quartile of cumulative wireless phone use gave OR = 1.2, 95 % CI = 0.9-1.4 increasing to OR = 2.0, 95 % CI = 1.6-2.6 in the fourth quartile (p trend < 0.0001) [7]. Thus, as the published results show no statistically significant increased risk was found in total in the shortest latency group contrary to what ICNIRP stated, although somewhat higher risk was found for ipsilateral use.

For acoustic neuroma, the Hardell group reported use of wireless phone (mobile and/or cordless phone) with latency time >1-5 years in total OR = 1.2, 95 % CI = 0.8-1.6 increasing to OR = 4.4, 95 % CI = 2.2-9.0 (p trend = 0.003) for latency > 20 years [8]. The risk increased with cumulative use of wireless phone; first quartile OR = 1.2, 95 % CI = 0.8-1.7 and fourth quartile OR = 2.2, 95 % CI =1.5 – 3.4, p trend = 0.03. Thus, the results were similar as for glioma. These results were dismissed by ICNIRP.

In addition, ICNIRP claims that the Hardell group results may be caused by recall bias. For meningioma no statistically significant increased risk was found in the same study. Using meningioma cases as "controls" (the comparison entity) still yielded statistically significant increased risk for glioma and mobile phone use; ipsilateral use OR = 1.4, 95 % CI = 1.1-1.8, contralateral OR = 1.0, 94 % CI = 0.7-1.4 and for cordless phone use ipsilateral OR = 1.4, 95 % CI = 1.1-1.9, contralateral OR = 1.1, 95 % CI = 0.8-1.6 [7]. Similar results were found for acoustic neuroma using meningioma cases as the comparison group [8]. These results clearly show that the increased risks for glioma and acoustic neuroma were not caused by recall bias.

The CERENAT study by Coureau et al. [16] was omitted by ICNIRP. The study strengthened the evidence of increased risk for glioma associated with mobile phone use. Life-long cumulative duration ≥896 h gave OR=2.89, 95% CI 1.41 - 5.93 for glioma. Number of calls ≥18,360 gave OR=2.10, 95% CI 1.03 - 4.31. Higher risks were obtained for the highest exposed area, (temporal tumor), as well as occupational and urban mobile phone use. The Danish cohort study on mobile phone use with serious methodological limitations was however discussed in ICNIRP 2020, adding to the no-risk paradigm.

Furthermore, ICNIRP claims that "Studies of other types of tumors have also not provided evidence of an increased tumor risk in relation to mobile phone use. Only one study is available on mobile phone use in children and brain tumor risk. No increased risk of brain tumors was observed." This is yet another incorrect statement [93]. The CEFALO study, as discussed previously, showed increased risks in spite of methodological shortcomings.

3.3. Thyroid cancer

In 2016 the Hardell group published increasing incidence of thyroid cancer in the Nordic countries especially during the last two decades [119]. The thyroid gland is a target organ for RF radiation from smartphones, which was discussed as an etiologic factor. A case-control study on mobile phone use suggested an increased risk for thyroid cancer associated

with long-term use [120]. The same material was used to study genotype-environment interaction between single nucleotide polymorphism (SNPs) and mobile phone use [121]. The study showed that mobile phone use increased the risk for thyroid cancer when genetic variants were present within some genes. It was concluded that pathways related to DNA repair may be involved in the increased risk. The study was published online 6 December 2019, that is well before the ICNIRP 2020 publication. ICNIRP omitted completely to discuss the increasing incidence of thyroid cancer and the association with mobile phone use. The statement by ICNIRP of no risk for other tumor types is not correct. The increasing incidence of thyroid cancer in the Nordic countries is confirmed in our recent publication [122].

3.4. Brain tumor incidence

Another example by ICNIRP that misguides the reader is the statement "trends in brain cancer incidence rates from a large number of countries or regions…have not found any increase in the incidence since mobile phones were introduced." This is not correct. Philips et al. [123] reported a statistically significant increasing incidence of glioblastoma multiforme in UK during 1995-2015. Similar results were published from USA [124]. In Sweden, the Hardell group published increasing rates of brain tumors based on the Swedish National Inpatient Register and the Causes of Death Register [125]. The same group also published an increasing incidence of brain tumors in the Swedish Cancer Register [126]. ICNIRP seems to have overlooked facts that would contradict their claim that the results showing brain tumor risk are "not consistent with trends in brain cancer trends".

3.5. Transmitters, base stations and cancer

According to ICNIRP, studies on exposure to environmental RF radiation "have not provided evidence of an increased cancer risk either in children or in adults". No references to that statement are given. In a review by Khurana et al. [127] two of three studies reported increased incidence of cancer at a distance < 350 m [128] or < 400 m [129] from a base station. Dode et al. [130] reported increased cancer mortality in an area within 500 m from a base station in Belo Horizonte, Brazil. A study from Taiwan found a statistically significant increased risk of all neoplasms in children with higher-than-median RF radiation exposure to mobile phone base stations [131]. A cause-effect relationship between RF radiation in occupational and military settings, mainly communication equipment and radar, and hematolymphatic malignancies was reported by Peleg et al. [18]. They concluded that available research "make a coherent case for a cause-effect relationship and classifying RFR exposure as a human carcinogen (IARC group 1)". DNA damage and oxidative stress were associated with living in a vicinity of base stations in a study from India which is also of interest in this context [132]. It would have been pertinent for ICNIRP to review the literature.

There are also studies showing increased risk for childhood leukemia from RF transmitters. One of the authors of the ICNIRP 2020 guidelines, commission member Martin Röösli, stated at a seminar organized by SSM in 2016 that until 2003 all but one results on transmitters had shown increased risk for childhood leukemia: "it was quite impressive that [for] almost all the studies for different type of leukemias basically they reported significantly increased risk. So it was not a random sample of risk estimates. All but one risk estimates were above 1" [133]. This is in obvious contrast to the claim in ICNIRP 2020.

4. Conflicts of Interests

The conclusion by ICNIRP is not objective and lacks scientific credibility according to a research report that investigated ICNIRP commissioned by two European Parliament Members published in June 2020 [58]. Industry funding has been found to influence the results on research on RF radiation and health effects. However, ICNIRP does not take this into account although ICNIRP members themselves have reported that industry-funded scientific research seems to influence the results by reporting less findings showing adverse health effects of EMF compared to independent research [134].

The composition of ICNIRP is very one-sided according to the EU report [58]:

"ICNIRP has been, and is still, dominated by physical scientists… ..As one can read in the 45 portraits of the members of the ICNIRP commission and of the Scientific Expert Group (SEG), they all share the same position on the safety issues: non-ionising radiation poses no health threats and the only effects it has are thermal".

The EU report [58] pointed to the fact that ICNIRP's chairman Eric van Rongen, in 2016 invited the industry organization ICES to comment and thereby influence the upcoming ICNIRP 2020 guidelines [48]. The report concludes that it is:

"clear from ICES minutes that ICNIRP worked very closely with IEEE/ICES on the creation of the new RF safety guidelines that were published in March 2020. And this implies that large telecom-companies such as Motorola and others, as well as US military, had a direct influence on the ICNIRP guidelines, which are still the basis for EU-policies in this domain".

The EU report [58] also highlights several ICNIRP experts' financial ties to the industry. As described in that report, it should be noted that for example the European Food and Safety Authority (EFSA) considers conflict of interests as "any situation where an individual has an interest that may compromise or be reasonably perceived to compromise his or her capacity to act independently and in the public interest in relation to the subject of the work performed at EFSA". Apart from the telecom industry funding of the WHO EMF project, while it was led by ICNIRP's first chairman Michael Repacholi [74] (1996-2006), the EU report documents that "the majority of ICNIRP-scientists did perform research partly funded by industry".

As cited in the EU Report [58], Professor David Carpenter, Environmental Health Sciences at the University of Albany, USA, considers the "perversion that can result due to conflicts of interests" to be "one of the greatest problems in scientific discovery…When funding for scientists comes from an organization or corporation with desires to present a clean bill of health to the public, there is strong motivation to give the funder what they want, if only to continue receipt of funding."

To act both on behalf of ICNIRP to set guidelines supposed to protect against harmful health effects of RF radiation, and at the same time evaluate the health risks representing other organizations, may constitute a conflict of interest, i.e. according to the opinion of the Ethical board of the Karolinska Institute, Stockholm, Sweden. Many of the ICNIRP commission and SEG members act on behalf of several organizations thereby evaluating their own ICNIRP

guidelines validity on behalf of other organizations. This kind of conflict of interest adds to those in terms of telecom funding and connection to ICES, see Table 1 [24, 71, 72, 86, 135-146].

5. Guidelines for RF Radiation Exposure

The new ICNIRP 2020 guidelines were developed with 5G in mind, especially considering frequencies that are higher to the presently used mobile phone communications. ICNIRP recognizes citizens' concerns regarding safety of 5G, however the new guidelines show no reduction of safety limits. The premise for safeguarding human health has remained the same – to avoid thermal effects. ICNIRP's 2020 guidelines [48] are based, like in 1998 [53], only on thermal effects, i.e. the RF radiation from mobile communications devices can be high as long as it causes no tissue heating. This may be problematic for mm waves as the radiation can cause heating effects on the surface of the skin. A systematic review on 5G safety limits based on thermal dose concluded that: "The results also show that the peak-to-average ratio of 1,000 tolerated by the International Council on Non-Ionizing Radiation Protection guidelines may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines" [147]. Furthermore, some organs are more susceptible to RF radiation damage so local dosimetry is more appropriate for characterizing organ-specific risk [10].

Currently the mobile communications reside on frequencies up to 2,600 MHz band, with some minor exceptions beyond that frequency. 5G frequencies are expected to be using bands all over the higher radiofrequency spectrum, including previous 2G and 3G bands. Main 5G frequencies, however, will be at 3.4 to 4.2 GHz. Later, millimeter waves will also be deployed to provide 5G services, these are expected to reside at frequencies of 24-28 and 39 GHz. Millimeter wave base stations are expected to cover mainly high public density areas, such as city squares, transportation hubs, business and shopping centers and other public areas.

With the new reference levels [48] ICNIRP differentiates whole body exposure and exposure to small areas of the body introducing two separate classes of reference levels. ICNIRP grants higher exposure when assessing compliance by reference values; basic restrictions however have remained the same. ICNIRP claims, that this is because of better scientific understanding with respect to the 1998 guidelines. In Table 4 we compare ICNIRP reference levels between the 1998 [53] and the 2020 guidelines [48]. The calculated values are for arbitrary frequencies per each designated band; mobile communications frequency bands differ from region to region. Table 4 characterizes bands used in most European countries.

In their 1998 guidelines, at frequencies over 10 MHz, the reference levels are based on electric and magnetic field strengths for the whole-body SAR basic restrictions, derived by computer simulations and experimental data [53]. The 2020 guidelines introduce reference levels for local exposure [48]. In 2020 whole body reference levels, the averaging time has been increased from 6 min to 30 min, which ICNIRP argues is to better match the time taken for body core temperature to rise [48].

Frequency (MHz)	Example usage	ICNIPR 1998 [53] reference level, 6 min	ICNIPR 2020 [48] reference levels, whole body exposure, 30 min	ICNIPR 2020 [48] reference levels, local exposure, 6 min
800	LTE	4	4	18.2
900	GSM, UMTS	4.5	4.5	20.1
1,800	GSM	9	9	36.6
1,900	DECT	9.5	9.5	38.3
2,100	UMTS	10	10	40
2,400	WiFi 2G	10	10	40
2,600	LTE	10	10	40
3,500	5G, WiMax	10	10	40
5,500	WiFi 5G	10	10	40
26,000	5G	10	10	30.9

Table 4: Comparison of ICNIRP 1998 and 2020 reference levels across common mobile communication frequencies, time averaged (W/m²).

The ICNIRP 2020 [48] reference levels are based on time averaged exposure over 6 min or 30 min, see Table 4. However, supra-additive effects between pulses from different RF radiation sources may give much higher peak radiation from short time pulses than the power density average. Using time averaging in reference values, as in the ICNIRP guidelines, definitely underestimates the risk.

Year	Power Density Limit ($\mu W/m^2$)	Name	Description
1966	100,000,000	ANSI C95.1 [149]	Based on thermal effects and 0.1-hour (or 6 minute) averaging time.
1991	10,000,000	ANSI/IEEE C95.1-1991 [150]	Based on thermal effects.
1996	10,000,000 5,800,000	FCC [151]	USA: 5,800,000 averaged over a 30-minute period (869 MHz), previously recommended in 1986 by NCRP; 10,000,000 for PCS frequencies (1.85-1.99 GHz).
1998	10,000,000 9,000,000 4,500,000	ICNIRP [53]	10,000,000 for 2–300 GHz 9,000,000 for 1800 MHz and 4,500,000 for 900 MHz averaged over 6 min.

2001	1,000	Salzburg Resolution [152]	
2001	100	EU Parliament STOA 2001 [153]	
2002	1	New Salzburg Precautionary Exposure Limit Indoor [154]	Maximum indoor exposure recommendation for GSM base stations proposed by the Public Health Office of the Government of Salzburg.
2009	See 1998	ICNIRP [54]	Confirmation of ICNIRP 1998.
2012	3-6	Bioinitiative 2012 Recommendation [44]	
2016	0,1-100	Europa EM EMF Guidelines [41]	For frequencies between GSM 900 to WiFi 5,6 GHz depending on sensitivity, night time or daytime exposure.
2020	400 MHz: 10,000,000 800 MHz: 18,200,000 1,800 MHz: 36,600,000 2,000 MHz: 40,000,000 6 GHz: 40,000,000 60 GHz: 26,600,000 300 GHz: 20,000,000	ICNIRP 2020 [48]	General public, local exposure, averaged over 6 min. For whole body exposure see Table 4.

Table 5: Guidelines by different organizations for radiofrequency radiation in $\mu W/m^2$.

In a recent review, average exposure limit was suggested to be considerably lower, 0.1 V/m; 26.5 $\mu W/m^2$ [148]. This guideline is comparable with the BioInitative Report from 2012 [44] with a scientific benchmark of 30-60 $\mu W/m^2$, and for chronic exposure to sensitive persons and children 3-6 $\mu W/m^2$. The EUROPAEM EMF guidelines published daytime RF radiation exposure to be 10-1,000 $\mu W/m^2$, nighttime 1-100 $\mu W/m^2$, and for sensitive persons 0.1-10 $\mu W/m^2$ [41]. All these guidelines by independent research groups without conflicts of interest are very much lower than the ICNIRP guidelines. These lower guidelines are aimed at preventing health effects and hazards, Table 5 [41, 44, 48, 53, 54, 149-154].

6. Discussion

As a general rule ICNIRP, WHO, SCENIHR and SSM have for many years dismissed available studies showing harmful effects from non-thermal RF exposure and have based their conclusions mainly on studies showing no effects. Results showing risk are criticized, disregarded or not even cited while studies showing no risks are accepted as evidence of no risk in spite of severe methodological problems. Many statements by these agencies are misleading and not correct. They are easily rebutted by reading the relevant publications.

In fact, these activities are not in line with prevention of health hazards. Previously the precautionary principle in

cancer prevention was discussed exemplified by e.g. asbestos, certain pesticides and RF radiation [155, 156]. It was noted that cancer prevention is usually very cost-effective. In a recent article we gave historical examples on lost opportunities based on early warnings with RF radiation as one more recent example [157].

In 2018 there was a call to dismantle ICNIRP and replace the organization with independent scientists [158]: "ICNIRP's mandate to issue exposure guidelines needs to be seriously questioned. ICNIRP is not independent of industry ties as it claims… Its opinions are not objective, not representative of the body of scientific evidence, but are biased in favor of industry."

The EU report investigating ICNIRP concluded in June 2020 that "for really independent scientific advice we cannot rely on ICNIRP." [58].

Our review reveals, with focus on cancer risks, an almost systematic downplaying of health risks from RF radiation by a group of persons that dominate the expert evaluations, see Table 1. Many of them reappear in several of these organizations' expert groups and also in other groups not described in this paper. One striking example is ICNIRP's chairman Eric van Rongen who also appeared in the WHO core group of six experts 2014 as well as one of SSM's eight experts and SCENIHR's nine experts in 2009 as well as secretary of the Health Council of the Netherlands expert group [159]. Another example is Maria Feychting, ICNIRP member since 2000, who was one of WHO's six core group experts behind the WHO 2014 draft, secretary of the SSM expert group evaluations 2003-2010, on the AGNIR (UK) expert group from 2009 and a Norwegian expert group in 2012 [160]. A third example is Martin Röösli, member of ICNIRP, the WHO external experts for the WHO draft 2014, the SSM expert group since 2010 and a Swiss expert group [99].

Our review also notes that there is a clear relationship between ICNIRP and ICES, which is dominated by industry representatives. Eric van Rongen, has been a member of ICES since 2000, ICNIRP member since 2001 and elected chair of ICNIRP in 2016, vice chair since 2020. From ICES annual report 2016 it was reported that:

"The new ICNIRP Chairman and one of the new members of the 14 member committee are also ICES members and ICNIRP is now willing to discuss harmonization of the exposure limits found in IEEE Stds C95.1TM-2005 and C95.6TM-2002 and the ICNIRP Guidelines. At a June 2016 Mobile Manufacturers Forum Workshop in Ghent, Belgium, the new ICNIRP Chairman, Dr. van Rongen, presented "ICNIRP's proposed HF guidelines" and extended an invitation to ICES to comment on the proposed guidelines. TC95 formed a 19 member task group to draft a document to comment on the ICNIRP proposed guidelines. The document was circulated to the TC95 membership for comment and a final document submitted to ICNIRP in time for discussion at the ICNIRP September meeting." [56].

The TC 95 committee's objective is "Development of standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 GHz". These standards are based on the same scientifically invalid approach as the ICNIRP guidelines. In this TC95 committee, in which many members come from the military or the telecom industry, or are consultants to them, ICNIRP's chairman Eric van Rongen, Michael Repacholi, ICNIRP's first chairman and leader of the WHO EMF project 1996-2006, Theodoros Samaras

(chairman SCENIHR) and Mats-Olof Mattson, Chairman SCENIHR 2009 and member of ICNIRP, are also found.

All these expert groups dominated by ICNIRP consequently reach similar conclusions that there are no health effects below ICNIRP guidelines. No representative from the scientific community that is of the opinion that there is increasing evidence of health risks below the ICNIRP guidelines, e.g. as expressed in the EMF Scientists Appeal [24], has ever been a member of the expert groups at the WHO, the EU, the SSM or ICNIRP. Certainly scientists who do not discount evidence of health effects from exposure to RF radiation that are observed at exposures below guideline levels should be represented.

The resistance to the abundant and growing scientific evidence on health risks is remarkable and not within the realm of public health. This behavior, due to the ICNIRP influence and dominant role in several other expert groups, is detrimental to human health and leads to suffering and even premature death that could have been prevented. Furthermore, it must be stressed that in general there is lack of persons with medical education and competence not only in the evaluating bodies but also in several research teams producing questionable results as exemplified in this text.

ICNIRP is not representative of the scientific community since it does not include representatives from scientists that agree there is evidence of harmful effects at levels well below ICNIRPs limits although these scientists are in majority in the scientific community [24].

7. Conclusion

ICNIRP's conclusion [48] on cancer risks is: "In summary, no effects of radiofrequency EMFs on the induction or development of cancer have been substantiated." This conclusion is not correct and is contradicted by scientific evidence. Abundant and convincing evidence of increased cancer risks and other negative health effects are today available. The ICNIRP 2020 guidelines allow exposure at levels known to be harmful. In the interest of public health, the ICNIRP 2020 guidelines should be immediately replaced by truly protective guidelines produced by independent scientists.

References

1. Balmori A, Hallberg Ö. The urban decline of the house sparrow (Passer domesticus): A possible link with electromagnetic radiation. Electromagnetic Biology and Medicine 26 (2007): 141-151.
2. Sharma VP, Kumar NR. Changes in honeybee behaviour and biology under the influence of cellphone radiations. Current Science 98 (2010): 1376-1378.
3. Sharma VP, Singh HP, Batish DR, et al. Cell phone radiations affect early growth of Vigna radiata (mung bean) through biochemical alterations. Z Naturforsch, C, J Biosci 65 (2010): 66-72.
4. Waldmann-Selsam C, Balmori-de la Puente A, Breunig H, et al. Radiofrequency radiation injures trees around mobile phone base stations. Science Total Environ 572 (2016): 554-569.
5. Hardell L, Näsman A, Påhlson A, et al. Use of cellular telephones and the risk for brain tumours: A case-control study. Int J Oncol 15 (1999): 113-116.

6. Hardell L, Hansson Mild K, Påhlson A, et al. Ionizing radiation, cellular telephones and the risk for brain tumours. Eur J Cancer Prev 10 (2001): 523-529.
7. Hardell L, Carlberg M. Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22 (2015): 1-13.
8. Hardell L, Carlberg M, Söderqvist F, et al. Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43 (2013): 1036-1044.
9. Baan R, Grosse Y, Lauby-Secretan B, et al. Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12 (2011): 624-626.
10. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. IARC Monogr Eval Carcinog Risks Hum 102 (2013): 1-460.
11. Hardell L, Carlberg M, Hansson Mild K. Pooled analysis of two case-control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997-2003. Int Arch Occup Environ Health 79 (2006): 630-639.
12. Hardell L, Carlberg M, Hansson Mild K. Pooled analysis of two case-control studies on the use of cellular and cordless telephones and the risk of benign brain tumours diagnosed during 1997-2003. Int J Oncol 28 (2006): 509-518.
13. Hardell L, Carlberg M, Hansson Mild K. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 38 (2011): 1465-1474.
14. INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Int J Epidemiol 39 (2010): 675-694.
15. INTERPHONE Study Group. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Cancer Epidemiol 35 (2011): 453-464.
16. Coureau G, Bouvier G, Lebailly P, et al. Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71 (2014): 514-522.
17. Carlberg M, Hardell L. Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. Biomed Res Int (2017): 9218486.
18. Peleg M, Nativ O, Richter ED. Radio frequency radiation-related cancer: assessing causation in the occupational/military setting. Environ Res 163 (2018): 123-133.
19. Hardell L, Carlberg M. Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. Int J Oncol 54 (2019): 111-127.
20. CTIA fights San Francisco cell safety law again. The mobile trade group has sued to block enforcement of a law requiring warnings about phones. Available online: https://www.computerworld.com/article/2498464/ctia-fights-san-francisco-cell-safety-law-again.html (2021).
21. Davis D. War-gaming cell phone science protects neither brains nor private parts. Whenever a report pops up questioning cell phone safety, a contrary report stands ready in the wings to cast doubt about its legitimacy. Available online:

https://www.huffpost.com/entry/cell-phones-braincancer_b_3232534?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuYWx0ZXJuZXQub3JnLzIwMTMvMDYvcm (2021).

22. Koppel T, Ahonen M, Carlberg M, et al. Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. Oncol Lett 18 (2019): 5383-5391.
23. Carlberg M, Hedendahl L, Koppel T, et al. High ambient radiofrequency radiation in Stockholm city, Sweden. Oncol Lett 17 (2019): 1777-1783.
24. EMFscientist. International Appeal: Scientists call for protection from non-ionizing electromagnetic field exposure. Available online: https://www.emfscientist.org/index.php/emf-scientist-appeal (2021).
25. National Toxicology Program. NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones Available online: https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf (2021).
26. National Toxicology Program. NTP technical report on the toxicology and carcinogenesis studies in Hsd:Sprague Dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595 Available online: https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf (2021).
27. Falcioni L, Bua L, Tibaldi E, et al. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ Res 165 (2018): 496-503.
28. Yakymenko I, Tsybulin O, Sidorik E, et al. Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35 (2016): 186-202.
29. Lai H, Singh NP. Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. Int J Radiat Biol 69 (1996): 513-521.
30. Ruediger HW. Genotoxic effects of radiofrequency electromagnetic fields. Pathophysiology 16 (2009): 89-102.
31. Smith-Roe SL, Wyde ME, Stout MD, et al. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ Mol Mutagen 61 (2020): 276-290.
32. Szmigielski S, Szudzinski A, Pietraszek A, et al. Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. Bioelectromagnetics 3 (1982): 179-191.
33. Cleary SF, Liu LM, Merchant RE. Glioma proliferation modulated in vitro by isothermal radiofrequency radiation exposure. Radiat Res 121 (1990): 38-45.
34. Cleary SF, Liu LM, Merchant RE. In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions. Bioelectromagnetics 11 (1990): 47-56.
35. Chou CK, Guy AW, Kunz LL, et al. Long-term, low-level microwave irradiation of rats. Bioelectromagnetics 13 (1992): 469-496.

36. Repacholi MH, Basten A, Gebski V, et al. Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. Radiat Res 147 (1997): 631-640.
37. Utteridge TD, Gebski V, Finnie JW, et al. Long-term exposure of E-mu-Pim1 transgenic mice to 898.4 MHz microwaves does not increase lymphoma incidence. Radiat Res 158 (2002): 357-364.
38. Hardell L, Carlberg M, Koppel T, et al. High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament. Mol Clin Oncol. 6 (2017): 462-476.
39. Tillmann T, Ernst H, Streckert J, et al. Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. Int J Radiat Biol 86 (2010): 529-541.
40. Lerchl A, Klose M, Grote K, et al. Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem Biophys Res Commun 459 (2015): 585-590.
41. Belyaev I, Dean A, Eger H, et al. EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. Rev Environ Health 31 (2016): 363-397.
42. Belpomme D, Hardell L, Belyaev I, et al. Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. Environ Pollut 242 (2018): 643-658.
43. Carpenter DO. The microwave syndrome or electro-hypersensitivity: historical background. Rev Environ Health 30 (2015): 217-222.
44. BioInitiative 2012. Available online: https://bioinitiative.org/conclusions/ (2021).
45. Aldad TS, Gan G, Gao X-B, et al. Fetal radiofrequency radiation exposure from 800-1900 MHz-rated cellular telephones affects neurodevelopment and behavior in mice. Sci Rep 2 (2012): 312.
46. Birks L, Guxens M, Papadopoulou E, et al. Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts. Environ Int 104 (2017): 122-131.
47. World Health Organization. Electromagnetic fields (EMF). Standards and guidelines. Available online: https://www.who.int/peh-emf/standards/en/ (2021).
48. International Commission on Non-Ionizing Radiation Protection. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys 118 (2020): 483-524.
49. Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Opinion on potential health effects of exposure to electromagnetic fields (EMF) Available online: https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf (2021).
50. Swedish Radiation Safety Authority 2015:19. Recent Research on EMF and Health Risk: Tenth Report from SSM's Council on Electromagnetic Fields 2015. Availableonline:https://www.stralsakerhetsmyndigheten.se/contentassets/ee7b28e0fee04e80bcaf84c24663a004/201519-recent-research-on-emf-and-health-risk---tenth-report-from-ssms-scientific-council-on-electromagnetic-fields-2015 (2021).
51. Swedish Radiation Safety Authority 2016:15. Recent Research on EMF and Health Risk: Eleventh Report from SSM's Scientific Council on Electromagnetic Fieldes, 2016. Available online: https://www.stralsakerhetsmyndigheten.se/contentassets/98d67d9e3301450da4b8d2e0f6107313/201615-

recent-research-on-emf-and-health-risk-eleventh-report-from-ssms-scientific-council-on-electromagnetic-fields-2016 (2021).

52. Swedish Radiation Safety Authority 2018:09. Recent Research on EMF and Health Risk: Twelfth Report from SSM's Scientific Council on Electromagnetic Fields, 2017. Available online: https://www.stralsakerhetsmyndigheten.se/publikationer/rapporter/stralskydd/2018/201809/ (2021).
53. International Commission on Non-Ionizing Radiation Protection. Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74 (1998): 494-522.
54. International Commission on Non-Ionizing Radiation Protection. ICNIRP statement on the "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)." Health Phys 97 (2009): 257-258.
55. ICNIRP: Aim, status & history. Available online: https://www.icnirp.org/en/about-icnirp/aim-status-history/index%20.html (2021).
56. International Committee on Electromagnetic Safety. ICES (SCC-39) Annual Report: 2015 – 2016. Available online: https://www.ices-emfsafety.org/wp-content/uploads/2017/01/SCC39-Annual-Report-2015-2016.pdf (2021).
57. Steneck NH, Cook HJ, Vander AJ, et al. The origins of U.S. safety standards for microwave radiation. Science 208 (1980): 1230-1237.
58. Buchner K, Rivasi M. The International Commission on Non-Ionizing Radiation Protection: Conflicts of interest, corporate capture and the push for 5G. Available online: https://www.michele-rivasi.eu/wp-content/uploads/2020/06/ICNIRP-report-FINAL-JUNE-2020_EN.pdf (2021).
59. ICNIRP: Emeritus members. Available online: https://www.icnirp.org/en/about-icnirp/emeritus-members/index.html (2021).
60. The International EMF Project. Progress report June 2005-2006. Available online: https://www.who.int/peh-emf/publications/reports/IAC_Progress_Report_2005-2006.pdf (2021).
61. Repacholi MH. WHO's International EMF project and results so far. Proceedings of the International Conference on Non-Ionizing Radiation at UNITEN. Available online: https://www.who.int/peh-emf/meetings/archive/en/keynote1repacholi.pdf (2003).
62. ICNIR. International conference on non-ionizing radiation. 5G Transforming our future. 1-3 October 2019, Kuala Lumpur. Available online: https://web.archive.org/web/20200920084041/https://www.icnir.org/program/speakers/ (2021)
63. Repacholi MH. The purpose of WHO's EMF standards harmonization project. Available online: https://www.who.int/peh-emf/meetings/southkorea/en/Repacholi_project_.pdf?ua=1 (2021).
64. The International EMF Project. Progress report 2001-2002. Available online: https://www.who.int/peh-emf/project/en/PR2001_2002.pdf (2021).
65. Microwave News. Repacholi: Half of WHO EMF project funding came from industry. Available online: https://microwavenews.com/news-center/repacholi-half-who-emf-project-funding-came-industry (2021).
66. Microwave News. It's Official: Mike Repacholi is an industry consultant and he's already in hot water. November 13, 2006. Available online:

https://web.archive.org/web/20200423145810/https://microwavenews.com/CT.html (2021).

67. Microwave News. Mike Repacholi leaves WHO Available online: https://web.archive.org/web/20170314232645/https://microwavenews.com/july-10-2006 (2021).
68. Department of electrical and computer engineering. T Emelie van Deventer. University of Toronto. Available online:https://web.archive.org/web/20110727050438/https://www.waves.utoronto.ca/prof/evd/evd.html (2021).
69. Wu X, Eleftheriades GV, van Deventer E. Design and characterization of single and multiple beam MM-Wave circularly polarized substrate lens antennas for wireless communication. Available online: http://www.waves.toronto.edu/prof/gelefth/Backup_Old/jpub/pdf/8.pdf (2021).
70. T. Emilie van Deventer's Homepage. Available online: http://www.next-up.org/pdf/EmilieVanDeventerCvBio.pdf (2021).
71. Swedish Radiation Safety Authority. Vetenskapligt råd för elektromagnetiska fält. Scientfic Council on Electromagnetic Fields. Available online: https://www.stralsakerhetsmyndigheten.se/om-myndigheten/organisation/rad-och-namnder/vetenskapligt-rad-for-elektromagnetiska-falt/ (2021).
72. ITU: Committed to connecting the world. van DEVENTER Tahera Emilie. Available online: https://www.itu.int/en/ITU-T/Workshops-and-Seminars/emf/201307/Pages/vanDEVENTERTaheraEmilie.aspx (2021).
73. Microwave News. Richard Saunders elected to ICNIRP Available online: https://web.archive.org/web/20170316221409/https://microwavenews.com/october-29-2006 (2021).
74. Hardell L. World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). Int J Oncol 51 (2017): 405-413.
75. Microwave News. WHO watch: Mike Repacholi & the EMF charade. 5 July 2005. Available online: https://microwavenews.com/docs/WHOWatch.pdf (2021).
76. World Health Organization. Electromagnetic fields (EMF). An Environmental Health Criteria Monograph. Available online: http://www.who.int/peh-emf/research/rf_ehc_page/en/ (2021).
77. BioInitiative letter to the International EMF Project. Available online: http://www.bioinitiative.org/wp-content/uploads/2016/12/BIWG-final-draft-WHO-RF-EHC-Monograph-team-composition.pdf (2021).
78. BioInitiative letter to the International EMF Project. Available online: http://www.bioinitiative.org/wp-content/uploads/2017/01/BIWG-EHC-substitution-letter.pdf (2021).
79. WHO Environmental Health Criteria Monograph on radiofrequency (RF) fields. The opinion of NGOs on the preliminary draft on Radio Frequencies and health effects. Available online: https://www.stralskyddsstiftelsen.se/wp-content/uploads/2014/12/NGO-Opinion-WHO-consultation.pdf (2021).
80. European coordination of organizations for an EMF exposure regulation which truly protects public health. The Conflict of Interest Scandal is repeating itself in the WHO: European citizens' organisations uncover conflicts of interest between the health and radiofrequency WHO expert group and telecommunications or electric companies. Available

online:http://www.peccem.org/DocumentacionDescarga/Plataforma-Estatal/notasprensa/European.coordination.press.release-february-2017.pdf (2021).

81. Russian National Committee on Non-Ionizing Radiation Protection. International EMF Project; unbalanced WHO working group (WG) on evaluation of health effects from radiofrequency (RF) radiation. Available online: https://www.emfsa.co.za/wp-content/uploads/2017/03/2017_03_01_WHO.pdf (2021).
82. Vimeo. Question to Emilie van Deventer, WHO, about 220 scientist's appeal for better protection of the public from EMF. Available online: https://vimeo.com/170983540 (2021).
83. Scientific Committee on Emerging and Newly Identified Health Risks, SCENIHR. Research needs and methodology to address the remaining knowledge gaps on the potential health effects of EMF. Available online:https://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_024.pdf (2021).
84. The Scientific Committees on Consumer Safety (SCCS) Health and Environmental Risks (SCHER) Emerging and Newly Identified Health Risks (SCENIHR). Rules of procedure. Available online: https://ec.europa.eu/health/sites/health/files/scientific_committees/docs/rules_procedure_2013_en.pdf (2021).
85. Commission Decision of 5 August 2008. Official Journal of the European Union. Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:241:0021:0030:EN:PDF (2021).
86. European Commission. Scientific Committee on Emerging and Newly Identified Health Risks. SCENIHR. Possible effects of Electromagnetic Fields (EMF) on Human Health. Available online: https://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_007.pdf (2021).
87. SCENIHR 2009. Health Effects of Exposure to EMF. Available online: https://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_022.pdf?fbclid=IwAR2eEiZadf96LIu4FiRYZSDBj5HwDckBCkD_muAh6v77UmH4PeUUktg0WAg (2021).
88. Mats Olof Mattsson. Declartion of Interests. Available online: https://ec.europa.eu/health/scientific_committees/emerging/docs/doi_scenihrwg_mattsson_en.pdf (2021).
89. Declaration of interests, Scientific Committée on Consumer Safety Health and Environmental Risks Emerging and Newly Identified Risks. Available online: https://www.stralskyddsstiftelsen.se/wp-content/uploads/2021/03/doi_scenihr_samaras_en.pdf (2021).
90. Johansen C, Boice J, McLaughlin J, et al. Cellular telephones and cancer--a nationwide cohort study in Denmark. J Natl Cancer Inst 93 (2001): 203-207.
91. Frei P, Poulsen AH, Johansen C, et al. Use of mobile phones and risk of brain tumours: update of Danish cohort study. BMJ 343 (2011): d6387.
92. Benson VS, Pirie K, Schüz J, et al. Mobile phone use and risk of brain neoplasms and other cancers: prospective study. Int J Epidemiol 42 (2013): 792-802.
93. Aydin D, Feychting M, Schüz J, et al. Mobile phone use and brain tumors in children and adolescents: a multicenter case-control study. J Natl Cancer Inst 103 (2011): 1264-1276.
94. Swedish radiation protection foundation. Complaint to the European Commission concerning the 2015

SCENIHR opinion on potential health effects of exposure to electromagnetic fields. Available online: https://www.stralskyddsstiftelsen.se/wp-content/uploads/2015/09/Complaint_European_Commission_SCENIHR_2015-08-31.pdf (2021).

95. Microwave News. The Danish Cohort Study. The Politics and Economics of Bias. Available online: https://microwavenews.com/DanishCohort.html (2021).
96. Schüz J, Jacobsen R, Olsen JH, et al. Cellular telephone use and cancer risk: update of a nationwide Danish cohort. J Natl Cancer Inst 98 (2006): 1707-1713.
97. Swedish Radiation Safety Authority. Research Report number: 2013:19 ISSN: 2000-0456. Available online: https://www.stralsakerhetsmyndigheten.se/contentassets/7f20edcd0b024940bca450d596568e30/201319-eighth-report-from-ssms-scientific-council-on-electromagnetic-fields (2021).
98. Hardell L, Nyberg R. Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Mol Clin Oncol 12 (2020): 247-257.
99. Hardell L, Carlberg M. Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. Oncol Lett 20 (2020): 15.
100. Söderqvist F, Carlberg M, Hardell L. Review of four publications on the Danish cohort study on mobile phone subscribers and risk of brain tumors. Rev Environ Health 27 (2012): 51-58.
101. Karolinska Institutet. Reassuring results from first study on young mobile users and cancer risk. Available online:https://web.archive.org/web/20130203041836/https://ki.se/ki/jsp/polopoly.jsp?d=130&a=125250&l=en&newsdep=130 (2021).
102. Universität Basel. Kein erhöhtes Hirntumorrisiko bei Kindern und Jugendlichen wegen Handys. No increased brain tumour risk in children and adolescents using mobile phones. Available online: https://www.unibas.ch/de/Aktuell/News/Uni-Research/Kein-erh-htes-Hirntumorrisiko-bei-Kindern-und-Jugendlichen-wegen-Handys.html (2021).
103. Söderqvist F, Carlberg M, Hansson Mild K, Hardell L. Childhood brain tumour risk and its association with wireless phones: a commentary. Environ Health 10 (2011): 106.
104. Lannering B, Sandström P-E, Holm S, et al. Classification, incidence and survival analyses of children with CNS tumours diagnosed in Sweden 1984-2005. Acta Paediatr 98 (2009): 1620-1627.
105. Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB, Davis DL. Exposure limits: the underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 31 (2012): 34-51.
106. European Commission: Results of the public consultation on SCENIHR's preliminary opinion on potential health effects of exposure to electromagnetic fields (EMF). Available online: https://ec.europa.eu/health/sites/health/files/scientific_committees/emerging/docs/followup_cons_emf_en.pdf (2021).
107. BioInitiative: Exhibit B. Comment by Drs. Lennart Hardell, Fredrik Soderqvist, PhD and Michael Carlberg, MSc. Available online: https://www.bioinitiative.org/wp-content/uploads/2014/04/Exhibit-B-Hardell-SCENIHR.pdf (2021).
108. Momoli F, Siemiatycki J, McBride ML, et al. Probabilistic multiple-bias modeling applied to the

Canadian data from the Interphone study of mobile phone use and risk of glioma, meningioma, acoustic neuroma, and parotid gland tumors. Am J Epidemiol 186 (2017): 885-893.

109. Swedish Radiation Safety Authority.2016: Ny rapport: allt svagare misstanke att mobilen kan orsaka cancer. May 19, 2016. New report: weaker suspicion that mobile phones can cause cancer. Available online: https://www.stralskyddsstiftelsen.se/wp-content/uploads/2017/11/SSM_pressmeddelande_20160519.pdf (2021).

110. Swedish Radiation Safety Authority: Recent research on EMF and health risk - Fourteenth report from SSM's Scientific Council on Electromagnetic Fields, 2019. Available online: https://www.stralsakerhetsmyndigheten.se/contentassets/47542ee6308b4c76b1d25ae0adceca15/2020-04-recent-research-on-emf-and-health-risk---fourteenth-report-from-ssms-scientific-council-on-electromagnetic-fields-2019.pdf (2021).

111. ICNIRP. New guidelines released by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Available online: https://www.icnirp.org/cms/upload/presentations/ICNIRP_Media_Release_110320.pdf (2021).

112. International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP Note: Critical Evaluation of Two Radiofrequency Electromagnetic Field Animal Carcinogenicity Studies Published in 2018. Health Phys 118 (2020): 525-532.

113. Melnick RL. Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ Res 168 (2019): 1-6.

114. Melnick RL. Regarding ICNIRP's evaluation of the National Toxicology Program's carcinogenicity studies on radiofrequency electromagnetic fields. Health Phys 118 (2020): 678-682.

115. ICNIRP, Response to Melnick (2020). (Correspondence). Health Phys 118 (2020): 683-685.

116. Röösli M, Lagorio S, Schoemaker MJ, Schüz J, Feychting M. Brain and salivary gland tumors and mobile phone use: Evaluating the evidence from various epidemiological study designs. Annu Rev Public Health 40 (2019): 221-238.

117. Cardis E, Armstrong BK, Bowman JD, et al. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. Occup Environ Med 68 (2011): 631-640.

118. Grell K, Frederiksen K, Schüz J, et al. The intracranial distribution of gliomas in relation to exposure from mobile phones: Analyses from the Interphone study. Am J Epidemiol 184 (2016): 818-828.

119. Carlberg M, Hedendahl L, Ahonen M, et al. Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data. BMC Cancer 16 (2016): 426.

120. Luo J, Deziel NC, Huang H, et al. Cell phone use and risk of thyroid cancer: a population-based case-control study in Connecticut. Ann Epidemiol 29 (2019): 39-45.

121. Luo J, Li H, Deziel NC, et al. Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut. Environ Res 182 (2020): 109013.

122. Carlberg M, Koppel T, Hedendahl LK, et al. Is the Increasing Incidence of thyroid cancer in the Nordic

countries caused by use of Mobile Phones? Int J Environ Res Public Health 17 (2020): 9129.

123. Philips A, Henshaw DL, Lamburn G, et al. Brain Tumours: Rise in Glioblastoma Multiforme Incidence in England 1995-2015 Suggests an Adverse Environmental or Lifestyle Factor. J Environ Public Health (2018): 7910754.
124. Zada G, Bond AE, Wang Y-P, et al. Incidence trends in the anatomic location of primary malignant brain tumors in the United states:1992-2006. World Neurosurgery 77 (2012;): 518-524.
125. Hardell L, Carlberg M. Increasing rates of brain tumours in the Swedish national inpatient register and the causes of death register. Int J Environ Res Public Health 12 (2015): 3793-3813.
126. Hardell L, Carlberg M. Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. PLoS ONE 12 (2017): e0185461.
127. Khurana VG, Hardell L, Everaert J, et al. Epidemiological evidence for a health risk from mobile phone base stations. Int J Occup Environ Health 16 (2010): 263-267.
128. Wolf R, Wolf D. Increased incidence of cancer near a cell-phone transmitter station. Int J Cancer Prev 1 (2004): 123-128.
129. Eger H, Hagen KU, Lucas B, et al. Einfluss der raumlichen nahe von mobilfunksendeanlagen auf die krebsinzidenz. The influence of being physically near to a cell phone transmission mast on the incidence of cancer. Umwelt-Medizin-Gesellschaft 17 (2004): 326-332.
130. Dode AC, Leão MM, Tejo F de AF, et al. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. Sci Total Environ 409 (2011): 3649-3665.
131. Li C-Y, Liu C-C, Chang Y-H, et al. A population-based case-control study of radiofrequency exposure in relation to childhood neoplasm. Sci Total Environ (2012): 472-478.
132. Zothansiama, Zosangzuali M, Lalramdinpuii M, et al. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med 36 (2017): 295-305.
133. YouTube. Swedish Radiation Safety Authority EMF-seminarium. Available online: https://www.youtube.com/watch?v=IKFf5zzlGqM (2021).
134. ICNIRP. Funding & Governance. Available online: https://www.icnirp.org/en/about-icnirp/funding-governance/index.html (2021).
135. ICNIRP. Former members. Available online: https://www.icnirp.org/en/about-icnirp/former-members/index.html (2021).
136. ICNIRP. Available online: https://www.icnirp.org/ (2021).
137. IEEE. Available online: https://www.ieee.org/ (2021).
138. European Commission. SCENIHR – opinions. Available online: https://ec.europa.eu/health/scientific_committees/emerging/opinions_en (2021).
139. The 5G appeal. Available online: http://5gappeal.eu (2021).
140. ICNIRP: Simon Mann. Available online: https://web.archive.org/web/20190331062221/https://www.icnirp.org/en/about-icnirp/scientific-expert-group/details/seg-member-mann.html (2021).

141. ITU. FEYCHTING Maria. Available online: https://www.itu.int/en/ITU-T/Workshops-and-Seminars/gsw/201406/Pages/bios/FEYCHTINGMaria.aspx (2021).

142. Swedish Radiation Safety Authority. Recent research on EMF and health risk. Seventh annual report from SSM:s Independent Expert Group on Electromagnetic Fields, 2010. Available online: https://www.stralsakerhetsmyndigheten.se/contentassets/63e6735284dc4634830c4dd6003d9b07/201044-recent-research-on-emf-and-health-risk-seventh-annual-report-from-ssms-independent-expert-group-on-electromagnetic-fields-2010 (2021).

143. Linkedin. Eric van Rongen. Available online: https://nl.linkedin.com/in/eric-van-rongen-73b84614 (2021).

144. ICNIRP. Commission. Available online: https://www.icnirp.org/en/about-icnirp/commission/index.html (2021).

145. ICNIRP. Declaration of personal interests. Eric van Rongen. Available online: https://www.icnirp.org/cms/upload/doc/VanRongenDoI2017.pdf (2021).

146. IREA, National Research Council of Italy. Maria Rosaria Scarfi. Available online: http://www.irea.cnr.it/en/index.php?option=com_comprofiler&task=userprofile&user=158&Itemid=100 (2021).

147. Neufeld E, Kuster N. Systematic derivation of safety limits for time-varying 5G radiofrequency exposure based on analytical models and thermal dose. Health Physics 115 (2018): 705-711.

148. Barnes F, Greenebaum B. Setting Guidelines for Electromagnetic Exposures and Research Needs. Bioelectromagnetics 41 (2020): 392-397.

149. Mason PA, Murphy MR and Petersen RC: IEEE EMF health & safety standards. Available online: https://www.who.int/peh-emf/meetings/southkorea/en/IEEE_EMF_HEALTH_-_Mason.pdf (2021).

150. IEEE. C95.1-1991 - IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz. 27 April, 1992. Available online: https://ieeexplore.ieee.org/document/159488 (2021).

151. FCC: Telecommunications Act of 1996. Available online: https://www.fcc.gov/general/telecommunications-act-1996 (2021).

152. Salzburg resolution on mobile telecommunication base stations. Salzburg, June 7-8, 2000. Available online: http://www.icems.eu/docs/resolutions/Salzburg_res.pdf?fbclid=IwAR3R4sB5VrAbqoHcFfPTF-hbaKoYTRdktA9wQUChQQRxFrWcWi8Bl5nv49w (2021).

153. European Parliament. The physiological and environmental effects of non-ionising electromagnetic radiation. Final Study. Luxembourg. Available online: https://www.europarl.europa.eu/RegData/etudes/etudes/join/2001/297574/DG-4-JOIN_ET(2001)297574_EN.pdf (2021).

154. Oberfeld G, Navarro AE, Portoles M, et al. The microwave syndrome - further aspects of a Spanish study. Available online: https://www.researchgate.net/publication/237410769_THE_MICROWAVE_SYNDROME_-_FURTHER_ASPECTS_OF_A_SPANISH_STUDY (2021).

155. Hardell L, Walker M, Walhjalt B, et al. Secret ties to industry and conflicting interests in cancer research. Am J Ind Med 50 (2007;): 227-233.

156. Hardell L. Pesticides, soft-tissue sarcoma and non-Hodgkin lymphoma - historical aspects on the precautionary principle in cancer prevention. Acta Oncologica 47 (2008): 347-354.

157. Hardell L, Carlberg M. Lost opportunities for cancer prevention: historical evidence on early warnings with emphasis on radiofrequency radiation. Rev Environ Health (2021). https://doi.org/10.1515/reveh-2020-0168.

158. The EMF Call. Scientists and NGOs call for truly protective limits for exposure to electromagnetic fields (100 kHz to 300 GHz). Available online: https://www.emfcall.org/ (2021).

159. ResearchGate. Eric van Rongen. Professional experience. Available online: https://www.researchgate.net/profile/Eric_Rongen/experience (2021).

160. Maria Feychting. Declaration of interests. Available online: https://microwavenews.com/sites/default/files/docs/DOI.Feychting%202012%20Norge%20expertgrupp.pdf (2021).

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Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report

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Abstract. Exposure to radiofrequency (RF) radiation was classified in 2011 as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer of the World Health Organisation. Evidence of the risk of cancer risk has since strengthened. Exposure is changing due to the rapid development of technology resulting in increased ambient radiation. RF radiation of sufficient intensity heats tissues, but the energy is insufficient to cause ionization, hence it is called non-ionizing radiation. These non-thermal exposure levels have resulted in biological effects in humans, animals and cells, including an increased cancer risk. In the present study, the levels of RF radiation were measured in an apartment close to two groups of mobile phone base stations on the roof. A total of 74,531 measurements were made corresponding to ~83 h of recording. The total mean RF radiation level was 3,811 μW/m^2 (range 15.2-112,318 μW/m^2) for the measurement of the whole apartment, including balconies. Particularly high levels were measured on three balconies and 3 of 4 bedrooms. The total mean RF radiation level decreased by 98% when the measured down-links from the base stations for 2, 3 and 4 G were disregarded. The results are discussed in relation to the detrimental health effects of non-thermal RF radiation. Due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults. For a definitive conclusion regarding the effect of RF radiation from nearby base stations, one option would be to turn them off and repeat the measurements. However, the simplest and safest solution would be to turn them off and dismantle them.

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Introduction

The use of wireless digital technology has grown rapidly during the last couple of decades. While in use, mobile and cordless phones emit radiofrequency (RF) radiation. The brain is the main target of exposure to RF radiation with handheld wireless phones (mobile and cordless) (1,2). An increased risk for brain tumors has been of concern for a long time. In May 2011, RF radiation in the range 30-300 GHz could be categorized in Group 2B, i.e., a 'possible' human carcinogen, by the International Agency for Research on Cancer (IARC) of WHO (3,4). The decision was based mainly on case-control human studies on the use of wireless phones by the Hardell group in Sweden (mobile and cordless phones; DECT) and the IARC Interphone study (mobile phones), which showed an increased risk for brain and head tumours, i.e., glioma and acoustic neuroma (3-6), which has since been confirmed (7-10), resulting in a recommendation to upgrade IARC's 2011 classification of RF radiation to Group 1, a human carcinogen. This conclusion was published in our up-dated review in 2013 (11) using the so-called Hill viewpoints on the association or causation put forward at the height of the tobacco and lung cancer controversy (12).

Due to the increasing use of the wireless technology, environmental exposure to RF radiation has been increasing, but there has been no systematic study of ambient exposure. We have measured RF radiation at Stockholm Central Station (13) and the Stockholm Old Town in Sweden (14). The results generally exceeded the levels known to have adverse biological effects. By contrast, low levels were measured at certain places in the WHO building in Geneva (15).

We have measured RF radiation in an apartment with a central location at Östermalm in Stockholm. The apartment is located on the 6th floor, with a tower including a bedroom on the first floor of the tower (7th floor) and a conference room on the second and highest floor (8th) of the tower, at the same level as the roof of the building. The measurements did not involve any human subjects, and therefore no ethical permission was needed. We also discuss laboratory studies on RF-radiation and biological effects relative to the levels of RF in question. Of particular interest are the non-thermal levels of RF radiation and

biological effects. For comparison, radiation was also measured in another apartment located on the 3rd floor in a high building of 9 floors at Gärdet in central part of Stockholm.

Materials and methods

EME-Spy 200 exposimeter. To measure RF radiation, a calibrated exposimeter EME-Spy 200 (Satimo, MVG Industries, Brest, France) was used. The instrument measures 20 predefined frequency bands (Table I), which cover the frequencies of most public RF radiation emitting devices now in use in Sweden. These frequencies are from 87 to 5,850 MHz. For frequency modulation (FM), TV3, TETRA, TV4&5, Wi-Fi 2.4 GHz and Wi-Fi 5 GHz, the lower detection limit is 0.01 V/m (0.27 μW/m^2). For all other bands, the lower detection limit is 0.005 V/m (0.066 μW/m^2). For all bands, the upper detection limit is 6 V/m (95,544 μW/m^2). Samples were taken every 4th second.

The exposimeter measures different telecommunications protocols: FM radio broadcasting; TV broadcasting; TETRA emergency services (police and rescue); GSM second generation mobile communications, 2G; UMTS third generation mobile communications, 3G; long-term evolution (LTE) fourth generation mobile communications standard, 4G; digital European cordless telecommunications (DECT) cordless telephone systems standard; Wi-Fi 2.4 GHz and 5 GHz wireless local area network protocol; worldwide interoperability for microwave access (WiMAX) wireless communication standard for high-speed voice, data and Internet.

EME-Spy 200 has a 3-axis antenna to capture RF radiation from every direction. The unit reports the exposure after statistical processing, since each value is a sampling outcome of many readings after statistical analysis, including minimum, mean, median and maximum values.

Study design. Measurements were taken on June 5, 6, and August 21, 22, 30, 31, 2017. Some measurements were made during the night to assess variation of RF exposure from daytime readings. While walking through all the rooms and balconies, the effect of body shielding was minimized by the exposimeter being held about 0.4 m in front of the investigator. More extended measurements were then taken in places judged to be of interest-bedrooms and the living room. The exposimeter was placed where people tend to occupy, e.g., corresponding to the upper part of the body, including the head of a bed. Three of the five balconies were located close to the 2 groups of base stations located on the roofs. The closest base stations were only 6 m from the balcony outside the tower.

Measurements in another apartment for comparison at Gärdet, Stockholm were taken on October 27-29 and November 6, 2017. This was a smaller apartment with a balcony and no visible surrounding base stations. A group of base stations are located at the top of another 9 floor building, but in the opposite direction to this apartment.

Statistical methods. Means, medians, minimum, and maximum values in μW/m^2 were calculated for all measured frequency bands, and box plots and bar graphs were constructed to illustrate the distribution of total exposure for all measurement rounds. Values at the lower detection limit were treated as zero exposure. Total exposure was calculated as the sum of all measured frequency bands. Stata/SE 12.1 (Stata/SE 12.1 for Windows; StataCorp., College Station, TX, USA) was used for all calculations.

Results

Whole apartment. The total of measurements made at the apartment in Östermalm was 74,531 readings (~83 h of recording). The daily data were consistent; therefore, totals are presented for the whole apartment including different locations. Some places of interest will be discussed in greater detail. The results are given as numbers of readings (measurements), and as mean, median, minimum and maximum values in μW/m^2.

Table II shows mean level 3,810.8 μW/m^2 for the total measurement of the whole apartment, including balconies, a high maximum level of 112,318 μW/m^2 being recorded. Over 55% of the mean level was caused by the 4 G down link from base stations (LTE 800 and LTE 2600). The 3G down link (GSM+UMTS 900 and UMTS 2100) yielded >40% of the total mean exposure. About 96% of the total mean value was caused by the 3G and 4G down links, with the 2G down link accounting for only 2% (GSM 1800). The results were calculated excluding all RF radiation from base stations, which gave a mean level 78.8 μW/m^2 and maximum 4,616.2 μW/m^2, Table II. Thus 3,732.0 μW/m^2, 97.9% of the mean RF radiation was caused by down link from the 2G, 3G and 4G base stations.

The measurements in the apartment, excluding the 5 balconies, were based on 64,070 readings (71 h of measurements). The mean level was 1,766 μW/m^2; median 1,051 μW/m^2 (range min 15.2 μW/m^2, max 50,431.0 μW/m^2; data not shown). These results nevertheless represent high levels of RF radiation.

Table III gives the levels for different locations within the apartment, and Table IV shows the results where the contribution from base stations is excluded at each location; thereby substantially lower values were generally obtained.

Balconies. The highest results were inevitably found on the balconies, especially the 3 facing at short distance the visible base stations. The highest mean value (24,885.9 μW/m^2) was measured on the balcony outside the living room (Table V), at which the highest maximum exposure was found (112,317.7 μW/m^2). The results were based on 5,251 entries corresponding to ~6 h of measurements. If the down link of RF radiation from the base stations was disregarded, the total mean on that balcony fell to 229.6 μW/m^2 (~0.9% of the total; Table V). The balconies outside the boy's bedroom and outside the tower gave similar results with high RF radiation from nearby base stations (Tables III and IV). Thus the mean RF radiation value outside the boy's bedroom was reduced from 6,803.3 μW/m^2 to 90.2 μW/m^2 when disregarding down links from base stations. For the balcony outside the tower, the RF radiation fell from 8,989.4 to 331.2 μW/m^2 excluding down links.

Bedrooms. Most of the time is usually spent in bedroom. The master bedroom showed lower RF radiation values compared with the other bedrooms, mean 569.7, and 32.4 μW/m^2 excluding down links (Tables III and IV). Especially high levels were recorded in the two children's bedrooms and the

Table I. Predefined measurement frequency bands of EME-Spy 200 Exposimeter. Frequency ranges.

Frequency band	Frequency Min (MHz)	Frequency Max (MHz)
FM	87	107
TV3	174	223
TETRA I	380	400
TETRA II	410	430
TETRA III	450	470
TV4&5	470	770
LTE 800, 4G (DL)	791	821
LTE 800, 4G (UL)	832	862
GSM 900 + UMTS 900, 3G (UL)	880	915
GSM 900 + UMTS 900, 3G (DL)	925	960
GSM 1800, 2G (UL)	1,710	1,785
GSM 1800, 2G (DL)	1,805	1,880
DECT	1,880	1,900
UMTS 2100, 3G (UL)	1,920	1,980
UMTS 2100, 3G (DL)	2,110	2,170
Wi-Fi, 2GHz	2,400	2,483.5
LTE 2600, 4G (UL)	2,500	2,570
LTE 2600, 4G (DL)	2,620	2,690
WiMax	3,300	3,900
Wi-Fi 5GHz	5,150	5,850

FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

Table II. Levels of RF-radiation in total based on 74,531 entries for 6 different tours (Östermalm, Stockholm).

Variable	Mean	Median	Min	Max
FM	38.3	3.4	0.0	3,441.2
TV3	4.7	0.0	0.0	308.4
TETRA I	1.2	0.0	0.0	229.3
TETRA II	0.2	0.0	0.0	33.9
TETRA III	0.1	0.0	0.0	26.5
TV4&5	3.0	0.0	0.0	2,206.2
LTE 800 (DL)	977.5	299.5	1.1	52,526.5
LTE 800 (UL)	0.0	0.0	0.0	2.5
GSM + UMTS 900 (UL)	0.0	0.0	0.0	4.5
GSM + UMTS 900 (DL)	1,236.2	459.0	2.5	44,241.5
GSM 1800 (UL)	0.0	0.0	0.0	7.5
GSM 1800 (DL)	78.9	17.8	0.3	8,442.1
DECT	27.3	5.1	0.0	4,614.8
UMTS 2100 (UL)	0.0	0.0	0.0	5.6
UMTS 2100 (DL)	301.8	92.8	0.2	18,445.0
WIFI 2G	0.0	0.0	0.0	203.5
LTE 2600 (UL)	3.9	0.0	0.0	904.7
LTE 2600 (DL)	1,137.5	70.5	0.5	95,522.5
WIMax	0.0	0.0	0.0	2.7
WIFI 5G	0.1	0.0	0.0	105.0
Total	3,810.8	1,312.9	15.2	112,317.7
Total excluding down link	78.8	27.0	0.0	4,616.2

Data is based on 74,531 entries for 6 different tours, June 5, 6 and August 21, 22, 30, 31, 2017 (apartment at Östermalm, Stockholm). Analysis of all data (μW/m^2) treating values at detection limit as 0. Frequency bands are given. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

one located in the tower (Tables VI-VIII). In the girl's bedroom, the mean level was 2,531.0 μW/m^2 (Table VI), whereas in the boy's bedroom it was 1,471.1 μW/m^2 (Table VII). The highest RF radiation level in the bedrooms was recorded in the tower bedroom, mean value 5,954.3 μW/m^2, Table VIII. Most of the RF radiation came from down links from the base stations, whereas excluding them gave a mean level in the girl's bedroom of 34.1 μW/m^2, 13.4 μW/m^2 in the boy's bedroom, and 205.4 μW/m^2 in the tower bedroom. Thus, RF radiation in the children's bedrooms was reduced ~99%, and by 97% in the tower bedroom by excluding down links from the base stations.

Fig. 1 shows box plots of median levels for all 18 measured areas, with the results in increasing median levels of RF radiation. The bottom and top of the boxes represent first and third quartiles of the levels, with outliers shown as points. Without doubt the balconies had the highest levels, especially the 3 visibly near the surrounding base stations. Fig. 2 shows a bar graph of the mean levels.

There was little variation of the levels in the day and night. Some fall in the measurements were noted from midnight until early morning in the boy's bedroom (Fig. 3), but there was still a high level of RF radiation.

Apartment at Gärdet for comparison. Data for the apartment at Gärdet, Stockholm, based on 36,799 entries corresponding to ~40 h of measurements are given in (Table IX). The highest RF radiation was measured on the balcony, but the total mean remained low, 15.6 μW/m^2 (min 2.2, max 195.1 μW/m^2). About 50% of the RF radiation was caused by the GSM + UMTS 900 (3G) down link.

Discussion

The results were based on a large sample of measurements in the apartment at Östermalm, Stockholm representing about 83 h

Table III. Levels of RF-radiation in total for different locations in the apartment (Östermalm, Stockholm).

	Total				
Location	No.	Mean	Median	Min	Max
1. Balcony outside kitchen[a]	166	1,083.2	895.6	226.5	5,026.6
2. Kitchen	1,973	256.4	194.0	70.4	2,091.7
3. Dining room	4,272	1,480.6	854.1	93.6	12,068.7
4. Master bedroom	12,920	569.7	370.5	36.1	6,280.8
5. Balcony outside bathroom[a]	506	1,912.8	1,684.4	31.8	6,475.8
6. Living room	4,415	321.7	236.1	15.2	8,782.6
7. Balcony outside living room	5,251	24,885.9	22,256.1	72.0	112,317.7
8. Main hall[a]	59	185.2	154.2	59.6	512.7
9. Workroom close to kitchen[a]	599	266.9	235.3	123.6	2,135.6
10. Workroom close to laundry	3,899	1,310.1	1,044.6	266.0	7,999.8
11. Laundry[a]	388	1,561.6	1,416.0	193.2	7,843.2
12. Girl's bedroom	11,440	2,531.0	2,270.5	79.1	11,802.6
13. Boy's bedroom	14,161	1,471.1	1,122.3	58.5	13,739.1
14. Balcony outside boy's room[a]	777	6,803.3	3,254.9	65.3	107,992.5
15. Hall outside elevator[a]	90	251.3	197.6	24.3	1,590.1
16. Bedroom in tower	6,797	5,954.3	4,503.5	96.8	50,431.0
17. Conference room in tower	3,057	432.5	229.3	89.9	12,840.7
18. Balcony outside tower	3,761	8,989.4	7,848.8	43.5	56,191.3
Whole apartment	74,531	3,810.8	1,312.9	15.2	112,317.7

[a]Only measured June 2017. Levels of RF-radiation in total for different locations in the apartment (Östermalm, Stockholm) based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017. Analysis of all data ($\mu W/m^2$) treating values at detection limit as 0. Numbers of entries are given for the different locations.

of recording. High levels of RF radiation were clearly measured throughout the apartment, but especially on the 3 balconies. Most of the RF radiation came from the outside base stations. The total mean level in the apartment fell from 3,810.8 to 78.8 $\mu W/m^2$, a reduction of ~98% occurring if the down links from base stations were excluded.

Table II shows that TV and radio communications contributed only to a minor extent. The contribution was more pronounced at the balcony outside the kitchen in the direction of the transmitting tower (mean level of 276.4 $\mu W/m^2$ for all TV and radio communications; data not in the Table). Most of the RF radiation in the tower bedroom was also caused by radio/TV towers when down links from base stations were excluded (see Table VIII). A minor contribution was from the DECT frequency (Table II). The source of radiation was probably from a neighboring apartment, since no DECT phone was used in the present apartment.

The highest RF radiation levels were measured on the balconies (Figs. 1 and 2 give median and mean values). Fig. 4 shows the group of base stations located only 12 m from the balcony outside the living room. It is questionable whether these balconies are suitable for any longer stay due to the high radiation; the balcony outside the living room (with mean level 24,885.9 $\mu W/m^2$, median 22,256.1 $\mu W/m^2$, and maximum level 112,317.7 $\mu W/m^2$) gave the highest of all recorded measurements (Table V). Regarding all 5 balconies, the results were based on 10,461 readings (>11 h of measurements). The mean level was 16,338.7 $\mu W/m^2$, with a median of 13,775 $\mu W/m^2$ (range min 31.8, max 112,318 $\mu W/m^2$). Usually balconies in Sweden are used only briefly due to the climate, but nevertheless these results far exceed levels known to be detrimental to health from RF radiation.

The use of balconies with decent views can be used for pleasure, a part of comfortable living, but most of the day and night is spent in the apartment. Thus, the level of RF radiation inside is of more concern, especially for a family with children. Notably there was high RF radiation in the bedrooms occupied by children, as also in the tower bedroom. There was little variation with time, although the level declining during night (Fig. 3) still exceeded what is known to give non-thermal biological effects from long-term RF radiation. In the boy's bedroom there seemed to be 2 steps in the reduction of radiation during night, one from approximately 7:00 p.m. and another from midnight, indicating less use of wireless communication after business hours and during late leisure time.

Interestingly measurements recorded in another centrally located apartment in Gärdet were considerably lower in RF radiation. Thus, the mean level was only 0.4% of that found in the apartment at Östermalm. The mean RF radiation on the balcony in Gärdet was much lower; only 0.3% of that on the balcony outside the living room in Östermalm. These results show extreme variation of RF radiation in 2 residential apartments in Stockholm.

Table IV. Levels of RF-radiation in total excluding down links in the apartment (Östermalm, Stockholm).

	Total excluding down links				
Location	No.	Mean	Median	Min	Max
1. Balcony outside kitchen[a]	166	288.2	310.3	68.1	565.1
2. Kitchen	1,973	87.4	44.5	15.0	440.7
3. Dining room	4,272	70.8	68.4	20.0	461.0
4. Master bedroom	12,920	32.4	22.5	4.8	606.5
5. Balcony outside bathroom[a]	506	77.3	56.8	5.8	687.1
6. Living room	4,415	26.8	25.5	2.0	383.8
7. Balcony outside living room	5,251	229.6	146.5	0.0	4,155.6
8. Main hall[a]	59	41.3	28.4	5.7	282.9
9. Workroom close to kitchen[a]	599	40.6	31.5	14.0	2,004.3
10. Workroom close to laundry	3,899	25.3	19.4	6.7	2,199.0
11. Laundry[a]	388	38.4	26.0	3.2	343.6
12. Girl's bedroom	11,440	34.1	23.1	7.2	1,069.8
13. Boy's bedroom	14,161	13.4	6.8	0.0	427.8
14. Balcony outside boy's room[a]	777	90.2	52.6	0.0	4,616.2
15. Hall outside elevator[a]	90	28.3	22.0	0.2	157.8
16. Bedroom in tower	6,797	205.4	158.4	13.5	3,457.8
17. Conference room in tower	3,057	44.5	36.7	9.4	743.4
18. Balcony outside tower	3,761	331.2	363.8	3.8	1,618.4
Whole apartment	74,531	78.8	27.0	0.0	4,616.2

[a]Only measured June 2017. Levels of RF-radiation in total excluding down links for different locations in the apartment (Östermalm, Stockholm) based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017. Analysis of all data ($\mu W/m^2$) treating values at detection limit as 0. Numbers of entries are given for the different locations. Down links from base stations are excluded.

The guideline for RF radiation in Sweden is set on the false assumption that adverse health effects are caused only by heating. However, human, animal and cell studies show biological effects at non-thermal exposure levels that are often exceeded during the life-time of most people, especially as shown from the measurements in the Östermalm apartment during this study. Exposure to RF radiation levels in the current study may clearly increase the risk for adverse health effects in the long run, since levels giving non-thermal biological effects are generally exceeded. Our findings will now be related to other measurements of RF radiation exposure, guidelines and studies regarding health issues.

Levels of RF radiation have increased considerably in recent years, both outdoor and indoor, due to new telecommunication technologies and protocols. In 2013, Estenberg and Augustsson (16) measured outdoor exposure with a car-based measuring system in Sweden. The median power-density for RF fields between 30 MHz and 3 GHz was measured in rural areas at 16 $\mu W/m^2$, urban areas 270 $\mu W/m^2$, and city areas 2,400 $\mu W/m^2$. The EME-Spy 200 exposimeter was used to measure 2 areas of high exposure to RF radiation in Stockholm. At the Central Railway Station, the mean total RF radiation level varied between 2,817 and 4,891 $\mu W/m^2$ (min 5.8, max 155,263 $\mu W/m^2$) when walking around (13). The total RF radiation in the Stockholm Old Town varied between a mean of 404 $\mu W/m^2$ (min 20.4, max 4,088 $\mu W/m^2$) on the streets around the Supreme Court, 756 $\mu W/m^2$ (min 0.3, max 50,967 $\mu W/m^2$) around the Royal Castle, and 24,277 $\mu W/m^2$ (min 257, max 173,302 $\mu W/m^2$) at Järntorget, which is a popular square with shops and outdoor restaurants (14).

Calvente *et al* in Spain (17) measured outside the homes of 123 boys aged 10 years. For all houses, the root mean-square of power density (S_{RMS}) was 286 $\mu W/m^2$ and the maximum power density (S_{RMS}) was 2,760 $\mu W/m^2$ for frequencies between 100 kHz and 6 GHz. The range between highest and lowest measured mean was large, ranging from 5.5 to 11,560 $\mu W/m^2$. The 10-year old boys with higher exposure of RF radiation in their immediate surroundings of their dwellings showed statistically significant lower scores in expression and comprehension, and higher behavioral and emotional problems, including anxiety and depressed behavior in different tests.

Usually much lower RF radiation exposure inside homes is measured since the walls can act as a shield against RF radiation. Frei *et al* (18) got 166 volunteers measure the frequencies 88-2,500 MHz with a body-born exposimeter (EME-Spy 120) in Switzerland. In the homes, the total mean value was 100 $\mu W/m^2$, and total median 44 $\mu W/m^2$. The maximum level in the homes was 1,212 $\mu W/m^2$.

Roser *et al* (19) got 90 adolescents to carry a body-born exposimeter (Expo-RF) for 3 consecutive days to measure frequencies from 620 to 2,450 MHz. The total mean for these measurements was 63.2 $\mu W/m^2$, and the total mean measured in the homes was 32.1 $\mu W/m^2$.

Table V. Levels of RF-radiation at the balcony outside the living room (Östermalm, Stockholm).

Variable	Mean	Median	Min	Max
FM	6.3	1.2	0.0	2,139.0
TV3	0.7	0.0	0.0	66.2
TETRA I	0.0	0.0	0.0	3.4
TETRA II	0.0	0.0	0.0	0.9
TETRA III	0.0	0.0	0.0	2.7
TV4&5	9.3	0.0	0.0	828.9
LTE 800 (DL)	1,280.2	706.2	4.9	17,533.3
LTE 800 (UL)	0.0	0.0	0.0	0.2
GSM + UMTS 900 (UL)	0.0	0.0	0.0	0.3
GSM + UMTS 900 (DL)	8,731.6	11,977.8	16.1	44,241.5
GSM 1800 (UL)	0.0	0.0	0.0	1.8
GSM 1800 (DL)	584.3	409.7	0.7	6,193.1
DECT	212.9	137.9	0.0	4,124.7
UMTS 2100 (UL)	0.0	0.0	0.0	5.6
UMTS 2100 (DL)	1,421.6	1,270.2	1.1	18,445.0
WIFI 2G	0.0	0.0	0.0	7.2
LTE 2600 (UL)	0.4	0.0	0.0	95.8
LTE 2600 (DL)	12,638.7	8,394.8	1.1	95,522.5
WIMax	0.0	0.0	0.0	0.8
WIFI 5G	0.0	0.0	0.0	1.8
Total	24,885.9	22,256.1	72.0	112,317.7
Total excluding down link	229.6	146.5	0.0	4,155.6

Levels of RF-radiation at the balcony outside the living room based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017 (apartment at Östermalm, Stockholm). Analysis of all data (μW/m^2) treating values at detection limit as 0. In total 5,251 entries corresponding to almost 6 h of measurements. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

Table VI. Levels of RF-radiation in the girls's bedroom (Östermalm, Stockholm).

Variable	Mean	Median	Min	Max
FM	1.2	0.5	0.0	1,056.1
TV3	0.1	0.0	0.0	28.7
TETRA I	0.0	0.0	0.0	0.0
TETRA II	0.0	0.0	0.0	1.0
TETRA III	0.0	0.0	0.0	1.4
TV4&5	0.2	0.0	0.0	44.8
LTE 800 (DL)	327.0	156.6	12.6	3,980.4
LTE 800 (UL)	0.0	0.0	0.0	0.3
GSM + UMTS 900 (UL)	0.0	0.0	0.0	0.1
GSM + UMTS 900 (DL)	774.9	590.9	18.7	5,561.5
GSM 1800 (UL)	0.0	0.0	0.0	0.3
GSM 1800 (DL)	29.4	18.3	1.2	243.5
DECT	8.1	4.0	0.0	167.1
UMTS 2100 (UL)	0.0	0.0	0.0	0.1
UMTS 2100 (DL)	808.5	706.2	2.9	3,806.9
WIFI 2G	0.0	0.0	0.0	0.5
LTE 2600 (UL)	24.5	15.7	0.0	904.7
LTE 2600 (DL)	557.1	420.2	1.4	7,584.8
WIMax	0.0	0.0	0.0	0.0
WIFI 5G	0.0	0.0	0.0	0.5
Total	2,531.0	2,270.5	79.1	11,802.6
Total excluding down link	34.1	23.1	7.2	1,069.8

Levels of RF-radiation in the girls's bedroom based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017 (apartment at Östermalm, Stockholm). Analysis of all data (μW/m^2) treating values at detection limit as 0. In total 11,440 entries corresponding to almost 13 h of measurements. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

Vermeeren *et al* (20) measured levels using exposimeters EME-Spy 121 and 140 in schools, kindergartens, offices and homes in Belgium and Greece. In homes, the total average was 0.32 V/m (272 μW/m^2) in Belgium and 0.42 V/m (468 μW/m^2) in Greece. The maximum levels were 0.77 V/m (1,574 μW/m^2) in Belgium and 2.08 V/m (11,482 μW/m^2) in Greece. In Belgium, FM-radio, GSM 900 down link from bases stations, and DECT telephones contributed most of the radiation, and in Greece DECT and Wi-Fi 2.45 GHz contributed most.

Verlock *et al* (21) measured schools, homes and public places in Belgium with a Narda NBM-550 in the frequency range 100 kHz-6 GHz. Total means for the measurements was 0.45 V/m (537 μW/m^2), for homes 0.08 V/m (16.9 μW/m^2), and maximum value in homes was 1.08 V/m (3,096 μW/m^2).

These studies, published from 2009 to 2017, show a large variation in the levels of RF radiation, with highest levels measured in Stockholm.

One obstacle to those concerned with RF radiation exposure in Sweden, as in many other countries, is that different authorities base their guideline for exposure on the International Commission on Non-Ionizing Radiation Protection (ICNIRP). This guideline is based on short-term (acute) exposure. Chronic, low-intensity cumulative exposures, possible long term health effects, and non-thermal biological effects have been ignored. The ICNIRP safety limit established in 1998 (22) was updated in 2009 (23) without change. The guideline from the ICNIRP for RF radiation is 2 to 10 W/m^2 (2,000,000 to 10,000,000 μW/m^2) depending

Table VII. Levels of RF-radiation in the boy's bedroom (Östermalm, Stockholm).

Variable	Mean	Median	Min	Max
FM	0.5	0.4	0.0	407.6
TV3	0.0	0.0	0.0	6.1
TETRA I	0.0	0.0	0.0	16.6
TETRA II	0.0	0.0	0.0	1.2
TETRA III	0.0	0.0	0.0	0.6
TV4&5	2.2	0.0	0.0	304.8
LTE 800 (DL)	448.2	292.4	2.4	8,651.6
LTE 800 (UL)	0.0	0.0	0.0	0.0
GSM + UMTS 900 (UL)	0.0	0.0	0.0	0.2
GSM + UMTS 900 (DL)	756.1	558.8	6.4	7,056.1
GSM 1800 (UL)	0.0	0.0	0.0	0.1
GSM 1800 (DL)	29.4	18.7	0.7	474.6
DECT	10.5	5.9	0.0	353.4
UMTS 2100 (UL)	0.0	0.0	0.0	0.1
UMTS 2100 (DL)	124.3	114.8	1.5	1,158.9
WIFI 2G	0.0	0.0	0.0	1.2
LTE 2600 (UL)	0.2	0.1	0.0	14.1
LTE 2600 (DL)	99.7	57.3	0.5	1,352.2
WIMax	0.0	0.0	0.0	0.0
WIFI 5G	0.0	0.0	0.0	0.9
Total	1,471.1	1,122.3	58.5	13,739.1
Total excluding down link	13.4	6.8	0.0	427.8

Levels of RF-radiation in the boy's bedroom based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017 (apartment at Östermalm, Stockholm). Analysis of all data ($\mu W/m^2$) treating values at detection limit as 0. In total 14,161 entries corresponding to almost 16 h of measurements. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

Table VIII. Levels of RF-radiation in the tower bedroom (Östermalm, Stockholm).

Variable	Mean	Median	Min	Max
FM	155.0	127.2	4.0	3,441.2
TV3	6.2	4.9	0.0	193.4
TETRA I	9.1	0.0	0.0	59.7
TETRA II	1.6	1.8	0.0	33.9
TETRA III	0.6	0.0	0.0	11.9
TV4&5	14.0	0.0	0.0	2,206.2
LTE 800 (DL)	3,712.1	2,333.8	8.6	48,136.9
LTE 800 (UL)	0.0	0.0	0.0	0.1
GSM + UMTS 900 (UL)	0.0	0.0	0.0	4.5
GSM + UMTS 900 (DL)	1,785.4	1,689.1	13.8	11,775.7
GSM 1800 (UL)	0.0	0.0	0.0	0.1
GSM 1800 (DL)	59.0	47.6	0.9	657.8
DECT	18.8	13.8	0.0	593.4
UMTS 2100 (UL)	0.0	0.0	0.0	0.7
UMTS 2100 (DL)	77.7	65.4	1.0	495.0
WIFI 2G	0.0	0.0	0.0	0.7
LTE 2600 (UL)	0.0	0.0	0.0	6.4
LTE 2600 (DL)	114.8	75.8	2.7	3,321.4
WIMax	0.0	0.0	0.0	0.0
WIFI 5G	0.0	0.0	0.0	1.5
Total	5,954.3	4,503.5	96.8	50,431.0
Total excluding down link	205.4	158.4	13.5	3,457.8

Levels of RF-radiation in the tower bedroom based on measurements in June 5, 6 and August 21, 22, 30, 31, 2017 (apartment at Östermalm, Stockholm). Analysis of all data ($\mu W/m^2$) treating values at detection limit as 0. In total 6,797 entries corresponding to almost 7.5 h of measurements. FM, frequency modulation; TV, television; LTE, long-term evolution; DL, downlink (transmission from base station to mobile phone); UL, uplink (transmission from mobile phone to base station); GSM, global system for mobile communications; UMTS, universal mobile telecommunications system; DECT, digital European cordless telecommunications; WiMAX, worldwide interoperability for microwave access.

on frequency (22). The Swedish Radiation Safety Authority (SSM) has adopted the ICNIRP guideline. Many experts at the SSM panel are also members of ICNIRP, which suggests a conflict of interest, since they would rarely compromise the ICNIRP view by expressing critical opinions (15).

Our results on RF radiation exposure in Östermalm are orders of magnitude lower than the ICNIRP guideline, with the median level of exposure being ~10,000 times lower. Using the ICNIRP guideline gives a 'green card' to roll out the technology, and position mobile phone base stations on roofs on apartment houses, in close to those living in the surrounding houses, since the high exposure level by ICNIRP is rarely compromised.

In contrast to ICNIRP, the BioInitiative Reports from 2007 and updated in 2012, based the evaluation on non-thermal health effects of RF radiation (24,25). A summary of the BioInitiative Report (2007) was published in a peer-reviewed article (26). Furthermore in both reports, all chapters were based on peer-review published articles, many of them by the authors of the different chapters. Thus, it is incorrect to suggest that the reports represent views and results that are not supported by the scientific literature.

The BioInitiative Report (2012) with updated references defined the scientific benchmark for possible health risks as 30-60 $\mu W/m^2$. Considering also chronic exposure and the sensitivity of children, the precautionary target level was proposed at 1/10th of this, i.e., 3-6 $\mu W/m^2$ (25). This exposure target level has not been acknowledged by SSM in Sweden, thus making it possible to neglect results on exposure, such as

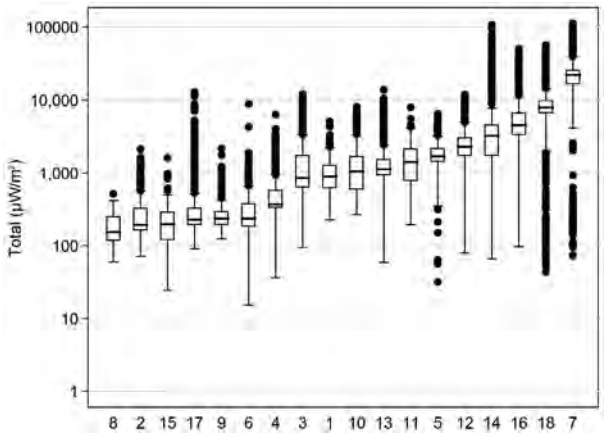


Figure 1. Box plot of exposure in μW/m^2, logarithmic scale, for the 6 measurement rounds and total exposure (apartment in Östermalm, Stockholm). The median is indicated by a black line inside each box; the bottom and top of the boxes show first and third quartiles; the end of the whiskers are calculated as 1.5xIQR (interquartile range). Points represent outliers. Results are displayed according to increasing median level. 1, Balcony outside kitchen; 2, Kitchen; 3, Dining room; 4, Master bedroom; 5, Balcony outside bathroom; 6, Living room; 7, Balcony outside living room; 8, Main hall; 9, Workroom close to kitchen; 10, Workroom close to laundry; 11, Laundry; 12, Girl's bedroom; 13, Boy's bedroom; 14, Balcony outside boy's bedroom; 15, Hall outside elevator; 16, Bedroom in tower; 17, Conference room in tower; 18, Balcony outside tower.

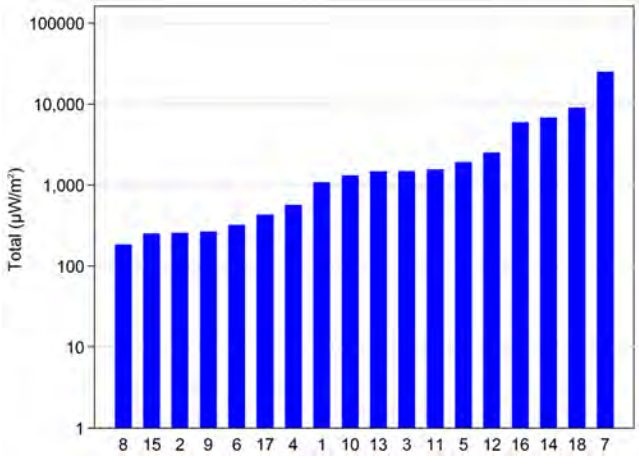


Figure 2. Bar graph on mean levels of total exposure in μW/m^2 displayed with a logarithmic scale and ranked according to increasing mean level in the different locations (apartment in Östermalm, Stockholm). 1, Balcony outside kitchen; 2, Kitchen; 3, Dining room; 4, Master bedroom; 5, Balcony outside bathroom; 6, Living room; 7, Balcony outside living room; 8, Main hall; 9, Workroom close to kitchen; 10, Workroom close to laundry; 11, Laundry; 12, Girl's bedroom; 13, Boy's bedroom; 14, Balcony outside boy's bedroom; 15, Hall outside elevator; 16, Bedroom in tower; 17, Conference room in tower; 18, Balcony outside tower.

in the apartment we measured, and not in providing precaution for the potential detrimental effects on health for those living therein.

We used the same exposimeter in the Geneva WHO building on March 3, 2017. The results show a low mean total exposure level of 21.5 μW/m^2, median 13.3 μW/m^2 (range min 4.8, max 433 μW/m^2), i.e., a mean level below the scientific benchmark of 30-60 μW/m^2 that has been proposed as the 'lowest observed effect level' (LOEL) for RF radiation,

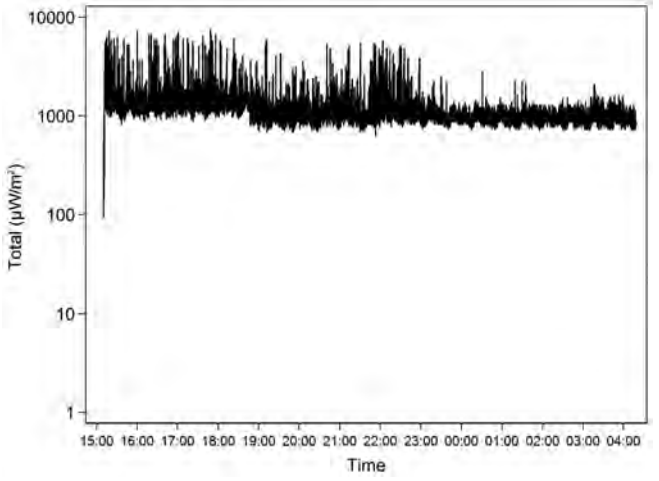


Figure 3. Time variation of measurements in boy's bedroom (apartment in Östermalm, Stockholm) from the afternoon until early next morning (μW/m^2 on a logarithmic scale). The spikes represent measurements taken every 4th sec.

[see Chapter 24 in the BioInitiative Report (25)]. The major sources were GSM + UMTS 900 DL (3G), GSM 1800 DL (2G) and UMTS 2100 DL (3G), i.e., down link (DL) of RF radiation from base stations. Thus these results indicate that, whether known or unknown, the WHO staff seems to protect themselves from high involuntary RF radiation levels at least within the measured areas of the Geneva building (15).

In the present study, for the whole apartment including the balconies, the measurements of RF radiation had a total mean of 3,811 μW/m^2 and a total median of 1,313 μW/m^2. For rooms inside the apartment, the tower bedroom had the highest mean (5,954 μW/m^2) and median (4,504 μW/m^2). Also the girl's bedroom with mean 2,531 μW/m^2 and median 2,271 μW/m^2 and the boy's bedroom with a mean of 1,471 μW/m^2 and median 1,122 μW/m^2 were high values. Time spent in a bedroom is usually many hours per night, which means long term exposure when relatively high levels of RF radiation are still present.

RF radiation exposure at or below these levels indicated above have influenced several physiological parameters in the body of mammals in laboratory studies. Effects on oxidative cell stress and DNA damage in cells, opening of the blood-brain barrier, up or down regulated proteins and microRNA in the brain, and testicular dysfunction, have been found. For people living near mobile phone base stations, effects have been seen on neurotransmitters, peripheral blood lymphocytes with DNA damage, lower antioxidant levels, decreased salivary secretion, adverse neuro-behavioral symptoms, and an increased incidence of cancer. People residing near mobile phone base stations have more often complained of sleep disturbances, headaches, dizziness, irritability, concentration difficulties and hypertension. Exposures to RF radiation were all below the reference levels in the ICNIRP guidelines. The effects were caused by non-thermal RF radiation exposure and will now be briefly discussed.

In rats exposed to RF radiation, the blood brain barrier (BBB) has opened up, leading to leakage into the brain tissues of large molecules, e.g., albumin and toxins that can

Table IX. Levels of RF-radiation in total for different locations in the apartment (Gärdet, Stockholm).

Location	No.	Mean	Median	Min	Max
Kitchen	6,815	9.2	7.8	4.2	55.6
Dining room	5,970	16.2	15.4	6.2	60.6
Bedroom	8,163	10.7	8.6	3.9	58.2
Living room	8,229	18.4	17.0	7.5	97.8
Hall	5,809	4.2	3.9	2.2	20.6
Balcony	1,813	82.4	73.1	9.1	195.1
Whole apartment	36,799	15.6	12.8	2.2	195.1
Whole apartment-excluding down link	36,799	1.1	0.7	0.0	124.6

Levels of RF-radiation in total for different locations in the apartment based on measurements in October 27-29 and November 6, 2017 (Gärdet, Stockholm). Analysis of all data (μW/m^2) treating values at detection limit as 0. Numbers of entries are given for the different locations.



Figure 4. Image taken from the balcony outside the living room where the highest mean and median were measured (24,885.9 and 22,256.1 μW/m^2). One group of base stations is located only 12 m from the balcony.

damage the brain tissue. The BBB is supposed to protect and prevent pathological leakage of toxins from the blood vessels (27). Several studies have shown that the BBB can open after RF radiation from a GSM mobile phone with a peak power output of only 1,000 μW, and with an average whole body specific energy absorption rate (SAR) of down to 120 μW/kg (28). Stronger effects on health due to RF radiation at lower exposure levels than at higher exposure indicate a U-shaped response curve (28,29).

Difference between sexes exposed to different RF radiation frequencies has been reported, where only female rats showed increased BBB permeability at 900 MHz frequency, whereas male rats had increased BBB permeability at both GSM 900 and 1,800 MHz pulse-modulated RF radiation (30).

Exposure to 900 MHz for 3 h per day for 28 days caused extravasation of albumin in the hippocampus and cortex, and impaired spatial memory in rats. The hippocampus, a center for co-ordination of memory and learning in the brain, seems in particular to be a primary target for neuronal damage from RF radiation and opening of the BBB (31). Exposure for 2 h each week for 55 weeks impaired the memory in rats exposed to GSM 900 MHz, but histopathological parameters did not seem to be statistically significantly affected (32,33).

Higher sensitivity to RF radiation has been reported in growing organisms. An increase in protein synthesis in proliferating human cells has been seen after 8 h of RF radiation exposure, but not in quiescent white blood cells (34). In stems cells, the capacity to repair DNA double-strand breaks was more affected by RF radiation compared to differentiated cells (fibroblasts) (35).

Mice exposed to RF radiation from a GSM 900 MHz mobile phone for 3 h/day or to DECT base station for 8 h/day over 8 months showed an up or down regulation of 143 out of 432 proteins analyzed from the cerebellum, hippocampus and frontal lobes of the brain. Several proteins involved in the brain metabolism and different neural functions were altered (36).

Two long-term studies have exposed rats for 24 h a day for 12 months to RF radiation emitted from a Wi-Fi system at 2.4 GHz. The peak power was 100,000 μW, with the antenna 50 cm above the cage. The SAR value over 10 g of brain tissue was 1,030 μW/kg. One study examined 5 different microRNAs (miRNA) in the rat brains, 2 of which decreased at least 70%. miRNA is important in the proliferation, differentiation, function and maintenance of all cells, including neurons; and dysfunction of their pathways can contribute to pathogenesis of neurodegenerative disorders, as well as being a key indicator of epigenetic changes and cancer risk (37).

Rat testes and prostate were examined in another study, where the SAR value was 1,020 W/kg over 10 gram tissue. The Wi-Fi exposed rats showed statistically significant greater effects on testicular function and histology, and increased defects in the heads of sperms (38). DNA damage in sperms has been reported in several other Wi-Fi exposure investigations (39-41).

In a review of 100 studies, Yakymenko *et al* (42) showed oxidative effects of low-intensity RF radiation on living cells, with exposure down to 2,500 μW/m^2 (43). SAR values down to 600 μW/kg increased oxidative stress in the cells (44,45). Embryos of Japanese quails were exposed to RF radiation using GSM 900 MHz (46). The average intensity of RF radiation on the surface of hatching eggs was 2,500 μW/m^2 (0.25 μW/cm^2). SAR was calculated to be 3 μW/kg. A statistically significant overproduction of reactive oxygen species (ROS) and oxidative damage of DNA in living cells was reported compared with the control group given no exposure. The exposure was far below the guideline of the ICNIRP for RF radiation at 2 to 10 W/m^2 depending on frequency and 2 W/kg to the brain. The results showed that the ICNIRP guidelines are outdated. Moreover, using a safety factor of 10 would give 250 μW/m^2 as a guideline, a level easily exceeded in many places, e.g., our measurements taken at the Stockholm Central Railway

Station (13), in the Old Town (14) and in most rooms in the present apartment at Östermalm.

Long-term RF radiation exposure for 2 h per day 5 days per week for 30-180 days at SAR values of 595-667 μW/kg and at the frequencies 900, 1,800 and 2,450 MHz resulted in oxidative stress, increase in pro-inflammatory cytokines, DNA damage with single-strand breaks, reduced levels of neurotransmitters and downregulation of mRNA in the hippocampus in the brain of rats (45,47,48), with memory and learning also being affected (47). More deleterious effects on several of the parameters were seen with an increase in frequency; 1,800 MHz and 2,450 MHz had a statistically significant effect, not only compared with sham exposed animals, but in some cases compared with 900 MHz exposure.

Even a SAR value down to 85 μW/kg exposure from 900 MHz during 2 h/day, 5 days/week for 30 days, increased oxidative stress parameters in lipid peroxidation and protein oxidation, and resulted in a statistically significant impairment in spatial memory in rats (49).

The pancreas was examined in young rats of 6 weeks of age exposed for 3 h/day for 30 days to 2.45 MHz, pulsed 217 Hz, from a RF test generator, with similar exposure to Wi-Fi 2.45 GHz. Compared to the control group, these rats had statistically significant increased levels of glucose, lipase and amylase in the blood, degenerative changes in both endocrine and exocrine cells, increased inflammatory cells and immune-positive markers, especially in the islets of Langerhans. These findings point to a deleterious effect on both endocrine and exocrine functioning of the pancreas. Langerhans islets secret hormones like insulin, glucagon and somatostatin, which regulate blood glucose levels; insufficient secretion can lead to diabetes, which have seen a big increase during the last few decades in parallel with the fast increasing use of wireless techniques (50).

The National Toxicology Program (NTP) under the National Institutes of Health (NIH) in the USA released a report in 2016 which showed an increased incidence of glioma in the brain and malignant schwannoma in the heart in up to 2 years in RF irradiated rats. These findings support human epidemiological studies on brain tumor risk and strengthen the association between RF radiation and cancer (51). Recent results from the NTP study showed genotoxicity of RF radiation in rats and mice (52). This result supports several previous findings of DNA strand-breaks in rat brain cells exposed to RF radiation, as first published by Lai and Singh (53). RF radiation leads to oxidative stress in biological systems, including the brain, due to an increase in free radicals and changes in antioxidant defence systems.

The NTP study has greatly strengthened the evidence of cancer risk, and reaffirms that there is sufficient scientific evidence to reclassify wireless phone radiation as a carcinogenic agent in Group 1, according to the IARC classification. It confirms that the current public safety limits based only on the thermal effects are inadequate and do not protect us against the associated detrimental health effects (10,11).

In the village of Rimbach in Germany, a GSM mobile base station was built in 2004. Buchner and Eger (54) studied 60 inhabitants (aged 0-69 years), measuring the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (PEA) in second morning urine samples before the base station was activated, and at 6, 12 and 18 months after activation. RF radiation was measured in peak value of the power density after the activation of the base station outside each participant's houses. The participants were divided into 3 groups based on exposure: less than 60, 60-100 or >100 μW/m^2. The stress hormones adrenaline and noradrenaline were significantly increased over the first 6 months after the activation of the GSM base station. The levels decreased, but were not restored to initial level, after 18 months. This was especially evident in the children and the chronically ill adults. A statistically significant decrease was seen for dopamine levels over the first 6 months, after which dopamine levels increased, but did not return to their initial level. For the participants with RF radiation exposure over 100 μW/m^2 at home, the 3 neurotransmitters showed a clear dose-response relationship. PEA levels decreased first for the highest exposed group, but after 18 months the 3 groups were all statistically significantly decreased. DECT, Wi-Fi and other wireless devices at home seemed to amplify the effect of GSM radiation. After 18 months, even the lowest exposed group (RF radiation <60 μW/m^2) had decreased dopamine and PEA levels.

PEA is often low in patients with depression, and in adults and children with attention deficit hyperactivity disorder (ADHD). Chronic dysregulation of the catecholamine system and PEA may contribute to chronic illnesses and health problems in the long term. Several of the 60 participants had new symptoms, including headache, dizziness, concentration problems, sleep disturbances and allergies (54).

Khurana *et al* (55) reviewed epidemiological studies on populations living near mobile phone base stations for indications of any health risks for humans. In 80% of the studies, people living <500 m from base stations had an increased prevalence in particular of adverse neuro-behavioral symptoms and cancer. In another review of 56 studies, Levitt and Lai (56) found that exposure from base stations and other antenna arrays induced changes in immunological and reproductive systems, DNA double-strand breaks, influence on calcium movement in the heart, and increased proliferation of astrocytoma cancer cells in humans and laboratory animals. Cortisol and thyroid hormones were also affected in people living near base stations (57,58).

A study with 40 healthy persons in India living <80 m from a mobile phone base station showed that RF radiation definitely induced DNA damage, a lowering of antioxidants levels, and a higher frequency of micronuclei in peripheral blood lymphocytes compared with a control group living >300 m from the base station. Those exposed were between 20 and 40 years old, 18 being male and 22 female. All but 3 used a mobile phone every day. None of the participants had occupational exposure to RF radiation and none lived near a high tension electric power line or electric transformer station (59).

Sleep disturbances, burned-out syndromes, depressions, pain problems and sick leaves are being increasingly reported in our daily papers. Scientific studies on humans, animals and biological material show adverse effects on physiological parameters due to RF radiation. The complex picture relates to wellbeing within the stress of working life and at home, and the rapid technological development leading to more sedentary behavior, with both children and adults watching the screen of a smart phone, laptop or television for many hours each day.

RF radiation may contribute to deterioration in physical and mental wellbeing and health. There seems also to be a large difference in sensitivity to RF radiation between individuals, both in humans and animals (28,60). One example is the findings of downregulation of a sleep-inducing neurohormone in the age group of 18-30 years. Its level decreased with increasing number of years in use of a wireless phone (61), whereas no effect was seen among older persons (62). Since tumors take several decades to develop, and chronic illnesses, like neurological and cardiac diseases, come in older ages, we will only know in the future if and to what degree RF radiation may influence on the incidence of these illnesses and disorders.

Children are probably more sensitive to RF radiation because of their growing bodies and more immature cells, and also because they will be exposed for probably a whole lifetime in contrast to present generation (34,35,63). High mean exposure levels in the bedrooms of growing children (one at 2,531 $\mu W/m^2$ and the other at 1,471 $\mu W/m^2$) may have deleterious effects on their physical and mental health, based on data already obtained from humans and animals. Cognitive effects have also been found in such studies (17,32,48,49), which might affect a child's future work and memory function in older age.

This study shows high RF radiation levels in an apartment with 2 groups of base stations in the near vicinity. Of special concern is the levels in bedrooms, especially those two used by children, since they seem to be more vulnerable to adverse health effects than grown-ups. They have also a longer expected life in which illnesses may later become manifest. The results indicate that this apartment is unsuitable for long-term living based on current knowledge of the potential adverse effects on health of RF radiation. For definitive conclusions regarding the effects of RF radiation levels from the base stations, one option would be to turn off all nearby base stations and make new measurements; some exposure from more distant located base stations cannot be excluded. However, the present results show that the safest solution is to turn off permanently and dismantle the base stations.

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Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to measurements performed in a private apartment, but are available from the corresponding author on reasonable request.

Authors' contributions

LHa made all measurements and drafted the article. MC made all statistical analyses, tables and figures. LHe was responsible for the literature review of other measurement studies in homes and studies about the biological effects from non-thermal levels of RF radiation. All authors contributed to the final article and approved the submitted version.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. Cardis E, Deltour I, Mann S, Moissonnier M, Taki M, Varsier N, Wake K and Wiart J: Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. Phys Med Biol 53: 2771-2783, 2008.
2. Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB and Davis DL: Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 31: 34-35, 2012.
3. Baan R, Grosse Y, Lauby Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
4. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields, vol. 102. IARC, Lyon, 2013. http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf. Accessed November 9, 2017.
5. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 38: 1465-1474, 2011.
6. INTERPHONE Study Group: Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.
7. Hardell L, Carlberg M, Söderqvist F and Hansson Mild K: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.
8. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R and Baldi I: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
9. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma-Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22: 1-13, 2015.
10. Carlberg M and Hardell L: Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. Biomed Res Int 2017: 9218486, 2017.
11. Hardell L and Carlberg M: Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones. Rev Environ Health 28: 97-106, 2013.
12. Hill AB: The environment and disease: Association or causation? Proc R Soc Med 58: 295-300, 1965.
13. Hardell L, Koppel T, Carlberg M, Ahonen M and Hedendahl L: Radiofrequency radiation at Stockholm central railway station in Sweden and some medical aspects on public exposure to RF fields. Int J Oncol 49: 1315-1324, 2016.
14. Hardell L, Carlberg M, Koppel T and Hedendahl L: High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament. Mol Clin Oncol 6: 462-476, 2017.

15. Hardell L: World Health Organization, radiofrequency radiation and health-a hard nut to crack (Review). Int J Oncol 51: 405-413, 2017.
16. Estenberg J and Augustsson T: Extensive frequency selective measurements of radiofrequency fields in outdoor environments performed with a novel mobile monitoring system. Bioelectromagnetics 35: 227-230, 2014.
17. Calvente I, Pérez-Lobato R, Núñez MI, Ramos R, Guxens M, Villalba J, Olea N and Fernández MF: Does exposure to environmental radiofrequency electromagnetic fields cause cognitive and behavioral effects in 10-year-old boys? Bioelectromagnetics 37: 25-36, 2016.
18. Frei P, Mohler E, Neubauer G, Theis G, Bürgi A, Fröhlich J, Braun-Fahrländer C, Bolte J, Egger M and Röösli M: Temporal and spatial variability of personal exposure to radio frequency electromagnetic fields. Environ Res 109: 779-785, 2009.
19. Roser K, Schoeni A, Struchen B, Zahner M, Eeftens M, Fröhlich J and Röösli M: Personal radiofrequency electromagnetic field exposure measurements in Swiss adolescents. Environ Int 99: 303-314, 2017.
20. Vermeeren G, Markakis I, Goeminne F, Samaras T, Martens L and Joseph W: Spatial and temporal RF electromagnetic field exposure of children and adults in indoor micro environments in Belgium and Greece. Prog Biophys Mol Biol 113: 254-263, 2013.
21. Verlock L, Joseph W, Goeminne F, Martens L, Verlack M and Constandt K: Assessment of radiofrequency exposures in schools, homes, and public places in Belgium. Health Phys 107: 503-513, 2014.
22. International Commission on Non-Ionizing Radiation Protection: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.
23. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
24. BioInitiative Working Group: BioInitiative Report 2007: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2007. http://www.bioinitiative.org/table-of-contents/. Accessed November 9, 2017.
25. BioInitiative Working Group: BioInitiative Report 2012: A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Radiation. Sage C and Carpenter DO (eds). http://www.bioinitiative.org. Accessed November 9, 2017.
26. Hardell L and Sage C: Biological effects from electromagnetic field exposure and public exposure standards. Biomed Pharmacother 62: 104-109, 2008.
27. Salford LG, Brun AE, Eberhardt JL, Malmgren L and Persson BR: Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. Environ Health Perspect 111: 881-883; Discussion A408, 2003.
28. Nittby H, Brun A, Eberhardt J, Malmgren L, Persson BR and Salford LG: Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. Pathophysiology 16: 103-112, 2009.
29. Eberhardt JL, Persson BR, Brun AE, Salford LG and Malmgren LO: Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones. Electromagn Biol Med 27: 215-229, 2008.
30. Sırav B and Seyhan N: Effects of GSM modulated radio-frequency electromagnetic radiation on permeability of blood-brain barrier in male & female rats. J Chem Neuroanat 75: 123-127, 2016.
31. Tang J, Zhang Y, Yang L, Chen Q, Tan L, Zuo S, Feng H, Chen Z and Zhu G: Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. Brain Res 1601: 92-101, 2015.
32. Nittby H, Grafström G, Tian DP, Malmgren L, Brun A, Persson BR, Salford LG and Eberhardt J: Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation. Bioelectromagnetics 29: 219-232, 2008.
33. Grafström G, Nittby H, Brun A, Malmgren L, Persson BR, Salford LG and Eberhardt J: Histopathological examinations of rat brains after long-term exposure to GSM-900 mobile phone radiation. Brain Res Bull 77: 257-263, 2008.
34. Gerner C, Haudek V, Schandl U, Bayer E, Gundacker N, Hutter HP and Mosgoeller W: Increased protein synthesis by cells exposed to a 1,800-MHz radio-frequency mobile phone electromagnetic field, detected by proteome profiling. Int Arch Occup Environ Health 83: 691-702, 2010.
35. Markovà E, Malmgren LO and Belyaev IY: Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells stronger than in differentiated cells: Possible mechanistic link to cancer risk. Environ Health Perspect 118: 394-399, 2010.
36. Fragopoulou AF, Samara A, Antonelou MH, Xanthopoulou A, Papadopoulou A, Vougas K, Koutsogiannopoulou E, Anastasiadou E, Stravopodis DJ, Tsangaris GT and Margaritis LH: Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation. Electromagn Biol Med 31: 250-274, 2012.
37. Dasdag S, Akdag MZ, Erdal ME, Erdal N, Ay OI, Ay ME, Yilmaz SG, Tasdelen B and Yegin K: Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue. Int J Radiat Biol 91: 555-561, 2015.
38. Dasdag S, Tas M, Akdag MZ and Yegin K: Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. Electromagn Biol Med 34: 37-42, 2015.
39. Avendaño C, Mata A, Sanchez Samiento CA and Doncel GF: Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril 97: 39-45.e2, 2012.
40. Atasoy HI, Gunal MY, Atasoy P, Elgun S and Bugdayci G: Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. J Pediatr Urol 9: 223-229, 2013.
41. Akdag MZ, Dasdag S, Canturk F, Karabulut D, Caner Y and Adalier N: Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats? J Chem Neuroanat 75: 116-122, 2016.
42. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35: 186-202, 2016.
43. Burlaka A, Tsybulin O, Sidorik E, Lukin S, Polishuk V, Tsehmistrenko S and Yakymenko I: Overproduction of free radical species in embryonal cells exposed to low intensity radiofrequency radiation. Exp Oncol 35: 219-225, 2013.
44. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK and Abegaonkar MP: Microwave radiation induced oxidative stress, cognitive impairment and inflammation in brain of Fischer rats. Indian J Exp Biol 50: 889-896, 2012.
45. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R and Abegaonkar MP: Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology 51: 158-165, 2015.
46. Tsybulin O, Sidorik E and Yakymenko I: Oxidative effect of low-intensity microwave radiation in the model of developing quail embryos. Oxid Antioxid Med Sci 6: 9-13, 2017.
47. Megha K, Deshmukh PS, Ravi AK, Tripathi AK, Abegaonkar MP and Banerjee BD: Effect of low-intensity microwave radiation on monoamine neurotransmitters and their key regulating enzymes in rat brain. Cell Biochem Biophys 73: 93-100, 2015.
48. Deshmukh PS, Nasare N, Megha K, Banerjee BD, Ahmed RS, Singh D, Abegaonkar MP, Tripathi AK and Mediratta PK: Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation. Int J Toxicol 34: 284-290, 2015.
49. Deshmukh PS, Banerjee BD, Abegaonkar MP, Megha K, Ahmed RS, Tripath AK and Mediratta PK: Effect of low level microwave radiation exposure on cognitive function and oxidative stress in rats. Indian J Biochem Biophys 50: 114-119, 2013.
50. Topsakal S, Ozmen O, Cicek E and Comlekci S: The amelioratove effect of gallic acid on pancreas lesions induced by 2,45 GHz electromagnetic radiation (Wi-Fi) in young rats. J Rad Res Appl Sci 10: 233-240, 2017.
51. Wyde M, Cesta M, Blystone C, Elmore S, Foster P, Hooth M, Kissling G, Malarkey D, Sills R, Stout M, *et al*: Report of Partial findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposure). US National Toxicology Program (NTP), 2016. http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf. Accessed November 9, 2017.

52. Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GA and Tice RR: Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. In: Proceedings of the Environmental Mutagenesis and Genomics Society, 48th Annual Meeting, Raleigh, NC, 2017.
53. Lai H and Singh NP: Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. Bioelectromagnetics 18: 446-454, 1997.
54. Buchner K and Eger H: Changes of clinically important neurotransmitters under the influence of modulated RF-fields-a long term study under real-life conditions. Umwelt Med Ges 24: 44-57, 2011.
55. Khurana VG, Hardell L, Everaert J, Bortkiewicz A, Carlberg M and Ahonen M: Epidemiological evidence for a health risk from mobile phone base stations. Int J Occup Environ Health 16: 263-267, 2010.
56. Levitt BB and Lai H: Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environ Rev 18: 369-395, 2010.
57. Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J and Pauser G: Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed Environ Sci 23: 199-207, 2010.
58. Eskander EF, Estefan SF and Abd-Rabou AA: How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin Biochem 45: 157-161, 2012.
59. Zothansiama, Zosangzuali M, Lalramdinpuii M and Jagetia GC: Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med 36: 295-305, 2017.
60. Hedendahl L, Carlberg M and Hardell L: Electromagnetic hypersensitivity-an increasing challenge to the medical profession. Rev Environ Health 30: 209-215, 2015.
61. Hardell L, Söderqvist F, Carlberg M, Zetterberg H and Mild K: Exposure to wireless phone emissions and serum beta-trace protein. Int J Mol Med 26: 301-306, 2010.
62. Söderqvist F, Carlberg M, Zetterberg H and Hardell L: Use of wireless phones and serum β-trace protein in randomly recruited persons aged 18-65 years: A cross-sectional study. Electromagn Biol Med 31: 416-424, 2012.
63. Morgan LL, Kesari S and Davis DL: Why children absorb more microwave radiation than adults: The consequences. J Microsc Ultrastruct 2: 197-204, 2014.


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Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz

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Abstract. During the use of handheld mobile and cordless phones, the brain is the main target of radiofrequency (RF) radiation. An increased risk of developing glioma and acoustic neuroma has been found in human epidemiological studies. Primarily based on these findings, the International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) classified in May, 2011 RF radiation at the frequency range of 30 kHz-300 GHz as a 'possible' human carcinogen, Group 2B. A carcinogenic potential for RF radiation in animal studies was already published in 1982. This has been confirmed over the years, more recently in the Ramazzini Institute rat study. An increased incidence of glioma in the brain and malignant schwannoma in the heart was found in the US National Toxicology Program (NTP) study on rats and mice. The NTP final report is to be published; however, the extended reports are published on the internet for evaluation and are reviewed herein in more detail in relation to human epidemiological studies. Thus, the main aim of this study was to compare earlier human epidemiological studies with NTP findings, including a short review of animal studies. We conclude that there is clear evidence that RF radiation is a human carcinogen, causing glioma and vestibular schwannoma (acoustic neuroma). There is some evidence of an increased risk of developing thyroid cancer, and clear evidence that RF radiation is a multi-site carcinogen. Based on the Preamble to the IARC Monographs, RF radiation should be classified as carcinogenic to humans, Group 1.

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Introduction

Recently, the US National Toxicology Program (NTP) released results on the toxicology and carcinogenicity of radiofrequency (RF) radiation in rats and mice, as further discussed below. This initiated this article for the comparison of earlier human epidemiological studies with the NTP the findings, including a short review of animal studies.

NTP is an interagency program established in 1978 to coordinate toxicology research and testing across the Department of Health and Human Services. The program was also created to strengthen the science base in toxicology, develop and validate improved testing methods, and provide information about potentially toxic chemicals to health regulatory and research agencies, scientific and medical communities, and the public. NTP is headquartered at the National Institute of Environmental Health Sciences (NIEHS) (https://ntp.niehs.nih.gov/about/org/index.html).

The brain is the main target of the exposure to RF radiation during the use of handheld wireless phones; both mobile and cordless phones (1,2). Thus, an increased risk of developing brain tumors has long been a cause for concern.

Our study group has since the end of the 1990s published results from case-control studies on use of wireless phones and brain tumor risk (3). A statistically significant increased risk for ipsilateral use of mobile phones, the same side of the brain as the phone was used, was published for malignant brain tumors (4) and vestibular schwannoma (5). Further scientific evidence on the association has more recently been discussed by Carlberg and Hardell (6).

In May, 2011 the International Agency for Research on Cancer (IARC) concluded that radiofrequency (RF) radiation in the frequency range 30 kHz-300 GHz is a 'possible' human carcinogen Group 2B (7,8). The classification was based primarily on evidence that long-term users of wireless phones (mobile and cordless phones) have an increased risk for glioma and acoustic neuroma. One major reason that the rating was not a 'probable' or a 'known' risk was the lack of clear evidence from animal studies. IARC at the World Health Organization (WHO) is independently financed and has its own governing and scientific councils, which WHO staff

only attend as observers (http://www.who.int/ionizing_radiation/research/iarc/en/).

Unfortunately, WHO itself has constantly refused to acknowledge the carcinogenicity of RF radiation. In fact, WHO seems to rely on the conclusion of the non-governmental organization International Commission on Non-ionizing Radiation Protection (ICNIRP) instead of the IARC evaluation. That organization is even declared to be their in-house experts (9,10). ICNIRP is a private non-governmental organisation (NGO) based in Germany. New expert members can only be elected by members of the organization. Many of the ICNIRP members have ties to the industry that are dependent on the ICNIRP guidelines (11). This creates a conflict of interest, since the former leader of the WHO International Electromagnetic Field (EMF) Project is also the founder and honorary member of the ICNIRP (11). The guidelines are of huge economic and strategic importance to the military, telecom/IT and power industry. These circumstances are further discussed in a recent publication (12).

The IARC cancer classification includes all sources of RF radiation. The exposure from mobile phone base stations, DECT base stations, Wi-Fi access points, smart phones, laptops and tablets can be long-term, sometimes around the clock, at home, at the work place, at school and in the environment. For children, this risk may be accentuated due to a cumulative effect during a long lifetime use (13).

The exposure guidelines used by many agencies and countries were established in 1998 by the ICNIRP and were based only on established short-term thermal (heating) effects from RF radiation neglecting non-thermal biological effects (14). ICNIRP provides the guideline of 2 to 10 W/m^2 for RF radiation, depending on the frequency. The ICNIRP guidelines were updated in 2009; however, they still do not cover cancer and other long-term or non-thermal effects (15) [see also Hardell (10)].

In contrast to the ICNIRP, the BioInitiative Reports from 2007 and 2012 based the evaluation also on the non-thermal health effects from RF radiation (16,17). The scientific benchmark for possible health risks was defined to be 30 to 60 μW/m^2. In 2012, the Bioinitiative Working Group proposed a precautionary target level of 3-6 μW/m^2, using a safety factor of 10. Using the significantly higher guideline by ICNIRP gives a 'green card' to roll out the wireless digital technology, thereby not considering non-thermal health effects from RF radiation.

The evidence of RF radiation as a carcinogen was confirmed when NTP released preliminary results of a study of long-term exposure of rats and mice to cell phone radiation (18). An increased incidence of glioma in the brain and malignant schwannoma in the heart was found. The NTP study has now been published online for public consultations (19,20) and is discussed below in relation to human epidemiological studies.

Background: Evidence from previous animal studies

There are several earlier animal studies that demonstrate the carcinogenic potential of RF radiation. Szmigielski *et al* already in 1982 published a study on the co-carcinogenic effects of RF radiation exposure and benzopyrene in mice (21). Cancer promotion was found for 2,450 MHz RF radiation at either 50 or 150 W/m^2. The results revealed an acceleration of spontaneous and chemically-induced cancers.

Non-thermal 2,450 MHz continuous-wave RF radiation has been shown to cause a biphasic effect on glioma cells (22) and lymphocytes (23). Cell proliferation was found at a specific absorption rate (SAR) of ≤50 W/kg, whereas a higher SAR suppressed DNA and RNA synthesis.

SAR ranged from 0.144 to 0.4 W/kg depending on the rats' weight in a study from 1992 on 200 rats exposed to 2,450 MHz pulsed RF radiation 21.5 h per day for 25 months (24). Compared with 200 sham-exposed rats, a statistically significant increased incidence of primary malignant diseases was found in exposed animals. Among the malignancies found in the exposed rats were malignant lymphoma and thyroid cancer. These findings are of interest since SAR values in the study were rather low compared to the ICNIRP guideline on SAR 2 W/kg to the brain for use of mobile phones (14).

A total of 100 mice were sham-exposed and 101 were exposed for two 30-min periods per day for up to 18 months to 900 MHz pulsed RF radiation with power densities 2.6-13 W/m^2 (SAR 0.008-4.2 W/kg, averaging 0.13-1.4 W/kg). The mice carried a lymphomagenic oncogene and their risk of developing lymphoma was found to be statistically significantly higher in the exposed mice than in the controls (25).

The same results were not found in the study by Utteridge *et al* (26) that has been criticized as it was not a replication study. However, the findings on lymphoma risk by Repacholi *et al* (25) and Chou *et al* (24) are of relevance in relation to the indications of an increased risk of non-Hodgkin lymphoma (NHL) in human epidemiological studies on the use of wireless phones. Thus, a statistically significant increased risk of T-Cell NHL was found in one study (27). In another study, NHL not otherwise specified was statistically significantly increased among subjects with ≥6 years duration [odds ratio (OR) =4.4 in men] for mobile phone use (28), although based on low numbers (n=7).

The thyroid gland is among the organs with the highest exposure to RF radiation during the use of the handheld wireless phone, particularly smartphones (29,30). The finding of thyroid cancer risk in the study by Chou *et al* (24), and the sharp increase in the incidence of thyroid cancer in humans during recent years (31) are of interest in that context.

In another study, mice were exposed to universal mobile telecommunications system (UMTS) fields with intensities of 0 (sham), 4.8 and 48 W/m^2 up to 24 months (32). The low-dose group, exposed to 4.8 W/m^2, was subjected to additional prenatal ethylnitrosourea (ENU) treatment. That group showed an increased lung tumor rate and an increased incidence of lung carcinomas as compared to the controls treated with ENU only. This indicated a cocarcinogenic effect of a lifelong UMTS exposure in female mice pretreated with ENU (32).

In a follow-up study, mice were exposed to RF radiation: 0 (sham), 0.04, 0.4 and 2 W/kg SAR (33). The numbers of tumors of the lungs and livers in exposed animals were statistically significantly higher than in sham-exposed controls, and the numbers of malignant lymphoma were also higher. A tumor-promoting effect of RF radiation was found at low to moderate levels (0.04 and 0.4 W/kg SAR), well below the ICNIRP exposure limits for users of mobile phones (33).

The study by the Ramazzini Institute is the largest long-term study ever performed on the health effects of RF radiation,

including 2,448 rats (34). Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz global system for mobile communication (GSM) far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day. A statistically significant increase in the incidence of malignant Schwannoma in the heart was found in male rats at the highest dose, 50 V/m, corresponding to 0.66 mW/cm^2 and whole-body SAR of 0.1 W/Kg. An increased incidence of heart Schwann cell hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), but was not statistically significant. In treated female rats at the highest dose (50 V/m), the incidence of malignant glial tumors was increased, although this was not statistically significant. The study revealed an increased incidence of tumor types similar to those associated with the use of wireless phones, glioma and acoustic neuroma, in human epidemiological studies.

The NTP study provides additional confirmation of the carcinogenicity of RF radiation (19,20). They showed an increased incidence of malignant schwannoma in the heart and brain glioma in male rats exposed either to GSM-modulated or code division multiple access (CDMA)-modulated cell phone RF radiation for two years. There are also increased incidences of some other tumor types and diseases. Below we discuss some of the major findings.

The results on schwannoma and glioma are of particular concern since they corroborate human epidemiological findings. Thus, it is noteworthy that similar tumors were found in the NTP study as in epidemiological studies on the human use of wireless phones; mobile phones or cordless phones (DECT). Malignant schwannoma in the heart is a similar type of tumor as vestibular schwannoma in humans, also known as acoustic neuroma, although acoustic neuroma is usually benign and rarely undergoes malignant transformation.

Below, we provide an updated evaluation of the scientific evidence of an increased risk of developing glioma and vestibular schwannoma (acoustic neuroma) associated with the use of wireless phones. It is pertinent to provide an updated presentation of the NTP reports on current evidence on cancer risks associated with the use of wireless phones.

Since the IARC evaluation in 2011, more human epidemiological studies have been published that support a causal association between RF radiation and brain and head tumors. A Danish cohort study on 'mobile phone users' (35,36) is not included herein due to serious methodological shortcomings in the study design [see Söderqvist *et al* (37)]. The study by Benson *et al* (38) is of limited value since the use of cordless phones was not included, mobile phone use was assessed only at baseline and no information on tumor laterality, including ipsilateral versus contralateral use was given. In spite of the many shortcomings, an increased risk of developing acoustic neuroma was reported. The study will not be further discussed below.

In the following, first, human epidemiological studies on specific tumor types are discussed. The NTP study findings are then presented and finally, an evaluation of the combined evidence from human and animal studies is presented.

Glioma

Human studies. Glioma is the most common malignant brain tumor and represents approximately 60% of all central nervous system (CNS) tumors. Most of these are astrocytic tumors divided into low-grade (WHO grades I-II) and high-grade (WHO grades III-IV). The most common glioma type is glioblastoma multiforme (WHO grade IV) with a peak incidence in the age group of 45-75 years and a median survival less than one year (39). No substantial increasing survival has been obtained in recent years. Three research groups have provided results in case-control studies on glioma, Interphone (40), Coureau *et al* (41) and the Hardell group in Sweden (42-46).

The random effects model was used for a meta-analyses of published studies, based on the test for heterogeneity in the overall group ('all mobile'), see also http://www.bioinitiative.org/report/wp-content/uploads/2017/11/Hardell-2017-Sec11-Update-Use_of_Wireless_Phones.pdf. Note that only our group also assessed the use of cordless phones. Thus, the reference category in our studies included cases and controls with no use of wireless phones, in contrast to the other studies investigating only mobile phone use. Including cordless phone use in the 'unexposed' group would bias the risk estimates towards unity (45).

In Table I, results of the highest cumulative use in hours of mobile phones are presented. All studies reported a statistically significantly increased risk of developing glioma and the meta-analysis yielded OR =1.90 and 95% confidence interval (CI) =1.31-2.76. For ipsilateral mobile phone use, the risk increased further to OR =2.54, 95% CI =1.83-3.52 in the meta-analysis based on 247 exposed cases and 202 exposed controls. Further support of the increased risk of glioma associated with mobile phone use has been obtained in additional analyses of parts of the Interphone study (47-49).

We previously analyzed the survival of the patients in our studies and found a shorter survival in patients with glioblastoma multiforme associated with the use of wireless phones compared with patients with no use (50). Interestingly, the mutation of the p53 gene involved in disease progression has been reported in glioblastoma multiforme in patients using mobile phones for ≥3 h per day. The mutation was statistically significantly associated with a shorter overall survival time (51).

NTP study. No increased incidence of glioma was reported in the mouse study (20).

In male rats (19), malignant glioma and glia cell hyperplasia occurred in all groups exposed to GSM-modulated cell phone RF radiation for two years. No lesions were observed in the sham controls. In female rats, glial cell hyperplasia occurred in one rat (3 W/kg), but none in the sham controls. One malignant glioma occurred in one rat in the 6 W/kg group but none in the sham controls.

In male rats exposed to CDMA-modulated cell phone RF radiation for two years, there was an increased incidence of malignant glioma with a statistically significant trend, P=0.044. In females, three malignant glioma occurred in the 1.5 W/kg group, but none in the other exposed groups or the sham control (P-value for trend =0.384). Glial cell hyperplasia was observed in most exposed groups, although this was not statistically significant (noted in text; P-value for trend not presented in NTP table).

Evaluation. Based on human epidemiological studies supported by the NTP animal study, there is clear evidence that RF radiation causes glioma in humans. There is also

Table I. Numbers of exposed cases (Ca) and controls (Co) and odds ratio (OR) with 95% confidence interval (CI) for glioma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

	All			Ipsilateral		
Study (ref.)	Ca/Co	OR	95% CI	Ca/Co	OR	95% CI
Interphone, 2010 (40)						
Cumulative use ≥1,640 h	210/154	1.40	1.03-1.89	100/62	1.96	1.22-3.16
Coureau *et al*, 2014 (41)						
Cumulative use >896 h	24/22	2.89	1.41-5.93	9/7	2.11	0.73-6.08
Hardell and Carlberg, 2015 (43)						
Cumulative use ≥1,640 h	211/301	2.13	1.61-2.82	138/133	3.11	2.18-4.44
Meta-analysis (40,41,43)						
Cumulative use ≥1,640 h[a]	445/477	1.90	1.31-2.76	247/202	2.54	1.83-3.52

[a]≥896 h used for Coureau *et al*.

Table II. Numbers of exposed cases (Ca) and controls (Co) and odds ratio (OR) with 95% confidence interval (CI) for meningioma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

	All			Ipsilateral		
Study (ref.)	Ca/Co	OR	95% CI	Ca/Co	OR	95% CI
Interphone, 2010 (40)						
Cumulative use ≥1,640 h	130/107	1.15	0.81-1.62	46/35	1.45	0.80-2.61
Coureau *et al*, 2014 (41)						
Cumulative use >896 h	13/9	2.57	1.02-6.44	6/4	2.29	0.58-8.97
Carlberg and Hardell, 2015 (56)						
Cumulative use ≥1,640 h	141/301	1.24	0.93-1.66	67/133	1.46	0.98-2.17
Meta-analysis (40,41,56)						
Cumulative use ≥1,640 h[a]	284/417	1.27	0.98-1.66	119/172	1.49	1.08-2.06

[a]≥896 h used for Coureau *et al*.

evidence of an increased glioma risk in occupational studies on exposure to EMF (52-54).

Meningioma

Human studies. Meningioma is an encapsulated, well-demarked and rarely malignant tumor. It is the most common non-malignant brain tumor that accounts for approximately 30% of intracranial neoplasms. It develops from the pia and arachnoid membranes that cover the CNS. It is slow-growing and presents neurological symptoms by the compression of adjacent structures. Most common are headaches and seizures. The incidence is greater than two-fold higher in women than in men and meningioma develops mostly among middle-aged and older individuals (55). The same research groups as for glioma also included meningioma in their case-control studies with a separate publication on meningioma by Carlberg and Hardell (56). The results of the meta-analyses for cumulative exposure in highest exposure category are presented in Table II. A statistically significant increased risk was obtained for ipsilateral mobile phone use with OR =1.49, 95% CI =1.08-2.06.

NTP study. No increased incidence of meningioma was reported in rats or mice (19,20).

Granular cell tumors (GCTs)

Human studies. GCTs are uncommon tumors. They are believed to be of neuronal origin (57). They are soft tissue tumors, which are thought to be derived from Schwann cells (58). The immunoprofile of granular cell tumors has revealed nerve sheath differentiation, lending support to their neuronal origin (59). GCTs can affect any organ in the body, although approximately 50% are found in the head and neck region (60). In our case-control studies on brain tumors, all diagnoses were based on a histopathological examination; no one was diagnosed with a granular cell tumor (42-46).

NTP study. In the rat study (19), increased incidence of malignant or non-malignant granular cell tumors in the meninges, likely derived from Schwann cells, occurred in the

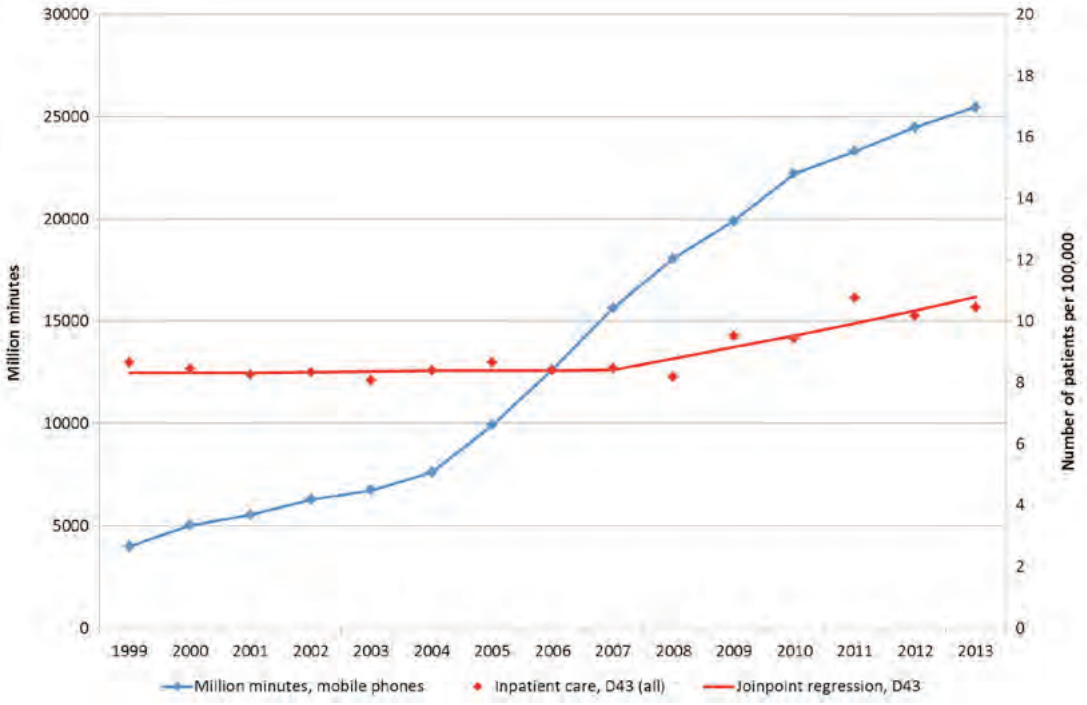


Figure 1. Number of out-going mobile phone minutes in millions during the period between 1999-2013 (http://statistik.pts.se/pts2013/download/Svensk%20Telemarknad%202013.pdf; accessed on April 1, 2015) and joinpoint regression analysis of number of patients per 100,000 inhabitants according to the Swedish National Inpatient Register for all ages during the period between 1999-2013 diagnosed with D43 = tumor of unknown type in the brain or CNS (http://www.socialstyrelsen.se/statistik/statistikdatabas/diagnoserislutenvard; accessed on April 1, 2015).

males exposed to GSM-modulated cell phone RF radiation for two years. This was not statistically significant (P-value for trend =0.343). In female rats, granular cell tumors, either malignant or non-malignant were not associated with RF radiation (P-value for trend =0.594). Since GCT is neuronal in origin, the NTP study findings in male rats add to the evidence that exposure to RF radiation damage nerve sheaths.

Evaluation. Based on human epidemiological studies and the NTP animal study, there is equivocal evidence that RF radiation causes meningeal tumors in humans (may be related to exposure).

Rate/incidence of brain tumors. The Swedish Cancer Register has not shown increasing incidence of brain tumors in a study for the time period between 1979-2008, and has been used to dismissing epidemiological evidence on risk associated with use of wireless phones (61). We have previously demonstrated that descriptive studies cannot be used to dismiss results in analytical epidemiology with individual exposure histories, such as in case-control studies. We have also published the deficiencies in the reporting of brain tumors to the Swedish Cancer Register (62). The results for more recent time periods have now been published. These articles also discuss results from studies in other countries.

We used the Swedish National Inpatient Register (IPR) and Causes of Death Register (CDR) to study the incidence of brain tumors comparing with the Swedish Cancer Register data for the time period between 1998-2013 using joinpoint regression analysis (62). In the IPR, we found a joinpoint in 2007 with Annual Percentage Change (APC) +4.25%, 95% CI +1.98, +6.57% during the period between 2007-2013 for tumors of unknown type in the brain or CNS. Fig. 1 shows time trends in IPR for brain tumors of unknown type (D43), red line, and mobile phone communication; number of out-going mobile phone minutes in millions per year (blue line). The figure shows increasing rates of brain tumors with some latency in relation to the increasing use of mobile phones.

In the CDR joinpoint regression, we found one joinpoint in 2008 with APC during the period between 2008-2013, +22.60%, 95% CI +9.68, +37.03%. These tumor diagnoses would be based on clinical examination, mainly CT and/or MRI, but without histopathology or cytology. No statistically significant increasing incidence was found in the Swedish Cancer Register during these years. We postulated that a large part of brain tumors of unknown type are never reported in the Cancer Register. Furthermore, the frequency of diagnoses based on autopsy has declined substantially due to a general decline of autopsies in Sweden, further adding to missing cases. We concluded that the Swedish Cancer Register is not reliable to be used to dismiss results in epidemiological studies on the use of wireless phones and brain tumor risk.

In Fig. 2, we present the rates per 100,000 of deaths in unknown type of brain tumor (D43), red line, and number of out-going mobile phone minutes in millions (blue line) during the period between 1999-2013. We postulate that the increasing rate of patients deceased with brain tumor may be associated with the increasing use of mobile phones.

In an updated further analysis, we used the Swedish IPR to analyze rates of brain tumors of unknown type (D43) during the period between 1998-2015 in different age groups (63). The Average Annual Percentage Change (AAPC) per 100,000 increased with +2.06%, 95% CI +1.27, +2.86% in both sexes combined. A joinpoint was found in 2007 with APC 1998-2007 of +0.16%, 95% CI -0.94, +1.28%, and 2007-2015 of +4.24%,

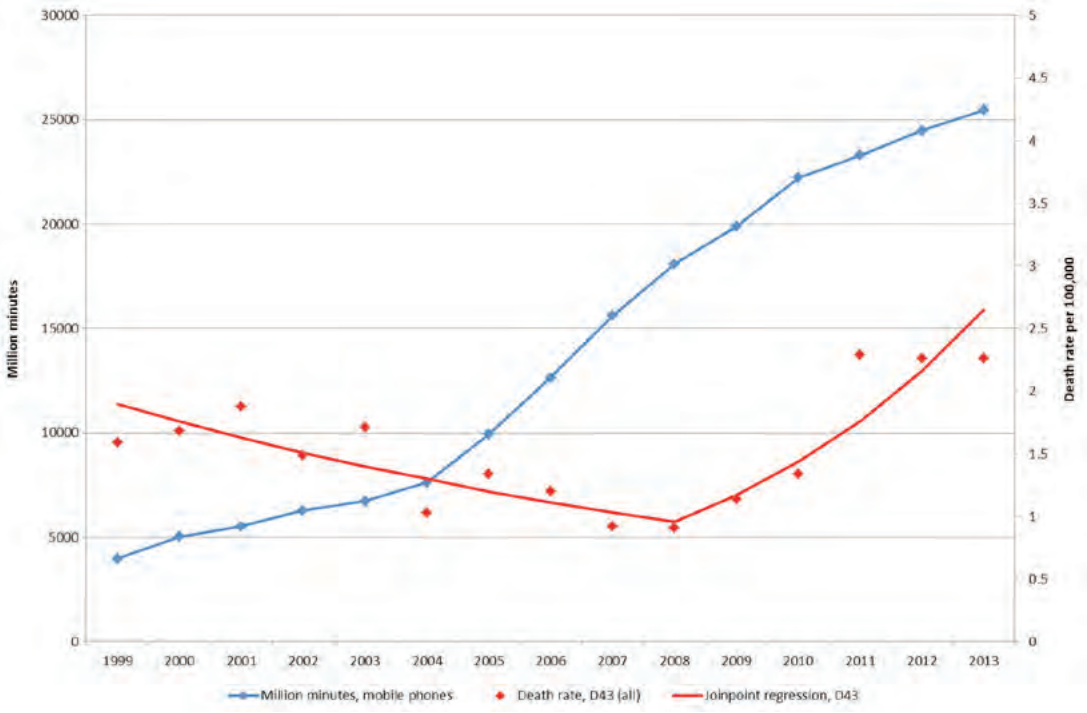


Figure 2. Number of out-going mobile phone minutes in millions during the period between 1999-2013 (http://statistik.pts.se/pts2013/download/Svensk%20Telemarknad%202013.pdf; accessed on April 1, 2015) and joinpoint regression analysis of age-standardized death rates per 100,000 inhabitants according to the Swedish Causes of Death Register for all ages during the period between 1999-2013 diagnosed with D43 = tumor of unknown type in the brain or CNS (http://www.socialstyrelsen.se/statistik/statistikdatabas/dodsorsaker).

95% CI +2.87, +5.63%. The highest AAPC was found in the age group of 20-39 years.

In the Swedish Cancer Register, the age-standardized incidence rate per 100,000 increased for brain tumors, ICD-code 193.0, during 1998-2015 with AAPC in men +0.49%, 95% CI +0.05, +0.94%, and in women +0.33%, 95% CI -0.29, +0.45% (63). The cases with brain tumor of unknown type lack morphological examination. Brain tumor diagnoses in the Cancer Register were based on cytology/histopathology in 83% for men and in 87% for women in 1980. This frequency increased to 90% in men and 88% in women in 2015. During the same time period, CT and MRI imaging techniques were introduced and morphology is not always necessary for diagnosis. If all brain tumors based on clinical diagnosis with CT or MRI had been reported to the Cancer Register the frequency of diagnoses based on cytology/histology would have decreased in the register. The results indicate underreporting of brain tumor cases to the Cancer Register. The real incidence would be higher. Thus, incidence trends based on the Cancer Register should be used with caution. Our results support mobile and cordless phones as risk factors for brain tumors with a reasonable latency period.

Fig. 3 shows joinpoint regression analyses of age-standardized incidence rates per 100,000 in men aged 60-79 years with astrocytoma grade III or IV in the Swedish Cancer Register during the period between 1998-2015, and Fig. 4 shows results in women (63).

Interestingly, a recent study demonstrated a similar increase in glioblastoma multiforme in England as in Sweden (64), '*We report a sustained and highly statistically significant ASR [age-standardized incidence rates] rise in glioblastoma multiforme (GBM) across all ages. The ASR for GBM more than doubled from 2.4 to 5.0, with annual case numbers rising from 983 to 2531. Overall, this rise is mostly hidden in the overall data by a reduced incidence of lower-grade tumours.*'

Evaluation. Increasing rates/incidences of brain tumors in Sweden, a country with among the earliest use of wireless phones in the world, have been published. Similar findings have been reported from other countries, see above and reviewed by us (62). The results have strengthened the evidence that RF radiation causes brain tumors in humans.

Acoustic neuroma (vestibular schwannoma)

Human studies. Acoustic neuroma, also known as vestibular schwannoma, is a non-malignant tumor located on the eight cranial nerve from the inner ear to the brain. It is usually encapsulated and grows in relation to the auditory and vestibular portions of the nerve. It grows slowly and due to the narrow anatomical space, may lead to the compression of vital brain stem structures. The first symptoms of acoustic neuroma are usually tinnitus and hearing problems. The results for the use of mobile phones in the Interphone (65) and Hardell *et al* (66) studies are presented in Table III. A statistically significant increased risk was found for cumulative ipsilateral use >1,640 h yielding an OR of 2.71, 95% CI of 1.72-4.28.

The study by Moon *et al* (67) was not included in the meta-analysis, since the data on cumulative mobile phone use with numbers of cases and controls were not given. Support of an increased risk was found in the case-case part of the study (67), as also reported by Sato *et al* (68) in their case-case analysis. Pettersson *et al* made a case-control study on acoustic neuroma in Sweden not overlapping our study (69). An increased risk for the highest category of cumulative use

Table III. Numbers of exposed cases (Ca) and controls (Co) and odds ratio (OR) with 95% confidence interval (CI) for acoustic neuroma in case-control studies in the highest category of cumulative use in hours for mobile phone use.

	All			Ipsilateral		
Study (ref.)	Ca/Co	OR	95% CI	Ca/Co	OR	95% CI
Interphone, 2011 (65)						
Cumulative use ≥1,640 h	77/107	1.32	0.88-1.97	47/46	2.33	1.23-4.40
Hardell *et al*, 2013 (66)						
Cumulative use ≥1,640 h	27/301	2.40	1.39-4.16	19/133	3.18	1.65-6.12
Meta-analysis (65,66)						
Cumulative use ≥1,640 h	104/408	1.73	0.96-3.09	66/179	2.71	1.72-4.28

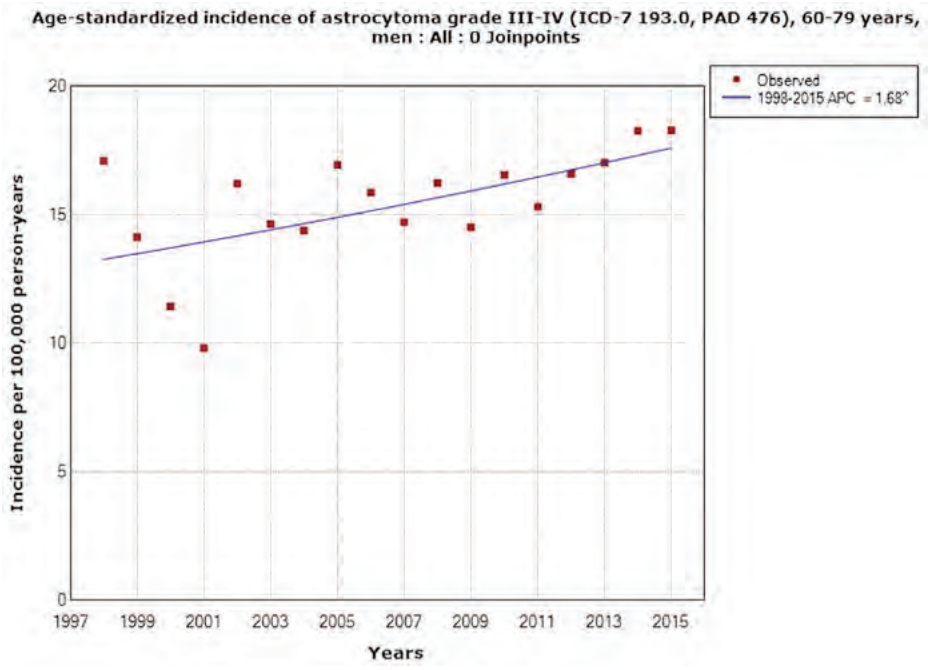


Figure 3. Joinpoint regression analysis of age-standardized incidence rates per 100,000 in men aged 60-79 years with astrocytoma grade III or IV in the Swedish Cancer Register during the period between 1998-2015. APC/AAPC +1.68%, 95% CI +0.39, +2.99% (http://www.socialstyrelsen.se/statistik/statistikdatabas/cancer).

of both mobile phone (≥680 h OR =1.46, 95% CI =0.98-2.17) and cordless phone (≥900 h OR =1.67, 95% CI =1.13-2.49) was found. We did not include that study in our meta-analysis due to the many scientific shortcomings in the study, e.g., laterality analysis was not made for cordless phone and the numbers in the laterality analysis for mobile phone are not consistent in text and tables and obviously not correct, and the 'unexposed' reference category included subjects using either mobile or cordless phone (70).

The Danish part of the Interphone study reported a mean tumor volume of 1.66 cm^3 among regular mobile phone users and 1.39 cm^3 for non-users (P=0.03) (71). We analyzed the percentage change in tumor volume per year of latency and 100 h of cumulative use (66). For all types of wireless phones, the percentage of tumor volume increased, and was statistically significant for analogue mobile phones per year of latency (P=0.02) and per 100 h of cumulative use (P=0.01). Moon *et al* (67) reported a statistically significant larger mean tumor volume for heavy users (11.32±15.43 cm^3) compared with light users (4.88±5.60 cm^3) based on the daily amount of mobile phone use (P=0.026). Similar results were found for cumulative hours of use. Taken together, these results support tumor promotion by RF radiation.

NTP study. No malignant schwannoma was reported in the mouse study (20).

In the rat study (19), there was a statistically significant increased incidence of malignant schwannoma in the heart of males exposed to GSM modulated cell phone RF radiation for 2 years; P-value for trend =0.041. The tumor was found in all exposure categories for male rats, whereas no malignant schwannoma was found in the sham controls. Endocardial hyperplastic Schwann cell lesions, that are preneoplastic, were found in one 1.5 W/kg and in two 6 W/kg males, but not in the sham control. A statistically significant trend was found in CDMA-modulated exposed males, P=0.011. Two female rats were diagnosed with malignant schwannoma in the heart

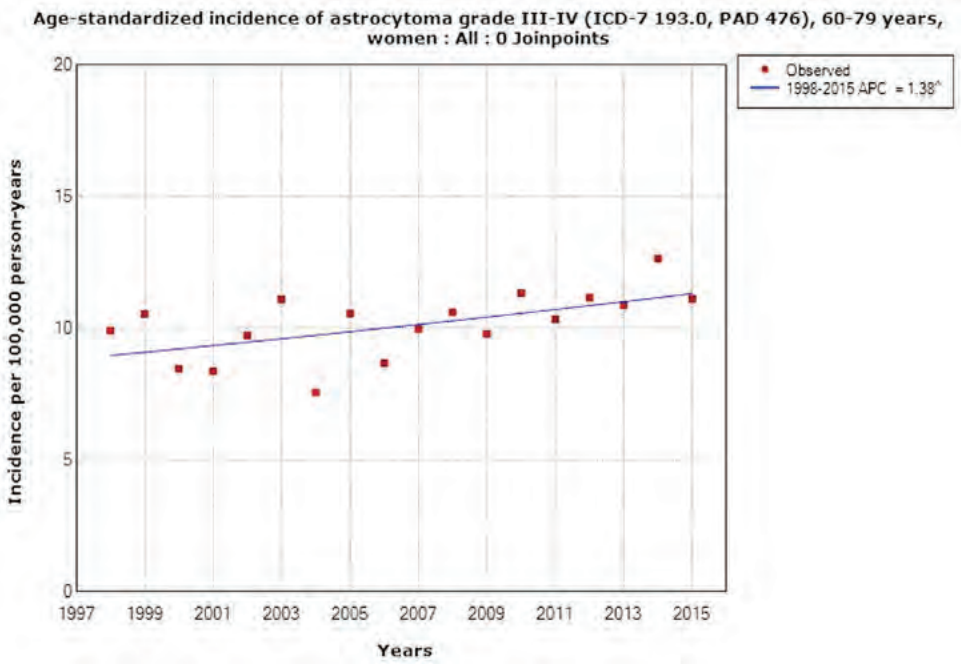


Figure 4. Joinpoint regression analysis of age-standardized incidence rates per 100,000 in women aged 60-79 years with astrocytoma grade III or IV in the Swedish Cancer Register during the period between 1998-2015. APC/AAPC +1.38%, 95% CI +0.32, +2.45% (http://www.socialstyrelsen.se/statistik/statistikdatabas/cancer).

in the 3 W/kg group, but no malignant schwannomas were found in the two other exposure groups or in the sham control, P-value for trend =0.640.

Evaluation. Based on human epidemiological studies and the NTP animal study, there is clear evidence that RF radiation causes vestibular schwannoma (acoustic neuroma) in humans.

Pituitary tumors

Human studies. In a case-control study from Japan, no statistically significant increased risks were found for the use of mobile phone (72). A somewhat increased risk was found in the highest cumulative call time in hours, OR =1.33, 95% CI =0.58-3.09. The cases were aged 30-69 years and diagnosed during the period between 2000-2004.

In a UK case-control study with patients diagnosed during the period between 2001-2005, overall no statistically significant increased risks were found (73). In the group with ≥10 years of use a somewhat increased risk was found for analog mobile phone use: OR =1.2, 95% CI =0.6-2.4, and digital mobile phone use with OR =2.5, 95% CI =0.7-9.1.

In a case-control study from China with cases diagnosed between 2006-2010, mobile phone use yielded an increased risk for pituitary tumor: OR =7.6, 95% CI =2.6-21.4 and a duration of use yielded OR =8.5, 95% CI =2.8-24.4 (74). However, no more data were provided.

The incidence of pituitary tumors increased during the time period between 2004-2009 in the USA (75). The incidence is increasing in Sweden, particularly since 2000, as shown in Fig. 5. There seems to be a decrease during the latest year, but this may be explained by a time lag in the reporting to the Swedish Cancer Register.

NTP study. In male mice (20) exposed to CDMA-modulated RF radiation for two years, two adenoma and one carcinoma occurred in the pars distalis of the pituitary gland. No carcinoma or adenoma occurred in the sham control or the other two exposure groups. No increased incidence was found in female mice.

In male rats exposed to GSM-modulated cell phone RF radiation for two years (19), an increased incidence of pituitary adenoma was found in all exposed groups, although no statistically significance was found (P-value for trend =0.301). In females, the incidence of adenoma in 1.5 and 6 W/kg was statistically significantly decreased (1.5 W/kg P=0.049; 6 W/kg P=0.038).

In male rats exposed to CDMA-modulated RF radiation for two years, an increased incidence of pituitary adenoma was found in the 1.5 W/kg (P=0.208) and 3 W/kg (P=0.030). In females there was a statistically significantly decreased incidence of adenoma or carcinoma in the 3 W/kg group (P=0.030).

Evaluation. Based on human epidemiological studies and the NTP animal study, there is equivocal evidence that RF radiation causes pituitary tumors in humans (may be related to exposure).

Thyroid cancer

Human studies. The incidence of thyroid cancer is increasing in many countries, particularly the papillary type that is the most radiosensitive type. We used the Swedish Cancer Register to study the incidence of thyroid cancer during the period between 1970-2013 using joinpoint regression analysis (31). In women, the incidence increased statistically significantly during the whole study period; AAPC +1.19% (95% CI +0.56, +1.83%). Two joinpoints were detected, 1979 and 2001, with a high increase of the incidence during the last period between 2001-2013 with an APC of +5.34% (95% CI +3.93, +6.77%).

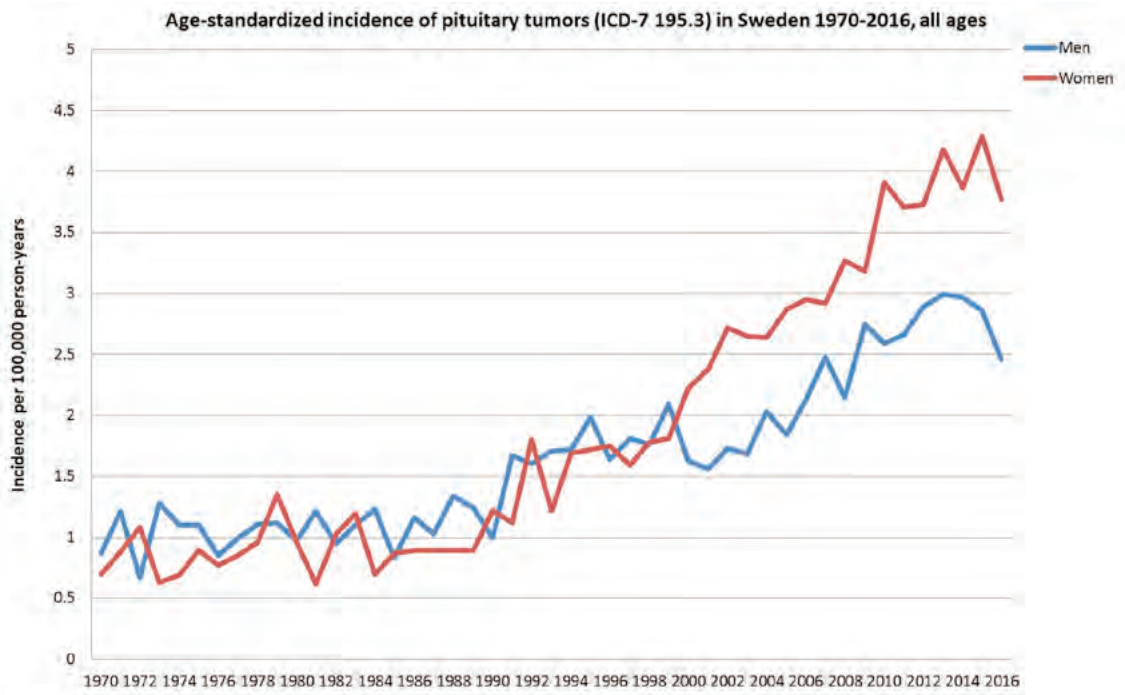


Figure 5. Age-standardized incidence of pituitary tumors (ICD-7 195.3) in Sweden between 1970-2016 for men and women, all ages, according to the Swedish Cancer Register (http://www.socialstyrelsen.se/statistik/statistikdatabas/cancer).

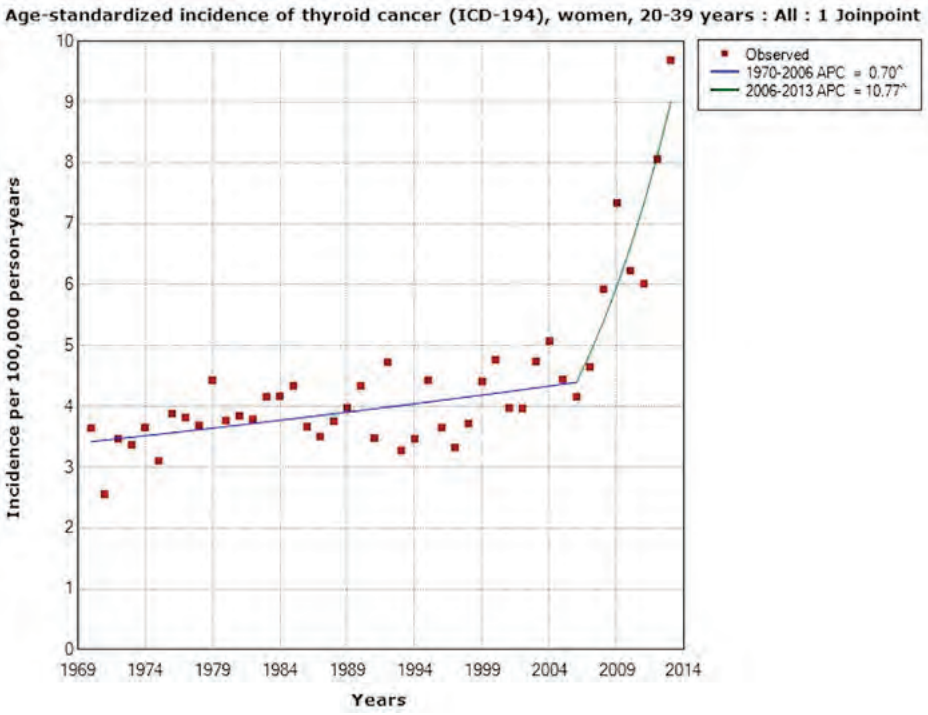


Figure 6. Joinpoint regression analysis of age-standardized incidence of thyroid cancer for women, aged 20-39 years, 1970-2013. Incidence per 100,000 inhabitants for ICD-7 code 194 according to the Swedish Cancer Register (http://www.socialstyrelsen.se/statistik/statistikdatabas/cancer).

In the age group of 20-39 years, joinpoint regression analysis of age-standardized incidence of thyroid cancer in women, aged 20-39 years, APC increased with +10.77% (95% CI +5.75, +16.04%) during the time period between 2006-2013 (Fig. 6).

Analyses based on data from the Cancer Register indicated that the increasing trend in Sweden was mainly caused by thyroid cancer of the papillary type. The incidence increased statistically significantly in women with an AAPC of +4.38% (95% CI +2.95, +5.84%) during the period between 1993-2013 (Fig. 7). One joinpoint was detected in 2006; 1993-2006 APC +1.69% (95% CI +0.32, +3.08%), 2006-2013 APC +9.58% (95% CI +5.85, +13.44%). The incidence of papillary cancer increased in men during the period between 1993-2013 with an AAPC of +3.95% (95% CI +2.20, +5.73%).

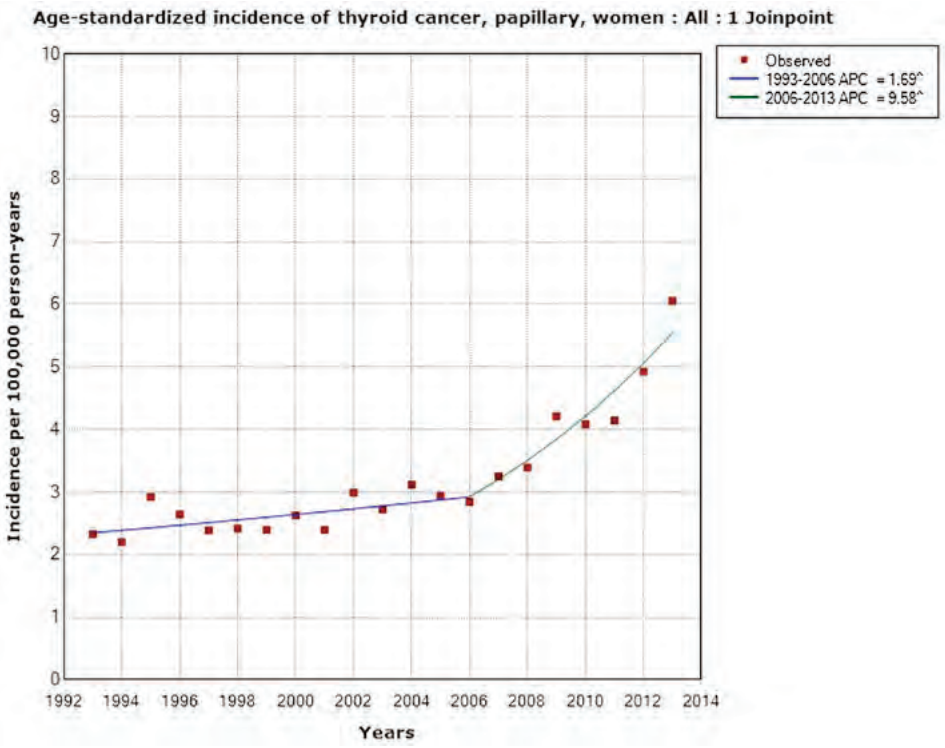


Figure 7. Joinpoint regression analysis of age-standardized incidence of papillary thyroid cancer for women, all ages, 1993-2013. Incidence per 100,000 inhabitants for ICD-7 code 194; data obtained from the Swedish Cancer Register.

AAPC for thyroid cancer in all men during the period between 1970-2013 was +0.77% (95% CI -0.03, +1.58%). One joinpoint was detected in 2005 with a statistically significant increase in incidence during the period between 2005-2013; APC +7.56% (95% CI +3.34, +11.96%). Based on the NORDCAN data, there was a statistically significant increase in the incidence of thyroid cancer in the Nordic countries during the same time period. In both women and men a joinpoint was detected in 2006. The incidence increased during 2006-2013 in women; APC +6.16% (95% CI +3.94, +8.42%) and in men; APC +6.84% (95% CI +3.69, +10.08%), thus showing similar results as in the Swedish Cancer Register (31).

We postulate that the whole increase cannot be attributed to better diagnostic procedures. In Fig. 8 data from the Nordic countries are shown on number of out-going mobile phone minutes during the period between 2001-2013 and the incidence of thyroid cancer in men (green line) and in women (red line). Clearly, with a lag time of some years after the increasing number of out-going calls, the thyroid cancer incidence is increasing.

Increasing exposure to ionizing radiation, e.g., medical CT scans, and to RF radiation should be further studied as causative factors to this emerging thyroid cancer health problem.

Fig. 9 presents three developments in the antenna design in mobile phones that may be of relevance in thyroid carcinogenesis. The second generation (2G) mobile phones appeared in the 1990s with the external retractable monopole or helical antennas. The 2G GSM band operated at a 800/900 MHz frequency band, later accompanied by a 1,800 MHz band. Around the turn of the millennium, the external antennas began to disappear, replaced with new phone models with internal planar or microstrip antennas. The first internal antenna was introduced in 1998 and the first dual-band mobile phone, with the internal antenna, was introduced on the market in 1999 (76). The internal antennas were positioned at the top of the telephone. With the emergence of the smartphones in the mid- and late 2000s, the internal antenna location started to shift from the top of the phone to the bottom. Currently, the majority of smartphone models have their antenna positioned at the bottom of the phone, thus closer to the thyroid gland (shown by grey color in Fig. 9). This would have a major impact on increasing radiation to the thyroid gland from smartphones.

Some published laboratory studies are of interest, Radiofrequency radiation at 2.45 GHz at a non-thermal level modified the morphology of the thyroid gland in a study on rats. The central and peripheral follicles presented increased in size and the thickness of peripheral septa decreased. Peripheral follicles increased in size with repeated exposure at 3 W power (77).

In another study on rats, whole body exposure to 900 MHz pulse-modulated RF radiation that was similar to that emitted by the global system for mobile communications (GSM) mobile phones caused pathological changes in the thyroid gland. The gland structure was altered and caspase-dependent pathways of apoptosis were enhanced (78).

NTP study. In mice (20) no increased incidence was reported.

In female rats (19) a statistically significant increased incidence of C-cell hyperplasia was found in the two years of GSM-exposed groups (1.5, 3 and 6 W/kg, respectively). In males, a statistically non-significant increased incidence was observed in the 1.5 W/kg exposure group (noted in text; P-value not given in NTP table).

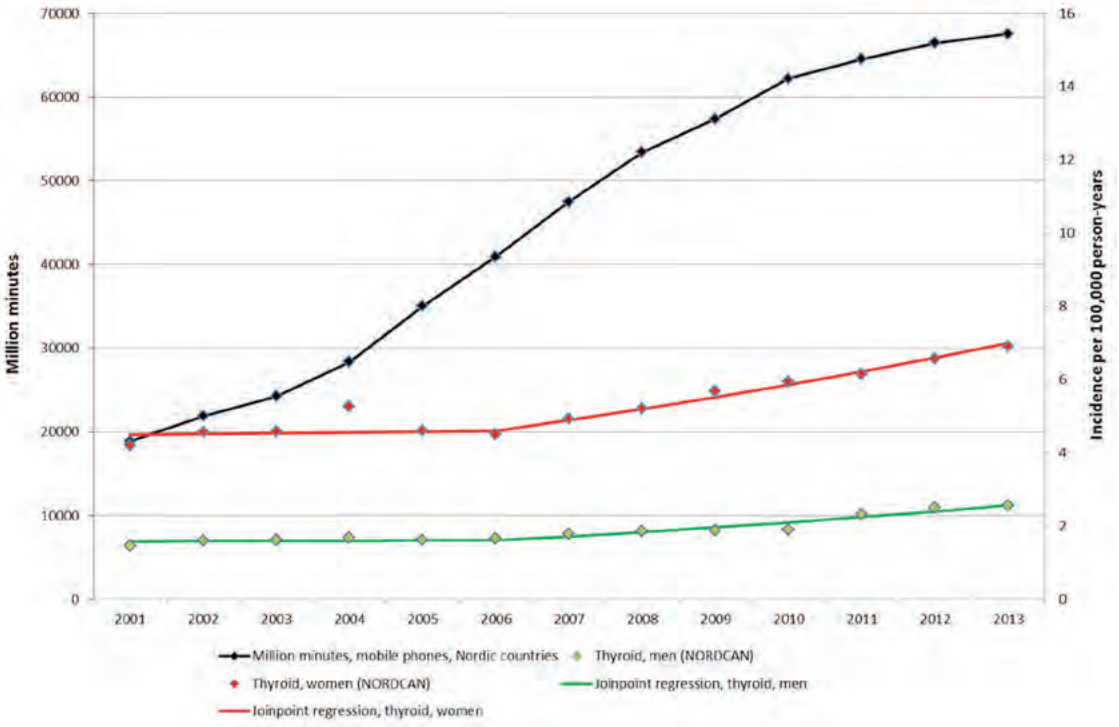


Figure 8. Number of out-going mobile phone minutes and incidence of thyroid cancer 2001-2013. Mobile phone minutes in millions in the Nordic countries (http://statistik.pts.se/PTSnordic/NordicBaltic2014/) and incidence per 100,000 person-years for all ages 2001-2013 according to NORDCAN (http://www-dep.iarc.fr/NORDCAN/english/frame.asp). Joinpoint regression analyses based on the time period between 1970-2013.

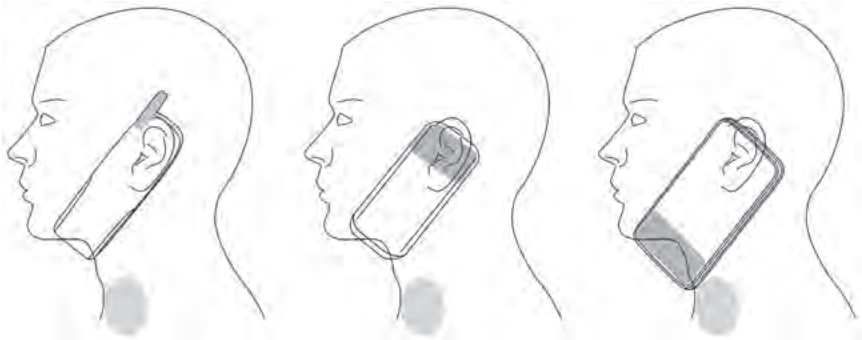


Figure 9. Mobile phone antenna placements in regard to the thyroid gland (grey). Different localizations of the antenna depending on new generations of mobile phones are shown in the panels from left to right.

Evaluation. C-cell hyperplasia as a precursor to familial medullary thyroid cancer in humans is well established. C-cell hyperplasia may be a precursor to other types of thyroid cancer but its role is not well established. Based on human cancer statistics and the NTP animal study, there is some evidence that thyroid cancer is caused by RF radiation in humans.

Malignant lymphoma

Human studies. Few studies exist on malignant lymphoma and exposure to RF radiation. In a case-control study male and female subjects aged 18-74 years living in Sweden were included during a period from December 1, 1999 to April 30, 2002 (27). Controls were selected from the national population registry. Exposure to different agents was assessed by a questionnaire. In total, 910 (91%) cases and 1,016 (92%) controls participated. NHL of the B-cell type was not associated with the use of cellular or cordless telephones. As regards T-cell NHL and the >5 year latency period, the use of analogue cellular phones yielded: OR =1.46, 95% CI =0.58-3.70; digital: OR =1.92, 95% CI =0.77-4.80; and cordless phones: OR =2.47; 95% CI =1.09-5.60. The corresponding results for certain lymphoma, e.g., of the cutaneous and leukemia types, were for analogue phones: OR =3.41, 95% CI =0.78-15.0; digital: OR =6.12, 95% CI =1.26-29.7; and cordless phones: OR =5.48, 95% CI =1.26-23.9. The results indicate an association between T-cell NHL and the use of cellular and cordless telephones; however, the study was based on low numbers and must be interpreted with caution. As regards B-cell NHL, no association was found.

A case-control study in USA used a questionnaire to assess cellular telephone use in 551 NHL cases and 462 frequency-matched population controls (28). Compared to persons who had never used cellular telephones, risks

were not increased among individuals whose lifetime use was >100 times (e.g., regular users, OR =0.9, 95% CI =0.6-1.4). Among regular users compared to those who had never used hand-held cellular telephones, risks of NHL were not statistically significantly associated with minutes per week, duration, cumulative lifetime or year of first use, although NHL was non-significantly higher in men who used cellular telephones for >8 years; OR =2.4, 95% CI =0.8-7.0. NHL not otherwise specified was statistically significantly increased in men for mobile phone use among subjects with ≥6 years duration, OR =4.4, 95% CI =1.3-14.6. There was little evidence to link the use of cellular telephones with total, diffuse large B-cell lymphoma or follicular NHL. No results were presented for T-cell lymphoma.

In the USA, primary central nervous system lymphoma (PCNSL) rates in immunocompetent men and women aged 65+ years increased statistically significantly (1.7 and 1.6% per year, respectively), but remained stable in other age groups during the period between 1992-2011 (79). Thus, the increasing rates could not be related to HIV or immune suppression in organ transplant patients.

In Sweden, the increasing incidence of PCNSL was reported for the time period between 2000-2013 in immunocompetent persons (80). With 359 identified PCNSL cases (median age, 66 years), the overall incidence was 0.26 (95% CI =0.24-0.29) per 100,000 person-years and the average annual increase 4% (P=0.002). The increasing trend was primarily observed among elderly individuals (70+ years). Similarly, an increase in incidence of all brain tumors was noted only among the elderly.

No etiological factor has clearly been defined to explain the increasing incidence of brain lymphoma. However, it has occurred during a time period when RF radiation to the brain from wireless phones has increased.

It should be noted that in transgenic mice, an increased incidence of lymphoma exposed to 900 MHz GSM RF radiation was reported; P=0.006 versus the sham group (25). No increased risk of malignant lymphoma was found in mice exposed to GSM 900 MHz in another study (26). However, the incidence in the sham exposed group was higher in the study by Utteridge *et al* (26) compared with the study by Repacholi *et al* (25) which might have influenced the results.

NTP study. In female mice exposed to GSM-modulated cell phone RF radiation for two years, there were increased incidences of malignant lymphoma in all exposed groups compared to the controls (20). The increase was statistically significant in the 2.5 W/kg (P=0.004) and 5 W/kg groups (P=0.035). In the CDMA-modulated cell phone RF radiation for two years, the incidence increased in female mice in all exposed groups compared to the controls, and was statistically significant in the 2.5 W/kg group (P=0.035).

No conclusive evidence of increased incidence of malignant lymphoma was reported in female rats (19); P-value for trend =0.537 for GSM-modulated cell phone RF radiation and P-value for trend =0.339 for CDMA-modulated cell phone RF radiation.

Evaluation. Based on human epidemiological studies and the NTP study, there is equivocal evidence that malignant lymphoma is caused by RF radiation in humans (may be related to exposure).

Skin (cutaneous tissue)

Human studies. Few studies exist on RF radiation and the risk of developing skin tumors. In a Danish cohort on mobile phone subscribers from the period between 1987-1995 followed to 2007, no increased risks of skin cancer were observed (81). The same cohort has also been used for studying brain tumor risk. Due to serious methodological problems, including the misclassification of exposure the study has been evaluated to be uninformative (8,37).

In a Swedish study on cutaneous malignant melanoma diagnosed during the period between 2000-2003, no increased risk was observed overall (82). In the shortest latency period of >1-5 years and highest cumulative use of >365 h, wireless phone use (mobile phone and/or cordless phone) yielded OR =1.6, 95% CI =0.96-2.9. For melanoma in the most exposed anatomical area during use of the handheld phone, temporal, ear, cheek, the risk increased to OR =2.1, 95% CI =1.1-3.8. The risk was overall highest for cases with first use of a wireless phone before 20 years of age, OR =2.7, 95% CI =0.6-12, although based on low numbers. No interaction was observed with known risk factors for malignant melanoma, such as hair and eye color, skin type or sunburns as a teenager.

Fig. 10 displays the rapidly increasing incidence of malignant melanoma in Sweden in both sexes. The increase is most marked from early 2000.

NTP study. The incidences of malignant fibrous histiocytoma in the skin were higher in 5 and 10 W/kg male mice exposed to GSM-modulated cell phone RF radiation for two years (20). The results were not statistically significant (5 W/kg P=0.124; 10 W/kg P=0.321). The incidences of fibrosarcoma, sarcoma or malignant fibrous histiocytoma were higher in exposed male mice compared with sham control, although border-line significant, P-value for trend =0.093. No increased incidence was observed in female mice.

Male rats exposed to GSM-modulated cell phone RF radiation for two years (19) exhibited higher incidences of fibroma, fibrosarcoma, myxosarcoma, or malignant fibrous histiocytoma in the skin (subcutaneous tissue) in all exposed groups. The increased rates were not statistically significant (P-value for =0.428). No statistically significant results were found in female rats (P-value for trend =0.551).

Evaluation. Based on human epidemiological studies and NTP animal studies there is equivocal evidence that RF radiation causes skin cancer in humans (may be related to exposure).

Concluding remarks. Based on case-control studies, as discussed above, there is a consistent finding of an increased risk of developing glioma and acoustic neuroma associated with the use of mobile phones. Similar results are found for cordless phones in the Hardell group studies. These results are supported by the results of the NTP animal studies (19,20). Malignant vestibular schwannoma is a similar tumor type as acoustic neuroma, also known as vestibular schwannoma.

The findings are less consistent for meningioma although somewhat an increased risk was observed in the meta-analysis of ipsilateral mobile phone use. A longer follow-up time is necessary for this type of slow-growing tumor.

The results on glioma and acoustic neuroma are supported by results from other animal studies showing

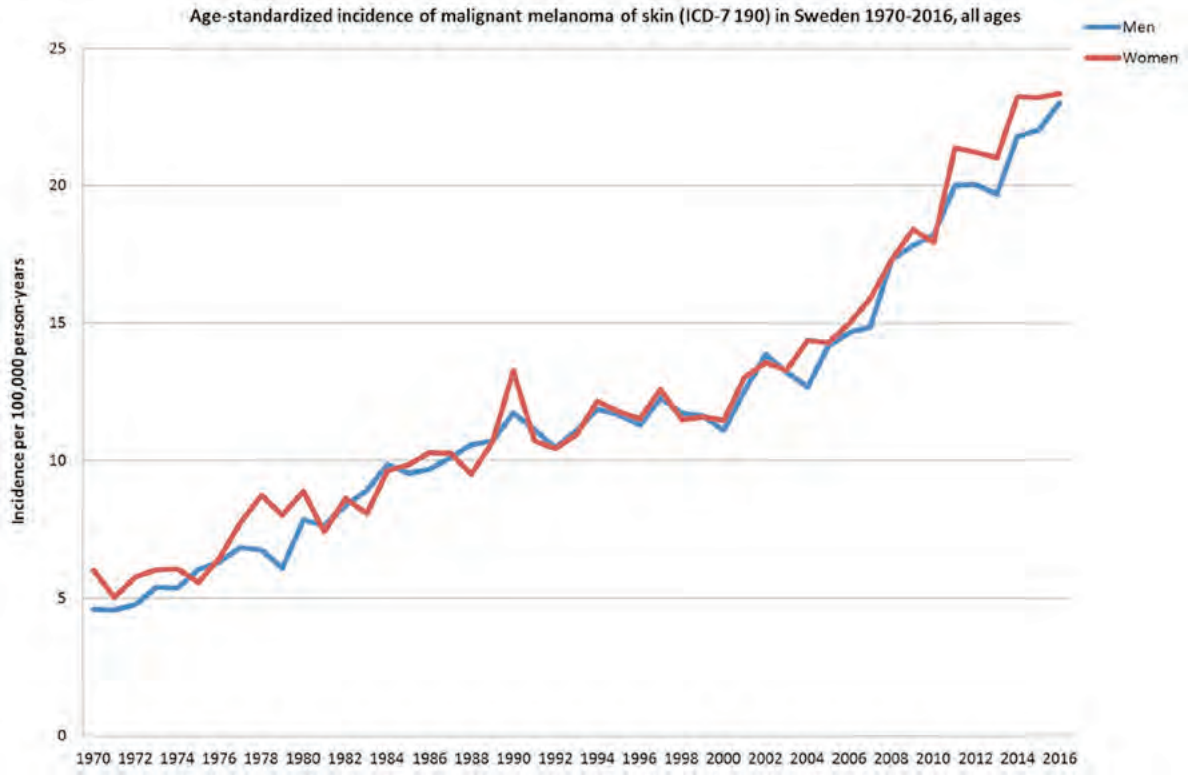


Figure 10. Age-standardized incidence of malignant melanoma (ICD-7 190) in Sweden between 1970-2016 for men and women, all ages, according to the Swedish Cancer Register (http://www.socialstyrelsen.se/statistik/statistikdatabas/cancer).

carcinogenic and/or tumor promoting effects from RF radiation (21-25,32-34). The NTP study showed genotoxicity of RF radiation in rats and mice exposed to RF radiation (83). That result supports previous findings of DNA strand breaks in rat brain cells exposed to RF radiation (84).

One mechanism in carcinogenesis may be oxidative stress with the production of reactive oxygen species (ROS), as summarized by Yakymenko *et al* (85). This could be an indirect mechanism for the increased brain and head tumor risk since ROS may lead to DNA damage (86).

By now carcinogenicity has been shown in human epidemiological studies, which has been replicated in animal studies. Laboratory studies on RF radiation have shown increased ROS production that can cause DNA damage. In 2013, we published the conclusion that RF radiation should be regarded as a human carcinogen, Group 1 according to the IARC definition, fulfilling Bradford Hill causality criteria (87). This was further supported in our updated article (6). That conclusion is reinforced by the current evaluation.

The evidence that RF radiation exposure is a risk factor for cancer is particularly worrying, taking the present deployment of the fifth generation (5G) for wireless communication. More than 200 scientists and medical doctors have asked for a moratorium until studies have been performed by independent researchers on hazards to human health and the environment (88). These millimeter waves have primarily effects on the skin and eye (89). Sweat ducts in the skin may act as helical antennas and boost RF radiation exposure (90). These findings are worrying, taking the present evaluation that present RF radiation may increase the risk of developing skin cancer.

Discussion

The NTP report uses five categories for the evaluation of RF radiation carcinogenicity as follows:

Clear evidence. Clear evidence of carcinogenic activity is demonstrated by studies that are interpreted as showing a dose-related i) increase of malignant neoplasms; ii) increase of a combination of malignant and benign neoplasms; or iii) marked increase of benign neoplasms if there is an indication from this or other studies of the ability of such tumors to progress to malignancy.

Some evidence. Some evidence of carcinogenic activity is demonstrated by studies that are interpreted as showing a test agent-related increased incidence of neoplasms (malignant, benign, or combined) in which the strength of the response is less than that required for clear evidence.

Equivocal evidence. Equivocal evidence of carcinogenic activity is demonstrated by studies that are interpreted as showing a marginal increase of neoplasms that may be test agent related.

No evidence. No evidence of carcinogenic activity is demonstrated by studies that are interpreted as showing no test agent-related increases in malignant or benign neoplasms.

Inadequate study. Inadequate evidence of carcinogenic activity is demonstrated by studies that, due to major qualitative or quantitative limitations, cannot be interpreted as valid

Table IV. National Toxicology Program (NTP) Cell Phone Radiation 2-Year Study Evaluation of Carcinogenicity of Cell Phone Radiation: NTP Draft Technical Reports (TR 595, TR 596) vs. Expert Panel Vote.[a]

Animal	Sex	Cell phone modulation	Tumor types and/or location	Evidence of carcinogenicity	
				NTP draft report	Expert panel (vote yes-no-abstention)
Rat	Male	GSMb	Heart: Schwannoma	Some evidence	Clear evidence (8-3)
Rat	Male	CDMAc	Heart: Schwannoma	Some evidence	Clear evidence (8-3)
Rat	Male	GSM	Brain: Glioma	Equivocal	Some evidence (7-4)
Rat	Male	CDMA	Brain: Glioma	Equivocal	Some evidence (6-4-1)
Rat	Male	GSM	Brain: Granular cell	Equivocal	Equivocal (11-0)
Rat	Male	GSM	Prostate gland	Equivocal	Equivocal (11-0)
Rat	Male	GSM	Pituitary gland	Equivocal	Equivocal (10-1)
Rat	Male	CDMA	Pituitary gland	Equivocal	Equivocal (11-0)
Rat	Male	GSM	Adrenal medulla	Equivocal	Some evidence (6-4-1)
Rat	Male	GSM	Pancreas	Equivocal	Equivocal (11-0)
Rat	Male	CDMA	Liver	Equivocal	Equivocal (11-0)
Rat	Female	GSM	Heart: Schwannoma	No evidence	Equivocal (9-2)
Rat	Female	CDMA	Heart: Schwannoma	No evidence	Equivocal (9-2)
Rat	Female	CDMA	Brain: Glioma	Equivocal	Equivocal (8-3) (4 voted earlier for 'some evidence')
Rat	Female	CDMA	Adrenal medulla	Equivocal	Equivocal (10-0-1)
Mouse	Male	GSM	Skin	Equivocal	Equivocal (8-3)
Mouse	Male	GSM	Lung	Equivocal	Equivocal (11-0)
Mouse	Male	CDMA	Liver	Equivocal	Equivocal (10-1)
Mouse	Female	GSM	Lymphoma	Equivocal	Equivocal (9-2)
Mouse	Female	CDMA	Lymphoma	Equivocal	Equivocal (11-0)

[a]Joel M. Moskowitz, School of Public Health, University of California, Berkeley, March 30, 2018 Electromagnetic Radiation Safety (https://www.saferemr.com/2018/01/national-toxicology-program-peer-public.html) with courtesy; [b]GSM, global system for mobile communications; [c]CDMA, code-division multiple access.

for showing either the presence or absence of carcinogenic activity.

On March 26-28, 2018, a panel of 11 external scientific experts met to evaluate carcinogenicity of the NTP carcinogenicity studies (https://factor.niehs.nih.gov/2018/4/feature/feature-2-cell-phone/index.htm). As shown in Table IV, the carcinogenicity was upgraded for seven tumor types and/or location. Thus for glioma the vote was 'some evidence' in male rats exposed to GSM or CDMA cell modulation. Evidence for heart Schwannoma was found in male rats and was equivocal in female rats, as shown in Table IV. Note that we have herein discussed carcinogenesis only for tumor types with human epidemiological data. It is of interest that animal data indicate also increased incidence for other tumor types and/or locations such as prostate gland, adrenal medulla, pancreas, liver and lung, see also https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/actions20180328_508.pdf.

In contrast to the NTP panel, ICNIRP has made its own evaluation (https://www.icnirp.org/cms/upload/publications/ICNIRPnote2018.pdf). They discuss mainly the Schwannoma findings and ignore glial tumors. ICNIRP does not recognize the pattern of increased risk for Schwannoma and glioma in both animal studies and human epidemiology on RF radiation. They conclude that '*ICNIRP considers that the NTP (2018a, b) and Falcioni et al (2018) studies do not provide a consistent, reliable and generalizable body of evidence that can be used as a basis for revising current human exposure guidelines*.' That conclusion is not based on scientific evidence, but is rather an ad hoc statement.

A recent commentary discussed '*several unfounded criticisms about the design and results of the NTP study that have been promoted to minimize the utility of the experimental data on RFR for assessing human health risks. In contrast to those criticisms, an expert peer-review panel recently concluded that the NTP studies were well designed, and that the results demonstrated that both GSM- and CDMA-modulated RFR were carcinogenic to the heart (schwannomas) and brain (gliomas) of male rats*.' (91).

Our conclusion on RF radiation carcinogenicity is the following based on human epidemiology and supported by animal results in the NTP reports: Glioma, clear evidence; meningioma, equivocal evidence; vestibular schwannoma (acoustic neuroma), clear evidence; pituitary tumor (adenoma), equivocal evidence; thyroid cancer, some evidence; malignant lymphoma, equivocal evidence; skin

(cutaneous tissue), equivocal evidence; multi-site carcinogen, clear evidence.

There is clear evidence that RF radiation causes cancer/tumor at multiple sites, primarily in the brain (glioma) and head (acoustic neuroma). There is also evidence of an increased risk of developing other tumor types. The results are similar in both the NTP studies (19,20) and the Ramazzini Institute findings (34). Based on the IARC preamble to the monographs, RF radiation should be classified as Group 1: The agent is carcinogenic to humans.

'*This category is used when there is sufficient evidence of carcinogenicity in humans. Exceptionally, an agent may be placed in this category when evidence of carcinogenicity in humans is less than sufficient but there is sufficient evidence of carcinogenicity in experimental animals and strong evidence in exposed humans that the agent acts through a relevant mechanism of carcinogenicity.*' (http://monographs.iarc.fr/ENG/Preamble/currentb6evalrationale0706.php)

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Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Both LH and MC participated in the conception, design and writing of the manuscript LH supervised the study. MC made all statistical calculations. Both authors have read and approved the final version.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. Cardis E, Deltour I, Mann S, Moissonnier M, Taki M, Varsier N, Wake K and Wiart J: Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. Phys Med Biol 53: 2771-2783, 2008.
2. Gandhi OP, Morgan LL, de Salles AA, Han YY, Herberman RB and Davis DL: Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagn Biol Med 31: 34-51, 2012.
3. Hardell L, Näsman A, Påhlson A, Hallquist A and Hansson Mild K: Use of cellular telephones and the risk for brain tumours: A case-control study. Int J Oncol 15: 113-116, 1999.
4. Hardell L, Mild KH and Carlberg M: Case-control study on the use of cellular and cordless phones and the risk for malignant brain tumours. Int J Radiat Biol 78: 931-936, 2002.
5. Hardell L, Hansson Mild K, Sandström M, Carlberg M, Hallquist A and Påhlson A: Vestibular schwannoma, tinnitus and cellular telephones. Neuroepidemiology 22: 124-129, 2003.
6. Carlberg M and Hardell L: Evaluation of mobile phone and cordless phone use and glioma risk using the Bradford Hill viewpoints from 1965 on association or causation. BioMed Res Int 2017: 9218486, 2017.
7. Baan R, Grosse Y, Lauby-Secretan B, El Ghissassi F, Bouvard V, Benbrahim-Tallaa L, Guha N, Islami F, Galichet L and Straif K; WHO International Agency for Research on Cancer Monograph Working Group: Carcinogenicity of radiofrequency electromagnetic fields. Lancet Oncol 12: 624-626, 2011.
8. Non-ionizing radiation, part 2: Radiofrequency electromagnetic fields. In: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol 102. International Agency for Research on Cancer Press, Lyon, 2013. http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf (Accessed on 4 July, 2018).
9. Starkey SJ: Inaccurate official assessment of radiofrequency safety by the advisory group on non-ionising radiation. Rev Environ Health 31: 493-503, 2016.
10. Hardell L: World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). Int J Oncol 51: 405-413, 2017.
11. Maisch D: Conflict of interest and bias in health advisory committees: A case study of the WHO's Electromagnetic Field (EMF) Task Group. J Aust Coll Nutr Environ Med 25: 15-17, 2006.
12. Belpomme D, Hardell L, Belyaev I, Ernesto Burgio E and Carpenter DO: Thermal and non-thermal health effects of non-ionizing radiation: an international perspective. Env Poll 242: 643-658, 2018.
13. Hedendahl L, Carlberg M and Hardell L: Electromagnetic hypersensitivity - an increasing challenge to the medical profession. Rev Environ Health 30: 209-215, 2015.
14. No authors listed: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection. Health Phys 74: 494-522, 1998.
15. International Commission on Non-Ionizing Radiation Protection: ICNIRP statement on the 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)'. Health Phys 97: 257-258, 2009.
16. BioInitiative Working Group: BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2007. Available from: http://www.bioinitiative.org/table-of-contents/ (Accessed on 4 July, 2018).
17. BioInitiative Working Group: BioInitiative Report 2012: A Rationale for a Biologically-based Exposure Standard for Electromagnetic Fields (ELF and RF). Sage C and Carpenter DO (eds). Bioinitiative, 2012. Available from: http://www.bioinitiative.org/table-of-contents/ (Accessed on 4 July, 2018).
18. Wyde M, Cesta M, Blystone C, Bucher J, Elmore S, Foster P, Hooth M, Kissling G, Malarkey D, Sills R, *et al*: Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposure). Draft 5-19-2016. US National Toxicology Program (NTP). doi: http://dx.doi.org/10.1101/055699. Available from: http://biorxiv.org/content/biorxiv/early/2016/05/26/055699.full.pdf (Accessed on 4 July, 2018).
19. National Toxicology Program: NTP technical report on the toxicology and carcinogenesis studies in Hsd: Sprague Dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 595, March 26-28, 2018. Available from: https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf (Accessed on 4 July, 2018).

20. National Toxicology Program: NTP technical report on the toxicology and carcinogenesis studies in B6C3F1/N mice exposed to whole-body radio frequency radiation at a frequency (1,900 MHz) and modulations (GSM and CDMA) used by cell phones. NTP TR 596, March 26-28, 2018. Available from: https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf (Accessed on 4 July, 2018).
21. Szmigielski S, Szudzinski A, Pietraszek A, Bielec M, Janiak M and Wrembel JK: Accelerated development of spontaneous and benzopyrene-induced skin cancer in mice exposed to 2450-MHz microwave radiation. Bioelectromagnetics 3: 179-191, 1982.
22. Cleary SF, Liu LM and Merchant RE: Glioma proliferation modulated in vitro by isothermal radiofrequency radiation exposure. Radiat Res 121: 38-45, 1990.
23. Cleary SF, Liu LM and Merchant RE: In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions. Bioelectromagnetics 11: 47-56, 1990.
24. Chou CK, Guy AW, Kunz LL, Johnson RB, Crowley JJ and Krupp JH: Long-term, low-level microwave irradiation of rats. Bioelectromagnetics 13: 469-496, 1992.
25. Repacholi MH, Basten A, Gebski V, Noonan D, Finnie J and Harris AW: Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. Radiat Res 147: 631-640, 1997.
26. Utteridge TD, Gebski V, Finnie JW, Vernon-Roberts B and Kuchel TR: Long-term exposure of E-mu-Pim1 transgenic mice to 898.4 MHz microwaves does not increase lymphoma incidence. Radiat Res 158: 357-364, 2002.
27. Hardell L, Eriksson M, Carlberg M, Sundström C and Mild KH: Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. Int Arch Occup Environ Health 78: 625-632, 2005.
28. Linet MS, Taggart T, Severson RK, Cerhan JR, Cozen W, Hartge P and Colt J: Cellular telephones and non-Hodgkin lymphoma. Int J Cancer 119: 2382-2388, 2006.
29. Lauer O, Frei P, Gosselin MC, Joseph W, Röösli M and Fröhlich J: Combining near- and far-field exposure for an organ-specific and whole-body RF-EMF proxy for epidemiological research: A reference case. Bioelectromagnetics 34: 366-374, 2013.
30. Lu M and Wu XY: Study of specific absorption rate (SAR) induced in human endocrine glands for using mobile phones. IEEE Asia-Pacific International Symposium on Electromagnetic Compatibility (APEMC): 1084-1086, 2016.
31. Carlberg M, Hedendahl L, Ahonen M, Koppel T and Hardell L: Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data. BMC Cancer 16: 426, 2016.
32. Tillmann T, Ernst H, Streckert J, Zhou Y, Taugner F, Hansen V and Dasenbrock C: Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model. Int J Radiat Biol 86: 529-541, 2010.
33. Lerchl A, Klose M, Grote K, Wilhelm AF, Spathmann O, Fiedler T, Streckert J, Hansen V and Clemens M: Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. Biochem Biophys Res Commun 459: 585-590, 2015.
34. Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, Gnudi F, Mandrioli D, Manservigi M, Manservisi F, Manzoli I, *et al*: Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ Res 165: 496-503, 2018.
35. Johansen C, Boice J Jr, McLaughlin J and Olsen J: Cellular telephones and cancer - a nationwide cohort study in Denmark. J Natl Cancer Inst 93: 203-207, 2001.
36. Schüz J, Jacobsen R, Olsen JH, Boice JD Jr, McLaughlin JK and Johansen C: Cellular telephone use and cancer risk: Update of a nationwide Danish cohort. J Natl Cancer Inst 98: 1707-1713, 2006.
37. Söderqvist F, Carlberg M and Hardell L: Review of four publications on the Danish cohort study on mobile phone subscribers and risk of brain tumors. Rev Environ Health 27: 51-58, 2012.
38. Benson VS, Pirie K, Schüz J, Reeves GK, Beral V and Green J; Million Women Study Collaborators: Mobile phone use and risk of brain neoplasms and other cancers: Prospective study. Int J Epidemiol 42: 792-802, 2013.
39. Ohgaki H and Kleihues P: Population-based studies on incidence, survival rates, and genetic alterations in astrocytic and oligodendroglial gliomas. J Neuropathol Exp Neurol 64: 479-489, 2005.
40. INTERPHONE Study Group: Brain tumour risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.
41. Coureau G, Bouvier G, Lebailly P, Fabbro-Peray P, Gruber A, Leffondre K, Guillamo JS, Loiseau H, Mathoulin-Pélissier S, Salamon R, *et al*: Mobile phone use and brain tumours in the CERENAT case-control study. Occup Environ Med 71: 514-522, 2014.
42. Hardell L and Carlberg M: Mobile phones, cordless phones and the risk for brain tumours. Int J Oncol 35: 5-17, 2009.
43. Hardell L and Carlberg M: Mobile phone and cordless phone use and the risk for glioma - Analysis of pooled case-control studies in Sweden, 1997-2003 and 2007-2009. Pathophysiology 22: 1-13, 2015.
44. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of two case-control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997-2003. Int Arch Occup Environ Health 79: 630-639, 2006.
45. Hardell L, Carlberg M and Hansson Mild K: Re-analysis of risk for glioma in relation to mobile telephone use: Comparison with the results of the Interphone international case-control study. Int J Epidemiol 40: 1126-1128, 2011.
46. Hardell L, Carlberg M and Hansson Mild K: Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. Int J Oncol 38: 1465-1474, 2011.
47. Cardis E, Armstrong BK, Bowman JD, Giles GG, Hours M, Krewski D, McBride M, Parent ME, Sadetzki S, Woodward A, *et al*: Risk of brain tumours in relation to estimated RF dose from mobile phones: Results from five Interphone countries. Occup Environ Med 68: 631-640, 2011.
48. Grell K, Frederiksen K, Schüz J, Cardis E, Armstrong B, Siemiatycki J, Krewski DR, McBride ML, Johansen C, Auvinen A, *et al*: The intracranial distribution of gliomas in relation to exposure from mobile phones: Analyses from the INTERPHONE study. Am J Epidemiol 184: 818-828, 2016.
49. Momoli F, Siemiatycki J, McBride ML, Parent ME, Richardson L, Bedard D, Platt R, Vrijheid M, Cardis E and Krewski D: Probabilistic multiple-bias modeling applied to the Canadian data from the INTERPHONE study of mobile phone use and risk of glioma, meningioma, acoustic neuroma, and parotid gland tumors. Am J Epidemiol 186: 885-893, 2017.
50. Carlberg M and Hardell L: Decreased survival of glioma patients with astrocytoma grade IV (glioblastoma multiforme) associated with long-term use of mobile and cordless phones. Int J Environ Res Public Health 11: 10790-10805, 2014.
51. Akhavan-Sigari R, Mazloum Farsi Baf M, Ariabod V, Rohde V and Rahighi S: Connection between cell phone use, p53 gene expression in different zones of glioblastoma multiforme and survival prognoses. Rare Tumors 6: 5350, 2014.
52. Turner MC, Benke G, Bowman JD, Figuerola J, Fleming S, Hours M, Kincl L, Krewski D, McLean D, Parent ME, *et al*: Occupational exposure to extremely low-frequency magnetic fields and brain tumor risks in the INTEROCC study. Cancer Epidemiol Biomarkers Prev 23: 1863-1872, 2014.
53. Carlberg M, Koppel T, Ahonen M and Hardell L: Case-control study on occupational exposure to extremely low-frequency electromagnetic fields and glioma risk. Am J Ind Med 60: 494-503, 2017.
54. Peleg M, Nativ O and Richter ED: Radio frequency radiation-related cancer: Assessing causation in the occupational/military setting. Environ Res 163: 123-133, 2018.
55. Cea-Soriano L, Wallander MA and García Rodríguez LA: Epidemiology of meningioma in the United Kingdom. Neuroepidemiology 39: 27-34, 2012.
56. Carlberg M and Hardell L: Pooled analysis of Swedish case-control studies during 1997-2003 and 2007-2009 on meningioma risk associated with the use of mobile and cordless phones. Oncol Rep 33: 3093-3098, 2015.
57. Shrestha B, Khalid M, Gayam V, Mukhtar O, Thapa S, Mandal AK, Kaler J, Khalid M, Garlapati P, Iqbal S, *et al*: Metachronous granular cell tumor of the descending colon. Gastroenterol Res 11: 317-320, 2018.
58. Kim HJ and Lee MG: Granular cell tumors on unusual anatomic locations. Yonsei Med J 56: 1731-1734, 2015.
59. Rejas RA, Campos MS, Cortes AR, Pinto DD and de Sousa SC: The neural histogenetic origin of the oral granular cell tumor: An immunohistochemical evidence. Med Oral Patol Oral Cir Bucal 16: e6-e10, 2011.
60. Kamal SA and Othman EO: Granular cell tumour of the larynx. J Laryngol Otol 112: 83-85, 1998.
61. Deltour I, Johansen C, Auvinen A, Feychting M, Klaeboe L and Schüz J: Time trends in brain tumor incidence rates in Denmark, Finland, Norway, and Sweden, 1974-2003. J Natl Cancer Inst 101: 1721-1724, 2009.

62. Hardell L and Carlberg M: Increasing rates of brain tumours in the Swedish national inpatient register and the causes of death register. Int J Environ Res Public Health 12: 3793-3813, 2015.
63. Hardell L and Carlberg M: Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. PLoS One 12: e0185461, 2017.
64. Philips A, Henshaw DL, Lamburn G and O'Carroll MJ: Brain tumours: Rise in glioblastoma multiforme incidence in England 1995-2015 suggests an adverse environmental or lifestyle factor. J Environ Public Health 7910754: 2018, 2018.
65. INTERPHONE Study Group: Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case-control study. Cancer Epidemiol 35: 453-464, 2011.
66. Hardell L, Carlberg M, Söderqvist F and Mild KH: Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.
67. Moon IS, Kim BG, Kim J, Lee JD and Lee WS: Association between vestibular schwannomas and mobile phone use. Tumour Biol 35: 581-587, 2014.
68. Sato Y, Akiba S, Kubo O and Yamaguchi N: A case-case study of mobile phone use and acoustic neuroma risk in Japan. Bioelectromagnetics 32: 85-93, 2011.
69. Pettersson D, Mathiesen T, Prochazka M, Bergenheim T, Florentzson R, Harder H, Nyberg G, Siesjö P and Feychting M: Long-term mobile phone use and acoustic neuroma risk. Epidemiology 25: 233-241, 2014.
70. Hardell L and Carlberg M: Long-term mobile phone use and acoustic neuroma. Epidemiology 25: 778, 2014.
71. Christensen HC, Schüz J, Kosteljanetz M, Poulsen HS, Thomsen J and Johansen C: Cellular telephone use and risk of acoustic neuroma. Am J Epidemiol 159: 277-283, 2004.
72. Takebayashi T, Varsier N, Kikuchi Y, Wake K, Taki M, Watanabe S, Akiba S and Yamaguchi N: Mobile phone use, exposure to radiofrequency electromagnetic field, and brain tumour: A case-control study. Br J Cancer 98: 652-659, 2008.
73. Schoemaker MJ and Swerdlow AJ: Risk of pituitary tumors in cellular phone users: A case-control study. Epidemiology 20: 348-354, 2009.
74. Leng L and Zhang Y: Etiology of pituitary tumors: A case control study. Turk Neurosurg 26: 195-199, 2016.
75. Gittleman H, Ostrom QT, Farah PD, Ondracek A, Chen Y, Wolinsky Y, Kruchko C, Singer J, Kshettry VR, Laws ER, *et al*: Descriptive epidemiology of pituitary tumors in the United States, 2004-2009. J Neurosurg 121: 527-535, 2014.
76. Garg R, Bhartia P, Bahl I and Ittipiboon A: Microstrip Antenna Design Handbook. Artech House, Norwood, 2001.
77. Misa-Agustiño MJ, Jorge-Mora T, Jorge-Barreiro FJ, Suarez-Quintanilla J, Moreno-Piquero E, Ares-Pena FJ and López-Martín E: Exposure to non-ionizing radiation provokes changes in rat thyroid morphology and expression of HSP-90. Exp Biol Med (Maywood) 240: 1123-1135, 2015.
78. Eşmekaya MA, Seyhan N and Ömeroğlu S: Pulse modulated 900 MHz radiation induces hypothyroidism and apoptosis in thyroid cells: A light, electron microscopy and immunohistochemical study. Int J Radiat Biol 86: 1106-1116, 2010.
79. Shiels MS, Pfeiffer RM, Besson C, Clarke CA, Morton LM, Nogueira L, Pawlish K, Yanik EL, Suneja G and Engels EA: Trends in primary central nervous system lymphoma incidence and survival in the U.S. Br J Haematol 174: 417-424, 2016.
80. Eloranta S, Brånvall E, Celsing F, Papworth K, Ljungqvist M, Enblad G and Ekström-Smedby K: Increasing incidence of primary central nervous system lymphoma but no improvement in survival in Sweden 2000-2013. Eur J Haematol 100: 61-68, 2018.
81. Poulsen AH, Friis S, Johansen C, Jensen A, Frei P, Kjaear SK, Dalton SO and Schüz J: Mobile phone use and the risk of skin cancer: A nationwide cohort study in Denmark. Am J Epidemiol 178: 190-197, 2013.
82. Hardell L, Carlberg M, Hansson Mild K and Eriksson M: Case-control study on the use of mobile and cordless phones and the risk for malignant melanoma in the head and neck region. Pathophysiology 18: 325-333, 2011.
83. Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Tice RR, Bucher JR, *et al*: Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environmental Mutagenesis and Genomics Society, Annual Meeting, Raleigh, North Carolina, USA, September 9-13, 2017.
84. Lai H and Singh NP: Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. Bioelectromagnetics 18: 446-454, 1997.
85. Yakymenko I, Tsybulin O, Sidorik E, Henshel D, Kyrylenko O and Kyrylenko S: Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med 35: 186-202, 2016.
86. Megha K, Deshmukh PS, Banerjee BD, Tripathi AK, Ahmed R and Abegaonkar MP: Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain. Neurotoxicology 51: 158-165, 2015.
87. Hardell L and Carlberg M: Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones. Rev Environ Health 28: 97-106, 2013.
88. The 5G Appeal: Scientists and doctors warn of potential serious health effects of 5G. Available from: http://www.5gappeal.eu/scientists-and-doctors-warn-of-potential-serious-health-effects-of-5g/ (Accessed on 4 July, 2018).
89. Russell CL: 5 G wireless telecommunications expansion: Public health and environmental implications. Environ Res 165: 484-495, 2018.
90. Betzalel N, Ben Ishai P and Feldman Y: The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? Environ Res 163: 208-216, 2018.
91. Melnick RL: Commentary on the utility of the National Toxicology Program Study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ Res 168: 1-6, 2018.

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I represent: Garment District Alliance

Address: 209 W 38th Street, 2nd Floor NY NY 10018

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I represent: Bronx Chamber of Commerce

Address: 1200 WATERS PL BX 10461

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Name: Lo van der Valk

Address: [redacted] E 92nd St, [redacted]

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Name: Theresa Westerdahl

Address: 187 Sullivan Place Brooklyn NY 11225

I represent: _____

Address: _____

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☐ in favor ☒ in opposition of 5G towers

Date: 06-07

(PLEASE PRINT)

Name: Donna Romo

Address: 9 West 64th St NYC NY 10023

I represent: New Yorkers 4 Wired Tech

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☐ in favor ☐ in opposition

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(PLEASE PRINT)

Name: Rev. Conrad B. Tillard

Address: 94 Bainbridge St

I represent: Black Clergy for Economic Empowerment

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THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☑ in favor ☐ in opposition

Date: 6.7.2023

(PLEASE PRINT)

Name: Susannah Perlman

Address: 110 E. 13th

I represent: ARTHOUSE.NYC

Address: SAME.

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: 6.7.23

(PLEASE PRINT)

Name: Ruth Fennessy Moss

Address: [redacted] Hillair Cir White Plains, NY

I represent: self; following John Fennessy who is also testifying

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: John Fennessy

Address: [redacted] W. 77 Sts/ NY, NY

I represent: self: testifying just before Ruth Fennessy Moss

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 5G Towers Res. No. _____

☐ in favor ☒ in opposition

Date: _____

(PLEASE PRINT)

Name: Minna Elias

Address: [redacted] West End Ave [redacted], NY NY 10023

I represent: _____

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 5G towers Res. No. _____

☐ in favor ☒ in opposition

Date: _____

(PLEASE PRINT)

Name: Carolyn Maloney

Address: [redacted] E 92 Apt. [redacted]

I represent: _____

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: 6/7/23

(PLEASE PRINT)

Name: OLETTE WILKINS 11375

Address: [redacted] DARTMOUTH ST. FOREST HILLS, NY

I represent: WIRED BROADBAND, INC.

Address: POBOX 750401, FOREST HILLS NY 11375

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☑ in opposition

Date: June 1 2023

(PLEASE PRINT)

Name: Courtney Gilard

Address: Almast Pittsfield ma

I represent: Pittsfield Injured+ Concerned Citizens

Address: Almast Pittsfield

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☑ in favor ☐ in opposition

Date: 6/7/23

(PLEASE PRINT)

Name: Luisa Lopez

Address: _____

I represent: LINKNYC / Intersection.

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Chantal Senatus

Address: _____

I represent: OTI

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Ryan Birchmeier

Address: _____

I represent: att

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Birtt Silloff

Address: _____

I represent: att

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☒ in opposition to 5G Towers

Date: 6/7/2023

(PLEASE PRINT)

Name: Susan Peters

Address: [redacted] W 98 [redacted]

I represent: New Yorkers 4 Wired Tech

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: Jun 7,

(PLEASE PRINT)

Name: James GERDING

Address: [redacted] East 85th St.

I represent: Self

Address: same

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Nicholas F. Curto Jr.

Address: [redacted] E 85 St. [redacted] NYC 10028

I represent: Myself

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☒ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Robert Sokota

Address: 10 Hudson Yards

I represent: CityBridge

Address: 10 Hudson Yards

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☑ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Nicole Robinson - Etienne

Address: [redacted] E-8 2nd St Bklyn NY 11231

I represent: LinkNYC / CityBridge

Address: [redacted] 10 Hudson Yards NY NY

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☑ in opposition

Date: _____

(PLEASE PRINT)

Name: JULIE MARDIN

Address: [redacted] 5th Ave. NYC 10003

I represent: self

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☑ in favor ☐ in opposition

Date: 06/08/23

(PLEASE PRINT)

Name: Stephen Keegan

Address: 211 Wilson Blvd. Arlington VA 22209

I represent: Wireless Infrastructure Assc.

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☑ in favor ☐ in opposition

Date: 6/7/23

(PLEASE PRINT)

Name: MARGNX KNEE

Address: 10 HUDSON YARDS NY NY 10001

I represent: LINKNYC

Address: 10 HUDSON YARDS NY NY 10001

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☑ in opposition

Date: _____

(PLEASE PRINT)

Name: ARNOLD GORE

Address: Plaza Street East

I represent: Self

Address: _____

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: 6/7/2023

(PLEASE PRINT)

Name: Raul Rivera

Address: _____

I represent: _____

Address: _____

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

50 ☒ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: Anthony FALLEO

Address: [redacted] Stanton St Northport NY

I represent: Local 3 IBEW

Address: 158-11 HVA JR AVE Flushing

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☒ in opposition

Date: _____

(PLEASE PRINT)

Name: LASHAUN ELLIS

Address: [redacted] STODDARD PLACE

I represent: MTOPP . FLAC . SLSNA

Address: \

Please complete this card and return to the Sergeant-at-Arms