

Docket 22-270

In the Matter of:

**Inquiry Concerning Deployment of Advanced Telecommunications
Capability to All Americans in a Reasonable and Timely Fashion (DA
23-89)**

SEVENTEENTH SECTION 706 REPORT NOTICE OF INQUIRY

Comments submitted: December 1, 2023

Paragraph 5. Section 706 requires us to annually conduct an inquiry “concerning the availability of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms)”

Paragraph 9. We seek comment on benchmarks to define advanced telecommunications capability for the purposes of evaluating section 706’s universal service goals for broadband. In addition to proposing an increase from the existing fixed broadband speed benchmark of 25/3 Mbps to 100/20 Mbps we seek comment on adopting a long-term fixed broadband speed goal of 1,000 Mbps, or 1 gigabit per second (Gbps), download speed paired with 500 Mbps upload speed. We also seek comment on whether we should adopt upload and download speed benchmarks for mobile service, and propose to include an assessment in our final report of the number of fixed and mobile broadband providers to which consumers have access.

Comments

We support efforts to make high-speed **wired** broadband available to all Americans.

Regarding speed benchmarks or speed goals for fixed wireless data service and mobile wireless data service, the FCC should not set or increase speed benchmarks, speed goals, or deployment goals until the federal government has determined safe levels of radiofrequency radiation exposure from wireless technology, especially from cell towers and transmission infrastructure, for humans, wildlife, and the environment.

Setting speed benchmarks or speed goals for fixed wireless or mobile wireless service will encourage service providers, as well as other federal, state, and local government decision-makers, to meet these goals by deploying more antennas, installing more towers, and overall increasing the radiofrequency emissions of their infrastructure, and exposure thereto. Antenna proliferation and radiofrequency densification endangers people, children, wildlife, and the environment. The applicability of section 706 to children in schools and classrooms creates



an additional duty of care for FCC to protect children by determining safety limits that protect children from harmful levels of wireless radiation.

FCC has ignored its responsibilities for at least ten years, including a court order from the US Court of Appeals for the DC Circuit (*Environmental Health Trust v. FCC*, 2021) and the recommendations of a GAO report (2012).

No federal agency with health or science expertise has evaluated the comprehensive body of scientific research on the health and environmental impacts of wireless radiation. Current FCC limits were developed by industry groups, largely based on studies (IEEE 1991 standard) that based exposure limits on effects found after exposing just 11 monkeys and 12 rats to radiation for less than one hour, more than 40 years ago. As the US Court of Appeals DC Circuit recognized, these antiquated studies are a far cry from properly assessing the health and environmental impacts of modern technology and ubiquitous wireless devices.

Instead of expanding the radiofrequency output of wireless networks, FCC should take actions to protect the public, children, and the environment.

Please see attached scientific information documenting biological effects of radiofrequency exposure, at levels significantly below current FCC limits, on:

- Humans
- Children
- Environment: Wildlife, Animals and Plants

If the FCC moves forward with wireless expansion that increases wireless radiation exposure, it will cause irreversible harm to people and the environment.

The FCC must comply with the National Environmental Policy Act and first launch an environmental review in regards to the impact of such environmental wireless radiation increases from the FCC's "**Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion (DA 23-89).**"

The FCC must also first respond to the DC Circuit and explain how its antiquated wireless radiation limits address long term exposure to children and wildlife before greenlighting wireless expansion.

Thank you for the opportunity to comment,

Theodora Scarato

Executive Director

Environmental Health Trust

Scientific Research

A [recent analysis](#) by the Environmental Working Group concluded that FCC limits should be 200 to 400 times lower than the whole-body exposure limit set by the FCC in 1996, yet school districts nationwide are deploying high capacity Wi-Fi networks in school buildings, testing out 5G networks with students and signing leases with companies that install cell towers on school property, relying on these outdated FCC limits to ensure safety.

A [substantial body of research](#) has found these types of non-ionizing EMFs associated with numerous adverse effects including [cancer](#), [DNA damage](#), [memory damage](#), [behavioral problems](#), [reproductive damage](#), [tumor promotion](#), [blood-brain barrier damage](#), [increased oxidative stress](#), [impacts to the endocrine system](#) and [brain damage](#). Many of these effects could be irreversible with grave consequences for our children's future.

Numerous [published](#) scientific [reports recommend](#) that the public, especially children and pregnant women, [reduce](#) their [exposure](#) to [non-ionizing](#) electromagnetic [radiation](#) in order to protect their health, including radiation frequencies that range from extremely [low-frequency fields](#) to all wireless and the higher frequencies of 5G.^{15,16,17,18,19,20,21,22,23}

As an example, recent research on human cells exposed to wireless frequencies published in the journal Biomedicines found numerous impacts including increased oxidative stress and impacts to mitochondrial function. In the experiments, human cells were exposed to the Wi-Fi frequency of 2.45 GHz. The study -[“The Exposure to 2.45 GHz Electromagnetic Radiation Induced Different Cell Responses in Neuron-like Cells and Peripheral Blood Mononuclear Cells”](#) - was published November 24th in the journal Biomedicines by researchers Maria Paola Bertuccio, Giuseppe Aciri, Riccardo Ientile, Daniela Caccamo, and Monica Currò from the University of Messina, Italy.

Significant findings of the study included:

- A significant increase in ROS generation in radiation-exposed cells, compared with controls at all exposure times.
- A time-dependent decrease in cell viability in comparison to unexposed cells
- Mitochondrial transmembrane potential values decreased (after 2 hours and 24 hours in exposed SH-SY5Y cells, and in PBMCs, values decreased soon after 2 hours of exposure.)
- Numerous alterations were found (in the NAD⁺/NADH ratio, mtTFA, SOD1, LC3 gene expression, and BAX/BCL2 ratio).
- The neuron-like cells were more prone to developing oxidative stress compared to PBMCs after 2.45 GHz exposure, activating an early antioxidant defense response.

Children's Vulnerability to Radiofrequency Radiation

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They are more exposed compared to adults because of their physiology. 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.
- Smaller bodies allow RF exposures to potentially cover larger body areas.

Children are more sensitive to RF because:

- Their brains are developing.
- Younger brains have more active stem cells- scientifically found to be uniquely impacted by wireless.
- Children will have a longer lifetime of higher exposures, starting from before they are born.

American Academy of Pediatrics

“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](#)

Cell Tower RF and Cancer

World Health Organization’s International Agency for Research on Cancer

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 their 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 cell tower emission RF levels 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

- 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 entitled Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations](#) published in *Electromagnetic Biology and Medicine* found changes in blood considered biomarkers predictive of cancer in people living closer to cell antenna arrays ([Zothanslama 2017](#)).
- A study by [Augner et.al \(2010\)](#) found that people who lived within 100 meters of cell phone towers had greater salivary alpha-amylase levels. Exposure to higher levels of GSM cell tower radiation increased the levels of this salivary enzyme.
- A [study](#) entitled [The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil](#) 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](#) entitled [Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil - ScienceDirect](#) 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](#)).

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 RF levels had not yet significantly increased, but this was due to the lack of 5G traffic. So the researchers did additional measurements specific to 5G in the 3500 MHz band with artificially generated traffic and concluded, “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 Stockholm, Sweden. The authors conclude, “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 note 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.

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 10-year [study](#) entitled [Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil - ScienceDirect](#) 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](#) entitled [The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil](#) 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 [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 2011](#)).
- 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](#)).
- The New Hampshire State Commission [Report on 5G Health and Environment](#) recommends a setback distance of at least 1640 feet for homes and schools.

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. \(2012\)](#) entitled [Research and evaluation of the intensity parameters of electromagnetic fields produced by mobile communication antennas](#) 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.”

Increased Exposure From Cellular 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.”

Health Symptoms Reported by People Living Close to Cell Antennas

Federal and state 5G streamlining laws have fast tracked transmitting cell antennas close to people's homes and workplace.

Five published case reports document illness that developed after 5G antennas were installed.

In [Hardell L. and Nilsson M. \(2023\)](#) a 52-Year healthy woman developed severe microwave syndrome shortly after installation of a 5G base station close to her apartment.

In [“The Microwave Syndrome after Installation of 5G Emphasizes the Need for Protection from Radiofrequency Radiation” \(Hardell and Nilsson 2023\)](#), a man and woman 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.

In [5G Radiofrequency Radiation Caused the Microwave Syndrome in a Family Living Close to the Base Stations](#) a family of three living at distances of about 50 and 70 meters to two 5G base stations reported symptoms included in the microwave syndrome. The daughter had the most

severe health issues, for example sleeping problems, headache, concentration and memory problems, skin disorders, irregular heartbeat, light sensitivity, anxiety and panic attacks.

In Nilsson M, Hardell L (2023) [“A 49-Year-Old Man Developed Severe Microwave Syndrome after Activation of 5G Base Station 20 Meters from his Apartment”](#) published in the Journal of Community Med Public Health a man rather immediately developed a variety of symptoms that are part of the microwave syndrome including headache, dysesthesia (abnormal sensation), loss of immediate memory, high and irregular pulse, chest squeeze, burning and lancinating skin after a 5G base station was installed 20 meters from his apartment. After moving to another apartment with low RF radiation the symptoms disappeared or decreased within a short time period but they reappear whenever he returns to his apartment close to the 5G antennas.

Surveys of people living near cell tower antennas in [France](#), [Spain](#), [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](#), [Pachuaau and Pachuaau 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](#)).

4G LTE and Health

“We found the spontaneous low frequency oscillations in brain were altered by the acute LTE RF-EMF exposure” [Clinical Neurophysiology 2014](#).

Many new “small” cells are 4G Long Term Evolution (LTE) antennas. Industry states that 4G is the backbone for 5G networks and so they are densifying 4G facilities in residential neighborhoods. However, just like 5G, 4G LTE was deployed *without premarket safety testing* for long-term exposure.

Studies on 4G exposure to rodents found behavioral changes ([Broom et al. 2019](#)), damage to the testes ([Yu et al. 2019](#)), reduced sperm ([Oh et al. 2018](#)), damage to the optic nerve ([Ozdemir et al. 2021](#)) and impacts to neuronal activity ([Souffi et al. 2022](#)).

Studies on human volunteers have found 4G impacts on brain waves ([Vecsei et al. 2018](#), [Yang et al. 2017](#), [Lv et al. 2014](#), [Wei et al. 2018](#)). A study on human cells found continuous exposure decreased human cell proliferation and increased intracellular reactive oxygen species (ROS) in human cells ([Choi et al. 2020](#)).

Over 30 state legislatures have enacted industry friendly small cell legislation that facilitates deployment of 5G small cells into neighborhoods and in front of schools. These laws generally streamline the application process, cap costs and fees for the companies and tighten timelines for the consideration and processing of cell siting applications.

Higher Frequency 5G

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 starting at 24 GHz.

Scientists state that long term exposure cannot be assumed as safe.

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](#)). Ultra-high frequency above 20 GHz could overheat tissue ([Matthew and Kazaure 2022](#)).

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](#)).

Biological impact studies on higher frequencies to be used in 5G

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 the 5G frequency of 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.

Male rats exposed to a 5G base station (4 months) that transmitted at 3.6 GHz, 28 GHz, and 36 GHz had moderately increased stress on neuroendocrine system ([Perov et al 2022](#)).

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.”

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 2021](#)); 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](#)).

[Pustake et al. \(2022\)](#) exposed butter bean seeds to a 4G/5G cell phone and found adverse effects on seed germination and growth.

A review by [Russell 2018](#) found evidence for millimeter wave effects to the skin, eyes, immune system, gene expression, and bacterial antibiotic resistance. While recent experimental research on high-band 5G impacts to animal fertility found that 27 GHz damages sperm quality in mussels ([Pecoraro et al 2023](#)), the US is not funding any research on biological effects of frequencies at 3.5 GHz or above 6GHz to humans.

Weller S, May M, McCredde J, Leach V, Phung D, Belyaev I. [Comment on "5G mobile networks and health-a state-of-the-science review of the research into low-level RF fields above 6 GHz" by Karipidis et al.](#) J Expo Sci Environ Epidemiol. 2022 Nov 24.

Betzalel, N., Feldman, Y., & Ishai, P. B. (2017). [The Modeling of the Absorbance of Sub-THz Radiation by Human Skin](#). *IEEE Transactions on Terahertz Science and Technology*, 7(5), 521–528.

2022, Pecoraro et al. [Biological Effects of Non-Ionizing Electromagnetic Fields at 27 GHz on Sperm Quality of *Mytilus galloprovincialis*](#). J Mar Sci Eng 10 (4): 521J Mar Sci Eng 10 (4): 521

2022, Wang et al. [3.5-GHz radiofrequency electromagnetic radiation promotes the development of *Drosophila melanogaster*](#) Environ Pollut 294: 118646

2021, Wang et al. [Simulated mobile communication frequencies \(3.5 GHz\) emitted by a signal generator affects the sleep of *Drosophila melanogaster*](#) Environ Pollut 283: 117087

2020, Kim et al. [Effects of Electromagnetic Waves with LTE and 5G Bandwidth on the Skin Pigmentation In Vitro](#) Int J Mol Sci 22 (1): E170

Dasgupta, S., Leong, C., Simonich, M. T., Truong, L., Liu, H., & Tanguay, R. L. (2022). [Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish](#). *Environmental Science & Technology Letters*, 9(4), 327–332.

Yang, H., Zhang, Y., Wu, X., Gan, P., Luo, X., Zhong, S., & Zuo, W. (2022). [Effects of Acute Exposure to 3500 MHz \(5G\) Radiofrequency Electromagnetic Radiation on Anxiety-Like Behavior and the Auditory Cortex in Guinea Pigs](#). *Bioelectromagnetics*, 43(2), 106–118.

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). [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*

Zothansiam 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

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*

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). [5 G 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

[A study of the long term changes in the electromagnetic environment using data from continuous monitoring sensors in Greece | Scientific Reports](#)

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*

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*

Urbiniello 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

<https://pubmed.ncbi.nlm.nih.gov/37725264/>

Broom et al. (2019). [Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6 J 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*

Notes regarding construction: all comments and materials in this submission and in any other attachments or materials we submit in this docket are responsive and apply to all paragraphs of the notice of inquiry, not any one particular paragraph. Web links in this document and in any other attachments or materials we submit in this docket refer to external websites; the external document or webpage to which each such link refers is incorporated by reference in its entirety in this document and in this docket.



To: Williamson County School Board
CC: Williamson County Board of Commissioners

The Scientific Evidence To Support Restrictions on Cell Towers On Or Near School Property

November 13, 2023

Dear Williamson County School Board:

Today, we are writing to advise you of the scientific grounds for enacting strong school policy to mitigate student, teacher and staff exposures to the non-ionizing electromagnetic field emissions from cell towers. Wireless radio frequency (RF) electromagnetic (EMF) radiation and magnetic field/extremely low-frequency electromagnetic fields (ELF-EMF) are a relatively new and rapidly increasing environmental exposure in classrooms today. Significant sources include cell towers, cell boosters and 5G/4G networks on and near school property.

Extensive published scientific evidence indicates that radiofrequency radiation at levels compliant with federal government limits can cause [cancer](#), [increased oxidative stress](#), [genetic damage](#), structural and functional changes of the [reproductive system](#), [memory deficits](#), [behavioral problems](#), and [neurological impacts](#). We consider radiofrequency radiation (RFR) to be a human carcinogen based on the [current body](#) of evidence. Many of these effects could be irreversible with grave consequences for our children's future.

We recommend policies to reduce human exposure to RF, especially in schools. We note that schools are now taking measures to reduce cell tower radiation from nearby cell towers. As an example, the Desert Sage High School in central Tucson, a public charter school has [installed shielding along the wall facing the cell tower](#) to reduce the cell tower radiation exposures in the classroom.

On August 13, 2021, the United States Court of Appeals for the District of Columbia Circuit [ruled in our case](#) against the FCC that the decision by the Federal Communications Commission (FCC) not to update its 1996 safety limits for human exposure to wireless radiation (which includes cell tower emissions) was "arbitrary and capricious." One of the most important aspects of the court decision was that the court found the FCC did not adequately explain why it ignored scientific evidence on impacts from long term wireless radiation exposure, especially in regards to children, who the American Academy of Pediatrics states are more vulnerable to wireless radiation. The court ordered the FCC to examine the record evidence regarding long term exposure to children. So far, the FCC has not responded. Thus, this landmark [ruling](#) highlights how no federal health agency has reviewed the full body of current research to ensure current safety standards are protective.

As an example of the research indicating federal regulations are inadequate to protect health, refer to a publication titled ["Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer"](#) by Balmori (2022). This publication reviewed the existing scientific literature on cell tower radiation and found associations with radiofrequency sickness, cancer and changes in biochemical parameters. We have attached this study for your review.

A review paper by [Pearce 2020](#) titled “[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.

Studies on people living near cell antennas have found increases in molecular markers in the blood that predict cancer. [Zothansiana et al. 2017](#) evaluated effects in the human blood of individuals living near mobile phone base stations (for study purposes, they chose a distance of 80 meters) compared with healthy controls living more than 300 meters from a base station. The study measured higher RFR levels in the homes of people living in homes within 80 meters from the cell antennas (documenting the impact of increased RFR radiation from the antenna installations) and found statistically significant differences in their blood. The group living closer to the antennas had statistically significant higher frequency of micronuclei and a rise in lipid peroxidation in their blood; these changes are considered biomarkers predictive of cancer.

Please note the following scientific publications regarding cell towers and cell phone radiation:

- In 2011, radiofrequency radiation was [classified](#) as a Class 2B possible carcinogen by the World Health Organization’s International Agency for Research on Cancer. Between then and now, the published peer-reviewed scientific evidence has significantly increased. Now, many scientists are of the opinion that the weight of current peer-reviewed evidence supports the conclusion that radiofrequency radiation should be regarded as a human carcinogen ([Hardell and Carlberg 2017](#), [Peleg et al. 2018](#), [Miller et al 2018](#)).
- The U.S. National Toxicology Program \$25 million animal study on long-term exposure to radiofrequency radiation found [DNA Damage](#), [heart damage](#), increased [brain tumors](#), and [increased heart tumors](#) deemed “clear evidence of cancer.” Researchers with the renowned Ramazzini Institute in Italy then published [findings](#) that lab animals exposed to levels of RFR comparable to cell tower base stations’ networks developed the same types of cancers as the [US National Toxicology Program](#) found in its large-scale animal study.
- An Australian [study](#) looked at RFR levels to which kindergarten children were exposed, depending on how close their school was to base stations/cell towers. Researchers equipped the children with RFR measuring devices. Researchers found that kindergartens located nearby base stations/cell towers (closer than 300 meters or approximately 330 yards) had total exposure to radiofrequency radiation (RFR or RF-EMF) more than 3 times higher than children at schools where base stations were further away than 300 meters.
- A review by [Yakymenko 2015](#) found that in 93 out of 100 studies, RFR exposure caused oxidative stress. Many well-known carcinogens (such as asbestos and arsenic) are understood to induce oxidative stress. [Schuermann et al., 2021](#) again confirmed non-ionizing radiation has oxidative effects in the majority of animal and cell studies.
- The International Association of Firefighters has officially opposed cell towers on their stations since 2004 after a study [found](#) neurological damage in firefighters with antennas on their fire station. In 2017, when 5G “small cells” were coming to California via a 5G streamlining bill (SB 649), firefighter organizations came out in strong opposition to the bill and requested that towers

not be installed on firehouses. They were successful and SB649 was [amended](#) to [exempt](#) their stations from the deployment due to their health concerns.

- A study by [Meo et al., 2019](#) of students in schools near cell towers found their higher RF exposure was associated with impacts on motor skills, memory, and attention. Examples of other health issues associated with cell towers in research studies include [neuropsychiatric problems](#), diabetes, [headaches](#), [sleep problems](#), and [genetic damage](#). Such research continues to accumulate after the 2010 landmark [review study](#) on 56 studies that reported biological effects found at very low intensities of wireless radiation, including impacts on reproduction, permeability of the blood-brain barrier, behavior, cellular changes and metabolic changes, and increases in cancer risk ([Lai and Levitt 2010](#)).
- The [International EMF Scientist Appeal](#) was submitted to the United Nations urging immediate protective policy action in light of the scientific evidence that has found adverse biological effects from electromagnetic radiation, including radiofrequency radiation, and, as of July 2023, this Appeal is signed by 259 scientists from 44 nations; these are scientists who have published peer-reviewed articles about electromagnetic fields. They state, “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.”
- The European Parliament Study Service “[Health Impact of 5G](#)” report concludes that the electromagnetic field emission frequencies of 450 to 6,000 MHz “are probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas” and in regards to reproductive developmental effects “these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, fetuses and newborns.”

The exposure limits of the U.S. are outdated and do not protect the health of the public, especially not the health of children and staff exposed every school day. This is why the [New Hampshire State Commission on 5G](#) and [Santa Clara Medical Association](#) recommend restricting cell towers near schools.

Please note that in several countries, governments have set policies to protect children, pregnant women and medically fragile persons by classifying areas with homes, hospitals and schools as “sensitive areas.” These countries reduce exposure in “sensitive” areas and have strict oversight and compliance measures in place.

Our position is that children require special protections from radiofrequency radiation and their exposures should be reduced to as low as possible. Teachers and staff should work in a healthy environment. We strongly recommend mitigating RFR exposure at schools.

EHT has been joined by other experts and organizations in writing to you and offering expertise to support the development of protective measures. Please see the attached resources with additional documentation. We are available to meet and present more about how to reduce and mitigate RF risks and answer any questions.

Thank you for your consideration and action on this important issue.

Signatories

Devra Davis, PhD, MPH
President and Founder, Environmental Health Trust

Anthony B. Miller, MD
Professor Emeritus at the Dalla Lana School of Public Health, University of Toronto
Senior Advisor to Environmental Health Trust

Theodora Scarato, MSW
Executive Director, Environmental Health Trust

David O. Carpenter, MD
Director, Institute for Health and the Environment
A Collaborating Center of the World Health Organization
University at Albany, New York

Alfonso Balmori, BSc, Biologist
Master in Environmental Education, Independent researcher

Kent Chamberlin, PhD
Professor & Chair Emeritus
Department of Electrical & Computer Engineering
University of New Hampshire

Paul Héroux, PhD
Professor of Toxicology and Health Effects of Electromagnetism
McGill University Medicine
Department of Surgery, McGill University Health Centre

Meg Sears, PhD
Chair, Prevent Cancer Now
Senior Research Associate, Ottawa Hospital Research Associate

Frank Clegg
CEO, Canadians for Safe Technology

References

Balmori, A. (2022). Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. *Environmental Research*, 214, 113851.
<https://doi.org/10.1016/j.envres.2022.113851>

Balmori, A. (2010). Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: The city turned into a laboratory. *Electromagnetic Biology and Medicine*, 29(1–2), 31–35. <https://doi.org/10.3109/15368371003685363>.

Blettner, M., Schlehofer, B., Breckenkamp, J., Kowall, B., Schmiedel, S., Reis, U., Potthoff, P., Schüz, J., & Berg-Beckhoff, G. (2009). Mobile phone base stations and adverse health effects: Phase 1 of a population-based, cross-sectional study in Germany. *Occupational and Environmental Medicine*, 66(2), 118–123. <https://doi.org/10.1136/oem.2007.037721>.

Bortkiewicz, A., Zmyślony, M., Szykowska, A., & Gadzicka, E. (2004). [Subjective symptoms reported by people living in the vicinity of cellular phone base stations: Review]. *Medycyna Pracy*, 55(4), 345–351. <https://pubmed.ncbi.nlm.nih.gov/15620045/>.

Broom, K. A., Findlay, R., Addison, D. S., Goiceanu, C., & Sienkiewicz, Z. (2019). Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6 J Mice. *Bioelectromagnetics*, 40(7), 498–511. <https://doi.org/10.1002/bem.22217>

Buchner, K., & Eger, H. D. I. (2011). Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields A Long-term Study under Real-life Conditions. <https://www.avaate.org/IMG/pdf/Rimbach-Study-20112.pdf>.

Carlberg, M., Hedendahl, L., Koppel, T., & Hardell, L. (2019). High ambient radiofrequency radiation in Stockholm city, Sweden. *Oncology Letters*, 17(2), 1777–1783. <https://doi.org/10.3892/ol.2018.9789>.

Choi, J., Min, K., Jeon, S., Kim, N., Pack, J.-K., & Song, K. (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*, 10(1), 9238. <https://doi.org/10.1038/s41598-020-65732-4>

Dode, A. C., Leão, M. M. D., Tejo, F. de A. F., Gomes, A. C. R., 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. *The Science of the Total Environment*, 409(19), 3649–3665. <https://doi.org/10.1016/j.scitotenv.2011.05.051>.

Eger, et al., The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer (2004). *Umwelt·Medizin·Gesellschaft*. <http://www.tetrawatch.net/papers/naila.pdf>.

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? *Clinical Biochemistry*, 45(1–2), 157–161. <https://doi.org/10.1016/j.clinbiochem.2011.11.006>.

Eşmekaya, M. A., Seyhan, N., & Ömeroğlu, S. (2010). Pulse modulated 900 MHz radiation induces hypothyroidism and apoptosis in thyroid cells: A light, electron microscopy and immunohistochemical study. *International Journal of Radiation Biology*, 86(12), 1106–1116. <https://doi.org/10.3109/09553002.2010.502960>.

Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Mandrioli, D., Manservigi, M., Manservigi, F., Manzoli, I., Menghetti, I., Montella, R., Panzacchi, S., Sgargi, D., Strollo, V., Vornoli, A., & 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. *Environmental Research*, 165, 496–503. <https://doi.org/10.1016/j.envres.2018.01.037>

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. *Electromagnetic Biology and Medicine*, 34(4), 344–354. <https://doi.org/10.3109/15368378.2014.933349>.

Gandhi, G., Naru, J., Kaur, M., & Kaur, G. (2014). DNA and Chromosomal Damage in Residents Near a Mobile Phone Base Station. *International Journal of Human Genetics*, 14(3–4), 107–118. <https://doi.org/10.1080/09723757.2014.11886234>.

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. <https://doi.org/10.1136/bmjopen-2013-003836>.

Hardell, L., & Koppel, T. (2022). Electromagnetic hypersensitivity close to mobile phone base stations—A case study in Stockholm, Sweden. *Reviews on Environmental Health*. <https://doi.org/10.1515/reveh-2021-0169>.

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 Academy of Sciences Journal*, 1(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. *Oncology Letters*, 15(5), 7871–7883. <https://doi.org/10.3892/ol.2018.8285>.

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. *Molecular and Clinical Oncology*, 6(4), 462–476. <https://doi.org/10.3892/mco.2017.1180>.

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*, 49(4), 1315–1324. <https://doi.org/10.3892/ijo.2016.3657>.

Hardell, L., & Sage, C. (2008). Biological effects from electromagnetic field exposure and public exposure standards. *Biomedicine & Pharmacotherapy*, 62(2), 104–109. <https://doi.org/10.1016/j.biopha.2007.12.004>.

Hecht, K., Savoley, E.N., (2007). Overloading of Towns and Cities with Radio Transmitters (Cellular Transmitter): a hazard for the human health and a disturbance of eco-ethics, IRCHET – International Research Centre of Healthy and Ecological Technology, Berlin, Germany. <https://ecfsapi.fcc.gov/file/7521097890.pdf>.

Hutter, H.-P., Moshhammer, H., Wallner, P., & Kundi, M. (2006). Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occupational and Environmental Medicine*, 63(5), 307–313. <https://doi.org/10.1136/oem.2005.020784>.

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. *International Journal of Occupational and Environmental Health*, 16(3), 263–267. <https://doi.org/10.1179/107735210799160192>.

Koppel, T., & Hardell, L. (2022). Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA. *World Academy of Sciences Journal*, 4(3), 1–12. <https://doi.org/10.3892/wasj.2022.157>

Koppel, T., Ahonen, M., Carlberg, M., & Hardell, L. (2022). Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. *Environmental Research*, 208, 112627. <https://doi.org/10.1016/j.envres.2021.112627>.

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. *Oncology Letters*, 18(5), 5383–5391. <https://doi.org/10.3892/ol.2019.10899>.

Kundi, M., & Hutter, H.-P. (2009). Mobile phone base stations-Effects on wellbeing and health. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*, 16(2–3), 123–135. <https://doi.org/10.1016/j.pathophys.2009.01.008>.

Levitt, B., & Lai, H. (2010). Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. *Environmental Reviews*, 18, 369–395. <https://doi.org/10.1139/a10-903>.

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. *Environmental Research*, 194, 110734. <https://doi.org/10.1016/j.envres.2021.110734>.

Lv, B., Chen, Z., Wu, T., Shao, Q., Yan, D., Ma, L., Lu, K., & Xie, Y. (2014). The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure. *Clinical Neurophysiology*, 125(2), 277–286. <https://doi.org/10.1016/j.clinph.2013.07.018>.

Marinescu, I. E., & Poparlan, C. (2016). Assessment of GSM HF-Radiation Impact Levels within the Residential Area of Craiova City. *Procedia Environmental Sciences*, 32, 177–183. <https://doi.org/10.1016/j.proenv.2016.03.022>.

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. *American Journal of Men's Health*, 13(1), 1557988318816914. <https://doi.org/10.1177/1557988318816914>.

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. *International journal of environmental research and public health*, 12(11), 14519–14528. <https://doi.org/10.3390/ijerph121114519>.

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). *Environmental Research*, 167, 673–683. <https://doi.org/10.1016/j.envres.2018.06.043>.

Navarro, E. A., Segura, J., Portolés, M., & Gómez-Perretta de Mateo, C. (2003). The Microwave Syndrome: A Preliminary Study in Spain. *Electromagnetic Biology and Medicine*, 22(2–3), 161–169. <https://doi.org/10.1081/JBC-120024625>.

Oberfeld, G., Navarro, E., Portoles, M., Maestu, C., & Gómez-Perretta, C. (2002). THE MICROWAVE SYNDROME - FURTHER ASPECTS OF A SPANISH STUDY. https://www.researchgate.net/publication/237410769_THE_MICROWAVE_SYNDROME_-_FURTHER_ASPECTS_OF_A_SPANISH_STUDY.

Özdemir, E., Çömelekoğlu, Ü., Degirmenci, E., Bayrak, G., Yildirim, M., Ergenoglu, T., Coşkun Yılmaz, B., Korunur Engiz, B., Yalin, S., Koyuncu, D. D., & Ozbay, E. (2021). The effect of 4.5 G (LTE Advanced-Pro network) mobile phone radiation on the optic nerve. *Cutaneous and Ocular Toxicology*, 40(3), 198–206. <https://doi.org/10.1080/15569527.2021.1895825>.

Pachauu, Lalrinthara & Pachauu, Zaithanzaauva. (2014). Study of Cell Tower Radiation and its Health Hazards on human body. *IOSR Journal of Applied Physics (IOSR-JAP)* e-ISSN: 2278-4861. Volume 6, Issue 1 Ver. 1, PP 01–06. <https://www.iosrjournals.org/iosr-jap/papers/Vol6-issue1/Version-1/A06110106.pdf>.

Pachauu, Lalrinthara & Pachauu, Zaithanzaauva. (2016). Health Effects of Mobile Tower Radiation on Human — Case Study. *International Journal of Applied Physics and Mathematics*. 6. 72–79. [10.17706/ijapm.2016.6.2.72-79](https://doi.org/10.17706/ijapm.2016.6.2.72-79).

Pearce, J. M. (2020). Limiting liability with positioning to minimize negative health effects of cellular phone towers. *Environmental Research*, 181, 108845. <https://doi.org/10.1016/j.envres.2019.108845>.

Richter, E. D., Berman, T., & Levy, O. (2002). Brain cancer with induction periods of less than 10 years in young military radar workers. *Archives of Environmental Health*, 57(4), 270–272. <https://doi.org/10.1080/00039890209601409>.

- Roda, C., & Perry, S. (2014). Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection. *Environmental Science & Policy*, 37, 204–214. <https://doi.org/10.1016/j.envsci.2013.09.009>.
- Rodrigues, N. C. P., Dode, A. C., de Noronha Andrade, M. K., O'Dwyer, G., Monteiro, D. L. M., Reis, I. N. C., Rodrigues, R. P., Frossard, V. C., & Lino, V. T. S. (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*, 18(3), 1229. <https://doi.org/10.3390/ijerph18031229>.
- SA, M., Alsubaie, Y., Almubarak, Z., Almutawa, H., AlQasem, Y., & Hasanato, R. (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. *International Journal of Environmental Research and Public Health*, 12, 14519–14528; <https://doi.org/10.3390/ijerph121114519>.
- Santini, R., Santini, P., Le Ruz, P., Danze, J. M., & Seigne, M. (2003). Survey Study of People Living in the Vicinity of Cellular Phone Base Stations. *Electromagnetic Biology and Medicine*, 22(1), 41–49. <https://doi.org/10.1081/JBC-120020353>.
- Santini, R., Santini, P., Danze, J. M., Le Ruz, P., & Seigne, M. (2002). Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex. *Pathologie-Biologie*, 50(6), 369–373. [https://doi.org/10.1016/s0369-8114\(02\)00311-5](https://doi.org/10.1016/s0369-8114(02)00311-5). [Article in French].
- Shinjo, T. & Shinjo, A. (2014) Significant Decrease of Clinical Symptoms after Mobile Phone Base Station Removal – An Intervention Study, *Tetsuharu Shinjo and Akemi Shinjo UmweltMedizinGesellschaft*, 27(4), S. 294–301.
- Souffi, S., Lameth, J., Gaucher, Q., Arnaud-Cormos, D., Lévêque, P., Edeline, J.-M., & Mallat, M. (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*, 12(1), 4063. <https://doi.org/10.1038/s41598-022-07923-9>
- Vecsei, Z., Knakker, B., Juhász, P., Thuróczy, G., Trunk, A., & Hernádi, I. (2018). Short-term radiofrequency exposure from new generation mobile phones reduces EEG alpha power with no effects on cognitive performance. *Scientific Reports*, 8, 18010. <https://doi.org/10.1038/s41598-018-36353-9>
- Wei, Y., Yang, J., Chen, Z., Wu, T., & Lv, B. (2019). Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study. *Bioelectromagnetics*, 40(1), 42–51. <https://doi.org/10.1002/bem.22165>
- Wolf, R., & Wolf, D. (2004). Increased incidence of cancer near a cell-phone transmitter station. *International Journal of Cancer*, 1(2), 123–128. [[Google Scholar](#)].
- 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. *Experimental Oncology*, 33(2), 62–70. <https://pubmed.ncbi.nlm.nih.gov/21716201/>.
- Yang, L., Chen, Q., Lv, B., & Wu, T. (2017). Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands. *Clinical EEG and Neuroscience*, 48(3), 168–175. <https://doi.org/10.1177/1550059416644887>.
- Yu, G., Tang, Z., Chen, H., Chen, Z., Wang, L., Cao, H., Wang, G., Xing, J., Shen, H., Cheng, Q., Li, D., Wang, G., Xiang, Y., Guan, Y., Zhu, Y., Liu, Z., & Bai, Z. (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*, 698, 133860.

<https://doi.org/10.1016/j.scitotenv.2019.133860>.

Zothansiam, Zosangzuali, M., Lalramdinpui, 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. *Electromagnetic Biology and Medicine*, 36(3), 295–305.

<https://doi.org/10.1080/15368378.2017.1350584>.



COLLABORATIVE FOR
HIGH PERFORMANCE
SCHOOLS.



2014 US-CHPS

Criteria

New Construction
and Renovation

Low-EMF Best Practices

Intent

Minimize exposure to extremely low frequency (ELF) magnetic fields.

EQ 15.1 – Low-EMF Wiring

EQ 15.2 – Low-EMF Best Practices

Numerous organizations recommend minimizing exposure to extremely-low frequency (ELF) electric and magnetic fields (EMF).

The US National Electrical Code (NEC) has been published since 1897 to promote safe electrical installations and to prevent fire hazards and electric shock. Wiring errors not only violate electrical code rules but may also cause unnecessary ELF magnetic field exposures. Wiring errors may occur in new construction or modernization projects, and inspections conducted by local code enforcement authorities may not detect the great majority of these problems.

In 2000, the expert panel of the [California EMF Project](#) (scientists of the California Department of Health Services on behalf of the

California Public Utilities Commission) concluded based on the then-available scientific evidence that “*EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig’s Disease, and miscarriage.*”

In 2002, the International Agency for Research on Cancer classified **extremely low frequency magnetic fields** (ELF MF) as possibly carcinogenic ([monograph volume 80](#)).

In 2006, the [IEQ Indoor Environmental Quality Project](#) committee of the **US National Institute of Building Sciences** recommended to keep [magnetic field exposure levels](#) in occupied areas below 2.5 mG (250 nT), and preferably below 1 mG (100 nT).

In 2009, the **Austrian Sustainability Building Council** with support by the Federal Ministry of Transportation, Innovation and Technology released its latest version of the [Total Quality Building Assessment](#) tool. This green building rating system includes a criterion for low ELF magnetic field exposure levels: less than 1 mG (100 nT) “excellent”, 1-2 mG (100-200 nT) “very good” (summary of threshold levels in [English](#)).

In addition, many education technology tools such as desktop computers, laptops, tablets, and other electronic devices are sources of electromagnetic fields. When used within close range of the human body, a student’s exposure to electromagnetic fields such as ELF magnetic and electric as well as radio-frequency electromagnetic fields may increase considerably. ELF magnetic fields were classified as possibly carcinogenic by the World Health Organization (WHO) International Agency for Research on Cancer (IARC) in 2002, and radio-frequency (RF) electromagnetic fields (including mobile phones) were classified as possibly carcinogenic by the WHO/IARC in 2011. In order to reduce the potential for adverse effects due to these exposures, it is important in school environments with children to apply the precautionary principle “as low as reasonably achievable (ALARA)” by providing low-EMF classrooms, specifying low-EMF IT equipment and wired Internet access network technology, and establishing low-EMF user practices.

EQ 15.1 – Low-EMF Wiring		Credit	
		2 points	
Applicability	Verification		
All projects.	Design Review	Construction Review	Performance Review



Requirement

2 points	EQ 15.1 <i>No net current magnetic fields – Correct school wiring</i> The wiring in all school rooms shall be compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code. All school rooms shall be free of the following common wiring errors: - Improperly wired subpanels (neutral-to-ground bond); - Incorrect three-way switch wiring; - Incorrect wiring of switched outlet circuits; - Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits; - Neutral-ground shorts (intentional or inadvertent) anywhere in the system. The correctness of the wiring shall be checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations, see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 below.
----------	--

EQ 15.2 – Low-EMF Best Practices		Credit	
		1 - 2 points	
Applicability	Verification		
All projects.	Design Review	Construction Review	Performance Review

Requirement

1 point	EQ 15.2.1 <i>Low EMF Best Practices for Computers</i> The District or equivalent governing body for a private school shall pass a resolution requiring: - Desktop computers, laptops, notebooks, and tablets be operated on a desk; operation of these devices on an occupant's lap or body is prohibited; computer workstation equipment must be greater than 2 feet from occupants. - Desktop computers, laptops, notebooks, and tablets be TCO-certified or laboratory tested to meet TCO Criteria "Mandate A.4.2" for EMF emissions. - Laptops or notebooks have an Ethernet port and a physical switch to conveniently disable all wireless radios at once and an adaptor with a 3-pin plug. - Only tablets that support a USB Ethernet adaptor for a wired network connection; operate tablets only in battery mode and not when plugged in.
---------	---



OR 1 point	EQ 15.2.2 <i>Wired local area network (LAN) to reduce radio-frequency (RF) EMF</i> • Install a wired local area network (LAN) for Internet access throughout the school. Provide wired network connections for desktop computers, laptops, notebooks, and tablets. All wireless transmitters shall be disabled on all Wi-Fi-enabled devices. Provide wired input devices for computer workstations.
OR 1 point	EQ 15.2.3 <i>Wired Phones to reduce RF EMF in classroom</i> • Install easily accessible hard-wired phones for teacher and student use and prohibit installation and use of standard DECT cordless phones and cordless phones operating at 2.4 GHz and 5.8 GHz unless they have been laboratory tested to demonstrate that the cordless phone base station and handsets (whether placed in the charging station or not) do not emit RF EMF emissions in standby mode. • Prohibit the use of cell phones and other personal electronic devices in instructional areas / classrooms. Additionally, they shall be required to be powered off or be in airplane mode (sleep mode is not sufficient) except during fire-life-safety drills and incidents.

Table 13: ELF EMF Exposure Guidelines and Reference Levels

EMF Emission Standard or Guideline	Performance Measure	Reference Level Band I ELF 5 Hz-2 kHz Magnetic field
CA EMF Project Survey of 89 schools- 5,403 school rooms	20% of measured areas had average magnetic fields	>1 mG (100 nT)
EMF Working Group of the Austrian Medical Association – Exposure greater than 4 hours per day	Within normal limits	≤0.2 mG (20nT)
	Slightly above normal limits	0.2-1 mG (20-100 nT)
	Above normal limits	1-4 mG
	Far above normal limits	≥4 mG
Austrian Sustainability Building Council (2009) – <i>Total Quality Building Assessment Rating System</i>	Excellent	≤1 mG (100 nT)
	Very good	1-2 mG
	Good	2-4 mG
	Satisfactory	≥4 mG
IEQ Project Committee Recommendation of the U.S. National Institute of Building Sciences (2006)	Preferably	<1 mG (100 nT)
	All occupied areas	<2.5 mG (250 nT)
TCO Criteria “Mandate A.4.2”: – International sustainability standard for IT equipment (since 1992)	At 12-20” distance from equipment	≤2 mG (200 nT)
Federal Safety Guideline of Russia for Computer Workstations, including schools (2003)	At 20” distance from equipment	≤2.5 mG (250 nT)
International Agency for the Research on Cancer/WHO (2002)	Possibly carcinogenic Group 2B	>3-4 mG (300-400 nT) Increased childhood leukemia risk

Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System

15.2.1

No net current magnetic fields – Correct school wiring

The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of the following common wiring errors:



- a. Improperly wired subpanels (neutral-to-ground bond);
- b. Incorrect three-way switch wiring;
- c. Incorrect wiring of switched outlet circuits;
- d. Neutrals from separate branch circuits that are connected anywhere beyond the panel of origin for the circuits;
- e. Neutral-ground shorts (intentional or inadvertent) anywhere in the system.

The correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations; see the Austrian Sustainability Building Council (2009) – Total Quality Building Assessment Rating System as shown in Table 13 above.

15.2.2

Submit wiring diagrams indicating LAN wiring to all rooms with computers.

15.2.3

Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

Note: This may be in conflict with emergency communications in classrooms unless there are landline phones, or with the use of portable handheld devices required for standardized testing.

Documentation Requirements

Design Review

EQ 15.1 Reference specifications requiring compliance with the necessary codes including testing of rooms for compliance.

EQ 15.2.1 The Project Team shall provide a letter stating the following:

1. Wiring in all school rooms is compliant with the currently adopted US National Electrical Code (NEC) in the local jurisdiction, and applicable state electrical code.
2. All school rooms are free of common wiring errors.

EQ 15.2.2 Submit wiring diagrams indicating LAN wiring to all rooms with computers.

EQ 15.2.3 - Submit wiring diagrams indicating phone wiring to all rooms with telephones. Also submit a district resolution indicating compliance with other required measures.

Construction Review

EQ 15.1 Measurement Report from a third party or testing lab documenting compliance of each classroom.

EQ 15.2.1: Provide a report from a third party or testing lab documenting that the correctness of the wiring has been checked in each room and the ELF magnetic field exposure measured levels (tRMS) comply with 1 mG (100 nT) in new construction and 2 mG (200 nT) in existing school modernizations.

Resources

- National Electrical Code NFPA 70: www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70



- Suggested Protocol for School Electricians for Correcting Wiring Errors Causing Net Current Magnetic Fields www.ehib.org/emf/WiringProtocol.pdf
 - Tracing EMFs in Building Wiring and Grounding. (book), Karl Riley (2005): www.magneticsscience.com/TracingEMFsBook.html
 - Tracing Magnetic Fields in Building Wiring. (DVD) www.magneticsscience.com/TracingEMFsVideo.html
 - California EMF Project- School Related Documents, www.ehib.org/emf/general.html#school School Design Guidelines <http://www.ehib.org/emf/cklist.html>
 - ELECTRIC AND MAGNETIC FIELD EXPOSURE ASSESSMENT OF POWERLINE AND NON-POWERLINE SOURCES FOR CALIFORNIA PUBLIC SCHOOL ENVIRONMENTS, Luciano E. Zaffanelia, H. Christopher Hooper, Prepared for the Public Health Institute, California Department of Health Services EMF Program, , January 31, 2000, www.ehib.org/emf/school_exp_ass_exec.pdf
 - EU Directive 90/270/EEC (1990 May 29) on the minimum safety and health requirements for work with display screen equipment: eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31990L0270:EN:HTML
 - Ministry of Health of the Russian Federation. 2003 Jun 30. [Sanitary and epidemiological norms on hygienic requirements for personal computers and work organization]. Norm No.: SanPiN 2.2.2./2.4.1340-03. (in Russian)
 - Katharina Gustavs (2008): Options to Minimize Non-Ionizing Electromagnetic Radiation Exposures (EMF/RF/Static Fields) in Office Environments: buildingbiology.ca/wd/wp-content/uploads/2012/09/2008_Low_EMR_Office_Environment.pdf
 - TCO standards for IT equipment: www.tcodevelopment.com
 - Product search data base: http://79.136.114.89/pls/nvp/!tco_search
 - Displays: tcodevelopment.com/manufacture-resources/product-categories-2/displays/
 - Notebooks: tcodevelopment.com/manufacture-resources/product-categories-2/notebooks/
 - Desktops: www.ultrasone.com/index.php/en/company/technology/ule-technology.html
 - All-in-on PCs: tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/
 - Projectors: tcodevelopment.com/manufacture-resources/product-categories-2/projectors/
 - Headsets: tcodevelopment.com/manufacture-resources/product-categories-2/headsets/
 - Desktops: www.ultrasone.com/index.php/en/company/technology/ule-technology.html
 - All-in-on PCs: tcodevelopment.com/manufacture-resources/product-categories-2/all-in-one-pcs/
 - Projectors: tcodevelopment.com/manufacture-resources/product-categories-2/projectors/
 - Headsets: tcodevelopment.com/manufacture-resources/product-categories-2/headsets/
 - Austrian Sustainability Building Council with support by the Federal Ministry of Transportation, Innovation and Technology: Total Quality Building Assessment tool www.oegnb.net/de/zertifikat.htm?typ=wb
- Threshold levels for ELF-modulated RF radiation: <10 $\mu\text{W}/\text{m}^2$ excellent / 10-100 $\mu\text{W}/\text{m}^2$ very good / 100-1000 $\mu\text{W}/\text{m}^2$ good / 1000-3000 $\mu\text{W}/\text{m}^2$ satisfactory
- EMF Working Group of the Austrian Medical Association (2012): EMF Guideline of the Austrian Medical Association for the diagnosis and treatment of EMF-related health problems and illnesses. freiburger-appell-2012.info/media/EMF%20Guideline%20OAK-AG%20%202012%2003%2003.pdf Benchmarks apply to regular exposure of more than four hours per day: <1 $\mu\text{W}/\text{m}^2$ within normal limits / 1-10 $\mu\text{W}/\text{m}^2$ slightly above normal limits / 10-1000 $\mu\text{W}/\text{m}^2$ far above normal limits / >1000 $\mu\text{W}/\text{m}^2$ very far above normal limits

HOW TO ELIMINATE AND REDUCE ELECTROMAGNETIC FIELD (EMF) EXPOSURE IN THE CLASSROOM: A GUIDE FOR SCHOOLS

EHT recommends eliminating sources of EMF radiation inside school buildings by the installation of corded/wired (instead of wireless) internet/phone/tech connections. Corded/wired connections will significantly reduce hourly and overall exposures to students, teachers and staff.

HEALTHY TECH ROUTINES IN THE CLASSROOM

- At start of class, remind students to power off cell phones and Personal Digital Devices.
 - Regularly remind students about phones and wireless PDD: Distance devices away from body and,
 - If cell phones are needed for photos or video remind students to turn transmitting antennas off: Select “airplane mode” and disable all wireless antennas including Cellular, Wi-Fi, Mobile hotspot, Mobile data, Siri, Bluetooth and Location.
- Post policy and best practices signs in every classroom and prominently at room entrances.

CURRICULUM PLANNING

- When curricula requires internet connectivity, limit it to specific times rather than interspersed throughout class. For example, curricula should not require students to use phones to look up things during class. Instead, have a plan that includes time when students organize their research questions and, subsequently, a separate time when students research online.
- When internet or other electronic connections are needed, use hardwire connections (cords/cables/wires/adapters) for all equipment (personal computer, any size electronic screen, printer, audio speakers, headphones, microphone, smartboard, printer, mouse, keyboard, and other devices and accessories).
- If hardwire connections are not available in the school, minimize use of cloud and other wireless network services and instead use applications and content that are pre-downloaded onto devices.
- Download and install files for curriculum prior to students’ use. This will eliminate the need for Wi-Fi during class.
- Teach students to turn OFF wireless antennas when not in use (Wi-Fi, Bluetooth, Data, Cellular) and to select Airplane Mode for their personal devices including on cell phones, laptops, and other wireless devices. Note that students may need to go to Settings to fully disable Wi-Fi and Bluetooth.*

- Store laptop carts outside of the classroom, and avoid recharging laptops near students/staff.
- Instead of virtual reality “field trips,” show movies and video in class on a large screen.

** Wi-Fi “OFF when not in use” will still result in radiation exposures to students and staff during Wi-Fi use and continuously from WLAN access points. EHT recommends the installation of wired networks.*

COMMUNITY EDUCATION

- Regularly schedule parent, teacher and community education sessions about safer use of technology, e.g.:
 - Strategies and practical advice on how to minimize health risks of cell phones, screens, and wireless digital devices.
 - Hands-on workshops that explain and demonstrate how to hardwire home electronics and create a low-EMF computer workstation.
- Regularly hold discussion forums about strategies to address the challenges of parenting in the digital age.
- Hold student forums about how to reduce radiation, reduce eye strain, and minimize adverse psychosocial impact.

SCHOOL POLICY

- Create and regularly update policies for cell phone and digital device use in classrooms that includes medical recommendations for children’s health and safety related to eyes, posture, addiction, and radiation.
- Institute a ban on personal cell phones and personal hotspot devices. Prohibit use of all internet-connected devices in classrooms unless during supervised use for specific instructional purpose. Such a policy may help prevent students from rushing through schoolwork to go online for gaming or other non-school purposes.
- PDD bans (unless wireless transmissions are OFF) should be extended to school buses. Prohibit Wi-Fi and cell phone network use in buses because EMF radiation is intensified inside metal vehicles.

HOW TO ELIMINATE AND REDUCE ELECTROMAGNETIC FIELD (EMF) EXPOSURE IN THE CLASSROOM: AN INTRODUCTORY GUIDE FOR SCHOOLS

- Institute a policy that allows for convenient, non-wireless methods for students to communicate with parents about last-minute scheduling issues. Non-wireless methods could include: corded phones, electronic bulletin board, and other practical, accessible ways to get messages to/from students.
- Incorporate a Technology Curriculum into other curricula. For example,
 - In the health curriculum, include information about why and how to reduce exposure to wireless radiation, including step-by-step instructions how to disable wireless on their personal devices.
 - In the environmental science curriculum, review current and historical regulatory policies on EMFs, including international approaches.
- Educate administrators, staff, and volunteers at least annually and when newly hired, about the safer use of technology. This might include:
 - Reviewing school policies and how to reinforce them in the school setting,
 - Explaining how to eliminate/minimize health risks of cell phones, screens, and wireless digital devices with hands-on workshops that explain and demonstrate how to hardwire electronics and create a low-EMF computer workstation.

LOW-EMF INFRASTRUCTURE IN SCHOOL BUILDINGS

- Install wired rather than wireless LAN and communication services in schools.
- Only purchase or use computers, tablets, and other school and personal technology devices that can be ethernet-connected and allow all wireless applications (including locators) and antennas to be disabled.
- Locate computer stations and ethernet ports throughout school for convenient internet access.
- Hard wire all technology devices. This includes: fixtures such as printers, projectors, scoreboard controls, and boards; computer accessories such as audio speakers, mouse, keyboard, microphone, headphones, etc.; all locations at school (auditorium, gymnasium, library, office, indoor and outdoor lounge or activity areas, daycare facilities, etc.). Always include a step to disable Wi-Fi/Bluetooth antennas via settings in the device, because otherwise even when the device is connected with wires, its antennas will often continue to emit EMF radiation.

- Operate laptops and tablets only in battery mode and not when plugged into an electrical outlet.
- Place corded phones in every room and in common areas so students and staff can communicate without cell phones. No cordless phones.
- Hardwire security systems.
- Do not use fluorescent lights. If fluorescents are already installed, consider improvements and perhaps optimizing natural daylight.
- Do not use RFID systems for persons or property.
- Install wired charging systems instead of wireless charging systems.
- Do not place microwave ovens in classrooms or schools. If you must use microwaves, then ensure ovens are checked for leaks and damaged seams. Teach students and staff to distance themselves from ovens.
- Replace utility smart meters with analogue meters.
- Replace wirelessly communicating environmental sensors with non-wireless alternatives.
- Ensure the electrical wiring in all school rooms complies with U.S. National Electrical Code and applicable state electrical code and local jurisdiction regulations. Have an electrician evaluate, and remediate if necessary, to ensure:
 - Student- and staff-occupied areas have no common wiring errors,
 - ELF magnetic field exposure is not above 1 mG (100 nT).
 - Classrooms are not above electrical panels, electronics, or facility equipment/appliances that generate high EMFs.
- Ensure cell network towers, antennas, and boosters are not located on, in, or near school property.

For documentation and references please see [EHT's Question and Answer on Wi-Fi in Schools](#)



HOW TO ELIMINATE AND REDUCE WIRELESS RADIATION AND EVERYDAY ELECTROMAGNETIC FIELD (EMF) EXPOSURE IN DORMITORIES



LOW-EMF INFRASTRUCTURE IN SLEEPING AREAS

Internet Connections

- Install wired (instead of wireless, and instead of cordless) LAN and communication services in each building.
- Ensure every room has multiple ethernet ports near desks in each room (at least 2 per resident).
- Wi-Fi routers, access points, boosters, smart speakers, wireless electronics, wireless charging systems, wireless video games and Bluetooth devices should not be in sleeping areas and should not be in hallways near sleeping areas.
- At minimum, Wi-Fi routers can be turned off at night to support a healthier sleep.

Telephones

- Ensure every dorm room has a wired telephone, preferably with caller ID.
- Cell phones can be forwarded to this corded phone for voice calls in the dorm room.
- Students can plug their cell phones into the internet with ethernet cords instead of cellular or Wi-Fi for most applications.

STUDENT EDUCATION

- Why and how to reduce cell phone radiation exposure and other electromagnetic fields (EMFs).
- How to turn off the wireless antennas of cell phones and other tech so they are not always transmitting wireless radiofrequency radiation. For example, if Bluetooth is not in use, it can be turned off. If cellular is not in use, it should be turned off. Students should not sleep with transmitting cell phones near their heads or with phones resting on their body. Students can learn about how to use Airplane Mode to decrease unnecessary exposure.
- Practical information on how to ethernet plug in their computers and cell phones with adapters so they can access the internet without Wi-Fi.
- Safer charging: Using a phone while it is charging increases EMF exposure. Students need to know why they should distance themselves from chargers and unplug chargers when not in use. Laptops and cell phones should not be charged while resting on soft materials like a bed or couch.
- Safer technology Informational posters can be placed and maintained throughout the dormitory to provide this information.

Additional Important Ways to Minimize EMF Exposure

- Ensure every student receives a battery powered alarm clock.
- Ensure every student has a wired speaker to hear music/audio in their own room instead of Wi-Fi connected speakers or virtual assistants.
- Do not use fluorescent lights.
- Do not provide wireless charging.

Magnetic Field Exposure

- Ensure appliances, utility meters, electronics, or electrical machinery are not on the walls of sleeping areas, and are not on walls adjacent to sleeping areas, and are not on or near ceilings below sleeping areas.
- Extension cords and electrical wiring should not be under or near beds.
- Small dorm refrigerators also emit high levels of EMF and should not be placed near beds and not directly behind bedroom walls.
- Microwaves also emit high magnetic fields. They should be distanced from beds and preferably not in bedrooms at all. Replace microwave ovens with toaster ovens as a best step. If a microwave oven is absolutely necessary, it must not be in a bedroom nor in a room adjacent to a bedroom, and should be distanced as far as possible from all bedrooms.

Purchasing

- Schools can request non wireless corded telephones. Some phones have screens and are internet connected so students can text etc.
- Intentionally purchase or use only computers, tablets, and other school and personal technology devices that can be ethernet-connected and can successfully connect when all wireless applications (including locators) and antennas are disabled.
- Schools can purchase ethernet adapters for the various make and models of devices so students have the technology they need to connect.
- Contract and purchase building equipment, systems, and services that do not rely on using or generating wireless signals/emissions during regular operating or standby conditions (e.g., vending machines, HVAC, security, pest control, bank machines, laundry facilities, furnishings and equipment in common areas/washrooms/bathrooms/fitness areas/etc.).
- Minimize blue light as much as possible with both software programs and external protective screens for all screens supplied by the school.

HOW TO ELIMINATE AND REDUCE WIRELESS RADIATION AND EVERYDAY ELECTROMAGNETIC FIELD (EMF) EXPOSURE IN DORMITORIES

LOW EMF POLICY IN DORMS

Schools need to develop, implement, and enforce personal devices policies that minimize emissions and eliminate sources in the dormitory.

- Students need practical and ongoing education on how to reduce EMFs.
- Safe alternatives for playing music, accessing the Internet, and communicating must be accessible so students and staff can have needs met with low-EMF technology or non-EMF alternatives.
- Student and staff culture needs to shift so it is accepted that reducing EMF is important and behaviors that reduce emissions and exposures are valued.
- Dormitories without Wi-Fi and with low EMF need to be available in every school.
- Measure EMFs in dormitories, both wireless radiofrequency as well as magnetic fields and compare to Collaborative for High Performance Schools identified threshold.

COMPUTER ROOMS & WORKSPACES

- A dedicated computer room in a dormitory with wired technology, printers, electronic accessories, and other technology is an important component of a low-EMF building — to create a separation between sleeping areas and work areas and to ensure people have access to information and communication technologies.
- Connect all technology devices (printers, computers, fax machine etc. with wires, cords, or cables, and use non-wireless adapters.

RESOURCES

- New Jersey Educational Association “Minimize health risks from electronic devices”
- Massachusetts Breast Cancer Coalition Let’s Talk Prevention Classroom Modules Download Module 3 on Cell Phones
- Alliance of Nurses for Healthy Environments Textbook of Environmental Health in Nursing 2nd Edition Includes Cell Phone, Cell Tower and Wi-Fi Radiation and EMF
- Collaborative for High Performance Schools Low EMF Criteria

SCIENTIFIC RESEARCH

1. Clegg et al. (2020). Building science and radiofrequency radiation: What makes smart and healthy buildings. *Building and Environment*, 176, 106324
2. Hedendahl et al. (2017). Measurements of Radiofrequency Radiation with a Body-Borne Exposimeter in Swedish Schools with Wi-Fi. *Frontiers in Public Health*, 5
3. Park, J., Jeong, E., & Seomun, G. (2020). Extremely Low-Frequency Magnetic Fields Exposure Measurement during Lessons in Elementary Schools. *International Journal of Environmental Research and Public Health*, 17(15), 5284.
4. Belpomme et al. (2018). Thermal and non-thermal health effects of low intensity non-ionizing radiation. *Environmental Pollution*, 242, 643–658
5. Miller et al (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*, 7
6. Avendaño et al. (2012). Use of laptop computers connected to the internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. *Fertility and Sterility*, 97(1), 39-45.e2
7. Davis et al. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. *Current Problems in Pediatric and Adolescent Health Care*, 53(2), 101374.
8. Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (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.
9. International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), (2022). Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. *Environ Health*. Oct 18;21(1):92.
10. McCredden et al. (2022). Wireless technology is an environmental stressor requiring new understanding and approaches in health care. *Frontiers in Public Health*, 10.



SOURCES OF WIRELESS IN SCHOOLS

Wireless radio frequency (RF) radiation is an invisible environmental exposure linked to numerous serious biological effects. Here are common sources of RF radiation in classrooms.



WIRELESS RADIATION AND CHILDREN'S HEALTH

EXPERT VOICES

"The National Toxicology Program studies clearly showed that non-ionizing cell phone radiofrequency 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.**

"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.**

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**

"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. 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**



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, cell phones and Wi-Fi emit wireless radiofrequency (RF) radiation.

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They have proportionately more exposure to RF compared to adults. More importantly, a child's brain is rapidly developing and more sensitive. Even very low exposures in childhood can have serious impacts later in life.

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.

EXPOSURES TO WI-FI AND SMARTPHONE



Wireless Radiation Exposures Into the Body

- Wi-Fi, cellphones and other wireless devices emit radio-frequency (RF) which is a type of non ionizing electromagnetic radiation.
- The energy from RF waves penetrates into the human body.
- Each wireless device has one or more antennas transmitting RF at different frequencies.
- A "frequency" is the number of RFR waves that pass a specific point per second, every second. One Hertz (Hz) is one wave per second. A GHz is a billion waves per second.

Wi-Fi frequencies include:

- 2.45 GHz = 2,450,000,000 waves per second
- 5 GHz = 5,000,000,000 waves per second
- 6 GHz = 6,000,000,000 waves per second

Smartphones can have at least 5 active RF antennas

Cell Phone network frequencies generally *start* at 600 MHz = 600,000,000 waves per second.

The range then extends to the much higher frequencies of LTE and 5G. LTE often uses 700 MHz to 2,100 MHz

5G Devices will include frequencies above 24 GHz, meaning up to 24,000,000,000+ waves per second.

Tablets and laptops will also have several antennas (Wi-Fi, Bluetooth and cellular).



REPLACE WI-FI WITH ETHERNET

Numerous medical doctors and experts have issued recommendations for safer technology in schools.

- [Collaborative for High Performance Schools Low EMF Criteria](#)
- [Maryland State Children's Environmental Health & Protection Council](#)
- [New Jersey Educational Association](#)
- [New Hampshire 5G Commission](#)
- [Santa Clara California Medical Association](#)

The Santa Clara California Medical Association

- Creating a "Safe Tech in Schools Program" to educate students and staff on how to use devices safely and how to reduce wireless use in the classroom
- Using blue light reduction methods.
- Establishing school cell phone-free policies
- Preferring and installing hard-wired ethernet devices instead of wireless wherever possible
- Consulting with an RF professional to measure RF.
- Avoiding installation of smart meters.

SCHOOL COMMUNITY EDUCATION

Students, families and staff can be informed on why and how to reduce exposure via:

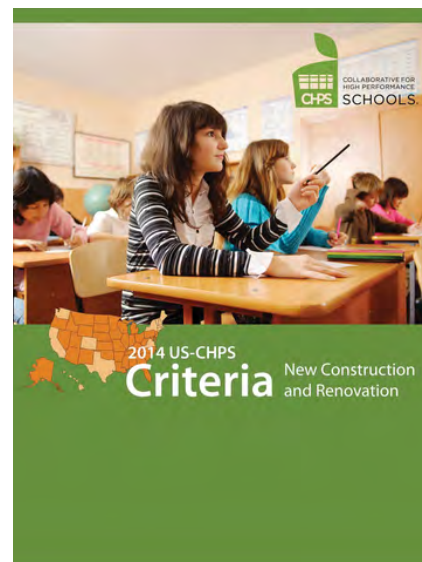
- Classroom posters.
- Educational content integrated into health curriculum.
- Digital safety education and movie screenings with community conversations for families.

"If you plan to watch a movie on your device, first download it, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure."

- American Academy of Pediatrics



The Massachusetts Breast Cancer Coalition developed "Lets Talk Prevention" educational modules on cell phone radiation for high school, middle school, and elementary students.



The Collaborative for High-Performance Schools Low EMF Criteria

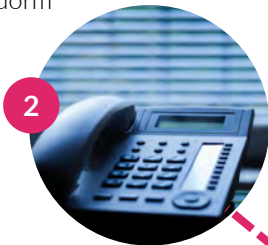
SCHOOL BEST PRACTICES

SAFE TECHNOLOGY

Choose corded, wired, LOW EMF technology to mitigate risk.

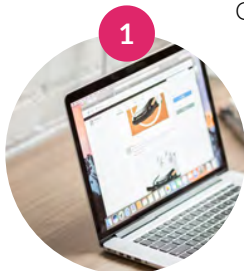
A CORDED PHONE

For every classroom and dorm



LAPTOPS

Connect with ethernet cords not Wi-Fi.



Wired LAN

Network with ethernet ports to connect devices to the internet,



TABLETS

Connect with ethernet not Wi-Fi & always on airplane mode. Pre-download programs instead of cloud based.



3

CELL PHONE POLICY

Cell phones OFF in classes, hallways and playgrounds.



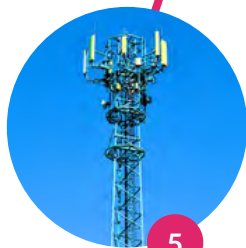
4

AIRPLANE MODE



EDUCATION

Educate students & staff on why and how devices should be placed in Airplane mode with Wi-Fi, Bluetooth and other antennas OFF.



5

CELL TOWER POLICY

No cell towers or 5G/4G wireless antennas on or near schools.



6

CLASS TECH

Hard wire all fixed classroom equipment such as printers, projectors and boards.



7

PERIPHERALS

Corded speakers, headphones, keyboard & mouse.

CELL PHONES AND WI-FI

INTERNATIONAL POLICY

FRANCE

Wi-fi is banned in nursery and kindergartens. Teacher computers must be ethernet connected. Wi-Fi is turned off in elementary schools unless turned on briefly for a specific lesson. The sale and advertising of cell phones for young children is prohibited. A 2019 Ministerial order ensures consumers buying cell phones are informed to use speakerphone, limit frequency and duration of calls for children and distance phone from the body. The instructions state, "Keep away from the belly of pregnant women, Keep away from the lower abdomen of adolescents."

BELGIUM

Ban on the sale of cell phones designed for young children. In 2014, Ghent banned Wi-Fi from pre-schools and day care.

FRENCH POLYNESIA

Ban on advertising of cell phones to children under fourteen years old. Advertising and phone labeling should clearly show and recommend the limiting of exposure to the head. Wi-Fi prohibited in nurseries and day cares. Wi-Fi is turned off in schools except for specific lessons if needed.

ISRAEL

Awareness website includes recommendations to reduce cell phone radiation exposure to the brain. Wi-Fi exposure is restricted to specific hours in elementary classrooms. Government measures RF and EMF levels in schools to monitor exposures.

CYPRUS

In 2017 the Minister of Culture and Education issued a directive to ban Wi-Fi from kindergartens and remove Wi-Fi from elementary classrooms. The Cyprus National Committee on Environment and Child Health has launched a multimedia public awareness campaign with brochures, videos and large scale ads on public buses featuring the importance of reducing children's wireless exposure.

PARLIAMENTARY ASSEMBLY OF THE COUNCIL OF EUROPE

Resolution 1815 called on to European governments to "take all reasonable measures" to reduce exposure to electromagnetic fields "particularly the exposure to children and young people who seem to be most at risk from head tumors." The Resolution calls for member states to implement public awareness campaigns and reduce exposure to as low as possible.

"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 schoolchildren on school premises."



PARENT TEACHER ASSOCIATIONS

CELL TOWERS & WIRELESS

BC CONFEDERATION OF PARENT ADVISORY COUNCILS

- Two resolutions. One calls on each Board of Education to have one public school at each education level that is free of Wi-Fi, cordless phones, and cell phones.
- The second calls on the Boards of Education to “cease to install Wi-Fi and other wireless networks in schools where other networking technology is feasible.”

BRIARLAKE ELEMENTARY (GA)

- Voted to oppose cell tower after board approved towers on schools.

CALIFORNIA PTA

- Resolution on Electromagnetic Fields
- PTA can educate and inform districts, councils and units about the potential hazards of EMFs to encourage school districts and schools to develop risk reduction policies and to disseminate information on the subject."

CASTLE HILL HIGH SCHOOL (AUSTRALIA) P&C COMMITTEE

- Funded ethernet plugs to reduce wireless exposure in classroom.
- Developed "Mobile Phone Safety Tips & Cyberbullying Information," which includes how to reduce cell phone and wireless radiation

FLETCHER HILLS (CA) PTA

- Resolution encouraging schools to use cable lines Internet connections and to avoid wireless networks on campus.

HILLSMERE ELEMENTARY SCHOOL PTA (MD)

- Sent letters to the school board in opposition to cell towers near the school.

MONTGOMERY COUNTY (MD) PTA

- Safe Tech PTA Committee shares online and print resources on reducing RFR exposure and on digital safety issues such as privacy.
- Meets monthly with school IT department.

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.

NEW YORK STATE PTA

- Resolution on Cell Towers supporting:
 1. laws that regulate tower placement near schools
 2. research into the long-term effects of RFR
 3. education for parents and school officials regarding cell towers and health.

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.

PALO ALTO, (CA) PTA

- Fact sheet on "Safe Use of Technology" which distributed to all the schools in the Palo Alto Unified School District

PHOENICIA ELEMENTARY NY PTA

- Sent a letter to the Onteora School District calling for the Wi-Fi to be turned off.



NORTH AMERICA TEACHER UNIONS

WI-FI IN SCHOOLS

UNITED EDUCATORS OF SAN FRANCISCO

- Resolution on Safer Technology calls for the California cell phone advisory on how to reduce cell phone exposure be disseminated to students and staff.
- Webinars on reducing RF exposure.

CANADA TEACHER FEDERATION

- Briefing document "Wi-Fi in School" recommends limiting Wi-Fi.

UNITED TEACHERS OF LOS ANGELES

- 2013 Resolution "UTLA will advocate for technological solutions that maintain technology upgrades while not increasing employees exposure to electromagnetic radiation."

UNITED FEDERATION OF TEACHERS

- Website shares Dr. Moskowitz's "Reducing Exposure to Wireless" brochure and The BabySafe Project "What You Need to Know About Wireless Radiation and Your Baby."

ELEMENTARY TEACHERS FEDERATION OF ONTARIO

- Call for Wi-Fi moratorium until health studies done (Limestone).

BC TEACHERS FEDERATION

- Resolution supporting members suffering from electromagnetic hypersensitivity by ensuring that their medical needs are accommodated in the workplace.

ONTARIO ENGLISH CATHOLIC TEACHERS

- Position Statement recommends wired networks as Wi-Fi "may present a potential health and safety risk or hazard in the workplace."

GREATER VICTORIA TEACHERS ASSOCIATION

- Recommends minimal or non-use of Wi-Fi.

NEW YORK STATE UNITED TEACHER UNION

- Resolution "Hazards of Wireless Radiation Emission"
- They issued "Best Practices" which includes to "avoid prolonged, close contact with wireless routers, laptop computers, tablets, cell phones and cordless phones."
- Webinar "Risks of wireless technologies and protecting children and staff in schools."

AMERICAN FEDERATION OF TEACHERS

- National AFT Conference presentation about wireless radiation posted online.

NEW JERSEY EDUCATIONAL ASSOCIATION

- 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.
- Put devices in airplane mode, which suspends EMF transmission in the device, disabling Bluetooth, GPS, phone calls, and WiFi.

"All educational facilities must have healthy indoor air quality, be smoke-free, be safe from environmental and chemical hazards, and be safe from hazardous electromagnetic fields...the public should be notified of actual and potential hazards."

— National Education Association

"We have enough evidence to justify taking action and we are not willing to wait until our members, their children and the students suffer health consequences from not doing anything,"
—Paul Pecorale, VP New York State United Teachers Union.

CELL TOWERS NEAR SCHOOLS

Source: BUWAL Switzerland

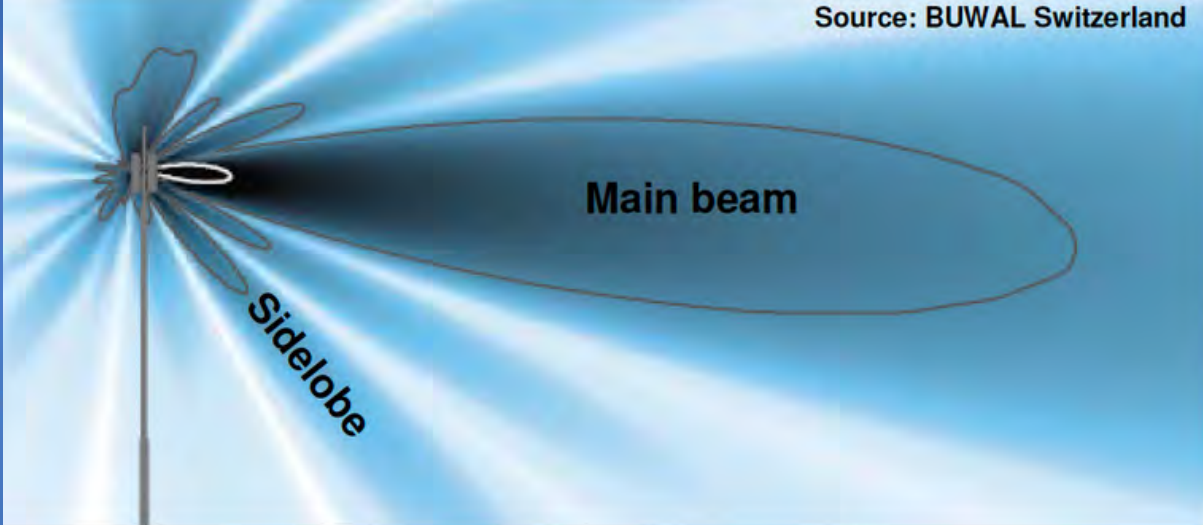


Image: Radiation Pattern of Sector Antenna V. Schorpp

PUBLISHED RESEARCH

A 2022 scientific research review found 3 types of effects in people living near base stations (cell towers): radio-frequency sickness, cancer and changes in biochemical parameters ([Balmori 2022](#)).

Published research on cell towers concludes:

- A 500 meter buffer is recommended for schools to reduce liability and minimize risk (Pearce 2019)
- A moratorium on 5G is needed due to current evidence indicating a lack of safety (Frank 2020)
- Cell towers near homes and schools is a human rights concern and 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)
- People living near cell antennas have increased DNA damage, cognitive effects, diabetes, sleep problems and headaches (Zothansiam 2017, Meo 2015, Meo 2018, Abdel-Rassoul 2007, Levitt & Lai 2010, Shahbazi-Gahruei 2013)

The European Parliament Research Service Report “Health Impact of 5G” was released in 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.

Firefighter unions have long opposed cell towers.

- 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.](#)
- In California firefighter unions lobbied to exempt their stations from 5G streamlining bills. They voiced strong opposition due to health risks posed by the radiation.

“As firefighters and paramedics, we live in these firehouses. What effect will these towers have on us? What are the risks to our neighbors? It’s a no-brainer that Los Angeles County should at least have done a proper study before putting 200-foot high-power microwave antennas on top of our heads.”

-[Dave Gillotte, Active Duty Fire Captain, President, LA County Firefighters Local 1014](#)

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, New York :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

- 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.
- A Tarrytown New York tower was removed after residents protested placement near a public housing complex and playground.

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](#) voted to oppose school towers.



LOS ANGELES UNIFIED SCHOOL DISTRICT, CALIFORNIA

- 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 has a policy no to allow any more 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 70 schools to be marketed as cell tower sites.
- Portland Oregon Schools ended new leases for cell towers.

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.

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.

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.

LETTER ON CELL TOWER

Agenda No. 11A, Attachment B
Exhibit A Page 46 of 186

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

WI-FI RADIATION

Clegg, Frank M. et al. (2019) "Building Science and Radiofrequency Radiation: What Makes Smart and Healthy Buildings." Building and Environment

Hedendahl, Lena K., et al. (2017) "Measurements of Radiofrequency Radiation with a body-borne exposimeter in Swedish schools with Wi-Fi." Frontiers in Public Health

Pall M., (2018) Wi-Fi is an important threat to human health, Environmental Research

Fahmy, H., & Mohammed, F. (2020) Hepatic injury induced by radio frequency waves emitted from conventional Wi-Fi devices in Wistar rats. Human & Experimental Toxicology

Ibitayo, A., et al., (2017) RAPD Profiling, DNA Fragmentation, and Histomorphometric Examination in Brains of Wistar Rats Exposed to Indoor 2.5 Ghz Wi-Fi Devices Radiation. BioMed Research International

Bamikole et al., (2019) Exposure to a 2.5 GHz Non-ionizing Electromagnetic Field Alters Hematological Profiles, Biochemical Parameters, and Induces Oxidative Stress in Male Albino Rats. Biomedical and Environmental Sciences

Atasoy H.I. et al. (2012) "Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices." Journal of Pediatric Urology

Avendaño, C., et al. (2012) "Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation." Fertility and Sterility

Li ZQ et al., (2020) Testing of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields. J Radiat Research

Yüksel, M. et al. (2015) "Long-term exposure to electromagnetic radiation from mobile phones and Wi-Fi devices decreases plasma prolactin, progesterone, and estrogen levels but increases uterine oxidative stress in pregnant rats and their offspring." Endocrine

Dasdag, S., et al.(2015) "Effects of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue." International Journal of Radiation Biology

Deshmukh, P.S., et al. (2015) "Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation." International Journal of Toxicology

Megha, K., et al. (2015) "Low intensity microwave radiation induced oxidative stress, inflammatory response and DNA damage in rat brain." Neurotoxicology

Papageorgio, C.C., et al. "Effects of Wi-Fi signals on the p300 component of event-related potentials during an auditory haying task." Journal of Integrative Neuroscience

Siervo, B., Morelli, M. S., Landini, L., & Hartwig, V. (2018). Numerical evaluation of human exposure to WiMax patch antenna in tablet or laptop. Bioelectromagnetics

RADIO FREQUENCY RADIATION

Miller et al., (2018) "Cancer Epidemiology Update, following the 2011 IARC Evaluation of Radiofrequency Electromagnetic Fields (Monograph 102)" Environmental Research

Davis, D., Birnbaum, L., Ben-Ishai, P., Taylor, H., Sears, M., Butler, T., & Scarato, T. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. Current Problems in Pediatric and Adolescent Health Care

Priyanka Bandara, David O Carpenter (2018) Planetary electromagnetic pollution: it is time to assess its impact, The Lancet Planetary Health

Belpomme D et al., (2018) Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. Environmental Pollution

Schuermann D, Mevissen M. Manmade Electromagnetic Fields and Oxidative Stress—Biological Effects and Consequences for Health. International Journal of Molecular Sciences. 2021

Luo, J., et al. (2020) Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut, Environmental Research

Carlberg, Michael and Lennart Hardell (2017) "Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation." BioMed Research International

Lerchl, Alexander, et al. (2015) "Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans." Biochemical and Biophysical Research Communications

Prasad, M., et al. "Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes." Neurological Sciences

Kostoff, Ronald N., and Clifford GY Lau, (2018) "Combined biological and health effects of electromagnetic fields and other agents in the published literature." Technological Forecasting and Social Change

Yakymenko, Igor, et al. (2016) "Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation." Electromagnetic Biology and Medicine

Sangün Ö, Dündar B, Çömlekçi S, Büyükgebiz A., The Effects of Electromagnetic Field on the Endocrine System in Children and Adolescents. Pediatr Endocrinol Rev. 2015

Himanshi et al., (2021) Radiofrequency radiation: A possible threat to male fertility, Reproductive Toxicology

West JG, Kapoor NS, Liao S, Chen JW, Bailey L, Nagourney RA. (2013). Multifocal Breast Cancer in Young Women with Prolonged Contact between Their Breasts and Their Cellular Phones. Case Reports in Medicine

Phillips JL, Singh NP, Lai H. (2009) Electromagnetic fields and DNA damage. Pathophysiology

CELL TOWER RADIATION

Balmori A. (2022) [Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer](#) Environmental Research

Zothansiam, 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

Meo, S. A. et al., (2018). Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health. American Journal of Men's Health.

Rodrigues NCP 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

Yakymenko (2011) Long-term exposure to microwave radiation provokes cancer growth: evidences from radars and mobile communication systems. Exp Oncology

Sultan Ayoub Meo et al, et al, (2015) 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 International Journal of Environmental Research and Public Health

Abdel-Rassoul et al, (2007) Neurobehavioral effects among inhabitants around mobile phone base stations, Neurotoxicology

Levitt & Lai (2010) Biological Effects from Exposure to Electromagnetic Radiation Emitted by Cell Tower Base Stations and Other Antenna Arrays, Environmental Reviews

Dode et al. (2011) Mortality by neoplasia and cellular telephone base stations. Science of the Total Environment

Pearce, M., (2020) Limiting liability with positioning to minimize negative health effects of cellular phone towers, Environmental Research

Claudia Roda, Susan Perry (2014) Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection, Environmental Science & Policy

Kharuna et al., (2010) Epidemiological Evidence for a Health Risk from Mobile Phone Base Stations, International Journal of Occupational Environmental Health, Vol 16(3):263-267, 2010

Shahbazi-Gahrouei et al, (2013) Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran. Electromagnetic Biology Medicine, 2013.

Eskander EF et al, (2011) How does long term exposure to base stations and mobile phones affect human hormone profiles? Clin Biochem

Santini et al, (2002) Investigation on the health of people living near mobile telephone relay stations: Incidence according to distance and sex, Pathol Bio

Navarro EA, (2003) The Microwave Syndrome: A Preliminary Study, Electromagnetic Biology and Medicine

Belpoggi 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 base station environmental emission" Environmental Research

Cindy L. Russell (2018) 5G wireless telecommunications expansion: Public health and environmental implications, Environmental Research,

MAGNETIC FIELD ELF-EMF

Li D et al., (2020) 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 Network Open.

Li, D., et al., (2012) A Prospective Study of In-utero Exposure to Magnetic Fields and the Risk of Childhood Obesity. Scientific Reports

Li, D. et al., (2011) Maternal Exposure to Magnetic Fields During Pregnancy in Relation to the Risk of Asthma in Offspring. Archives Of Pediatrics & Adolescent Medicine

Li, D., (2017) Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study. Scientific Reports

Carles et al. (2020) Residential proximity to power lines and risk of brain tumor in the general population. Environmental Research

Soffritti, M., et al. (2016) Synergism between sinusoidal-50Hz magnetic field and formaldehyde in triggering carcinogenic effects in male Sprague-Dawley rats. American Journal Of Industrial Medicine

Soffritti, M., et al. (2016) Life-span exposure to sinusoidal-50Hz magnetic field and acute low-dose γ radiation induce carcinogenic effects in Sprague-Dawley rats. International Journal Of Radiation Biology

Juutilainen, J., et al., (2006) Do extremely low frequency magnetic fields enhance the effects of environmental carcinogens? A meta-analysis of experimental studies. International Journal Of Radiation Biology

Zendehdel, R. et al., (2019) DNA effects of low level occupational exposure to extremely low frequency electromagnetic fields (50/60 Hz). Toxicology And Industrial Health

Tiwari, R., et al., (2014) Epinephrine, DNA integrity and oxidative stress in workers exposed to extremely low-frequency electromagnetic fields (ELF-EMFs) at 132 kV substations. Electromagnetic Biology And Medicine

Park J, Jeong E, Seomun G. (2020) Extremely Low-Frequency Magnetic Fields Exposure Measurement during Lessons in Elementary Schools. International Journal of Environmental Research and Public Health.

Karimi, A., et al., (2020) Insights in the biology of extremely low-frequency magnetic fields exposure on human health. Molecular Biology Reports

Antoccia, et al., (2015). Genotoxicity Induced by Foetal and Infant Exposure to Magnetic Fields and Modulation of Ionising Radiation Effects. PLoS One

Ren, Y., et al., (2019) Prenatal Exposure to Extremely Low Frequency Magnetic Field and Its Impact on Fetal Growth. Environmental Health

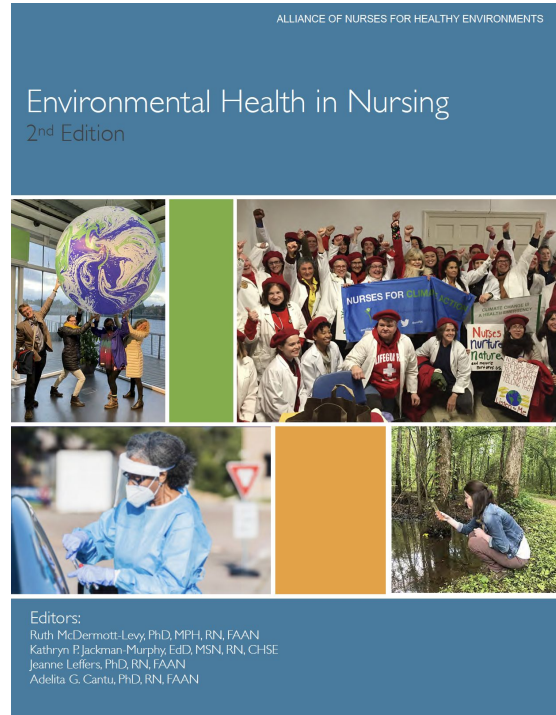
**The Case for Mitigating Wireless Radiation in the
School Setting as Primary Prevention**
to support children's physical and mental health

Theodora Scarato MSW
Executive Director of Environmental Health Trust

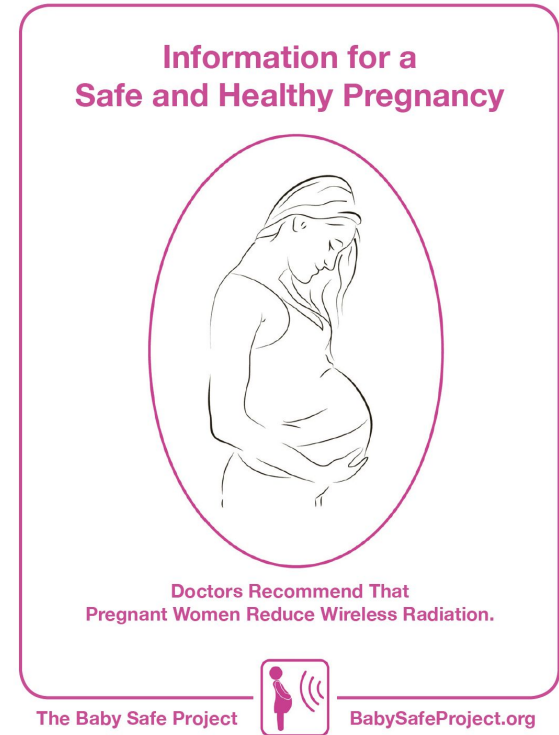
Student, Teacher, and Staff Education



Classroom Education
Massachusetts Breast Cancer
Coalition and EHT



Chapter on EMF
Alliance of Nurses for Healthy
Environments and EHT



Baby Safe Project
Grassroots Environmental
Education and EHT

Increasing Daily Exposure in Home and Classroom

Bellieni, C. V., Pinto, I., Bogi, A., Zoppetti, N., Andreuccetti, D., & Buonocore, G. (2012). [Exposure to Electromagnetic Fields From Laptop Use of "Laptop" Computers](#). *Archives of Environmental & Occupational Health*, 67(1), 31–36.

Clegg, F. M., Sears, M., Friesen, M., Scarato, T., Metzinger, R., Russell, C., Stadtner, A., & Miller, A. B. (2020). [Building science and radiofrequency radiation: What makes smart and healthy buildings](#). *Building and Environment*, 176, 106324.

Hedendahl, L. K., Carlberg, M., Koppel, T., & Hardell, L. (2017). [Measurements of Radiofrequency Radiation with a Body-Borne Exposimeter in Swedish Schools with Wi-Fi](#). *Frontiers in Public Health*, 5.

Park, J., Jeong, E., & Seomun, G. (2020). [Extremely Low-Frequency Magnetic Fields Exposure Measurement during Lessons in Elementary Schools](#). *International Journal of Environmental Research and Public Health*, 17(15), 5284.

Mehzabeen Mannan, Yamane W. Weldu, Sami G. Al-Ghamdi, (2020) [Health impact of energy use in buildings: Radiation propagation assessment in indoor environment](#), Energy Reports February: Pages 915-920

Boussad Y, Chen XL, Legout A, Chaintreau A, Dabbous W. [Longitudinal study of exposure to radio frequencies at population scale](#). *Environ Int.* Apr;162:107144

U.S. FCC Standards for Wireless Unchanged Since 1996 Need To Be Strengthened

International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), (2022). [Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G.](#) Environ Health. Oct 18;21(1):92.

Hardell, L., & Sage, C. (2008). [Biological effects from electromagnetic field exposure and public exposure standards.](#) Biomedicine & Pharmacotherapy = Biomedecine & Pharmacotherapie, 62(2), 104–109.

Lai, H., & Levitt, B. B. (2022). [The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines.](#) Electromagnetic Biology and Medicine, 41(2), 230–255.

Lin, J. C. (2023). [Incongruities in recently revised radiofrequency exposure guidelines and standards.](#) Environmental Research, 222, 115369.

Lopez I, Rivera M, Feliz N, Maestu C. (2022) [It is mandatory to review environmental radiofrequency electromagnetic field measurement protocols and exposure regulations: An opinion article.](#) Front. Public Health, 24 October

Uche, U. I., & Naidenko, O. V. (2021). [Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach.](#) *Environmental Health*, 20(1), 84.

Higher Absorption Into Children's Brains and Bodies

A. Christ, M.-C. Gosselin, M. Christopoulou, S. Kühn, N. Kuster, 2010 "[Age-dependent tissue-specific exposure of cell phone users](#)". Physics Medicine Biology 55, pp.1767–1783

Fernández, C., de Salles, A. A., Sears, M. E., Morris, R. D., & Davis, D. L. (2018). [Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality](#). *Environmental Research*, 167, 694–699.

Fernández-Rodríguez, C. E., De Salles, A. A. A., & Davis, D. L. (2015). [Dosimetric Simulations of Brain Absorption of Mobile Phone Radiation–The Relationship Between psSAR and Age](#). *IEEE Access*, 3, 2425–2430.

Ferreira, J., & Almeida de Salles, A. (2015). [Specific Absorption Rate \(SAR\) in the head of Tablet users](#). *The 7Th IEEE Latin-American Conference On Communications (Latincom 2015)*, 1538, 5-9. Retrieved 3 June 2020.

Gandhi, O. P. (2015). [Yes the Children Are More Exposed to Radiofrequency Energy From Mobile Telephones Than Adults](#). *IEEE Access*, 3, 985–988.

Gandhi, O. P., Morgan, L. L., de Salles, A. A., Han, Y.-Y., Herberman, R. B., & Davis, D. L. (2012). [Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children](#). *Electromagnetic Biology and Medicine*, 31(1), 34–51.

Mohammed, B., Jin, J., Abbosh, A. M., Bialkowski, K. S., Manoufali, M., & Crozier, S. (2017). [Evaluation of Children's Exposure to Electromagnetic Fields of Mobile Phones Using Age-Specific Head Models With Age-Dependent Dielectric Properties](#). *IEEE Access*, 5, 27345–27353.

Siervo, B., Morelli, M. S., Landini, L., & Hartwig, V. (2018). [Numerical evaluation of human exposure to WiMax patch antenna in tablet or laptop](#). *Bioelectromagnetics*, 39(5), 414–422.

Wang J, Fujiwara O, Kodera S, Watanabe S. [FDTD calculation of whole-body average SAR in adult and child models for frequencies from 30 MHz to 3 GHz](#). *Phys Med Biol*. 2006 Sep 7;51(17):4119-27. doi: 10.1088/0031-9155/51/17/001. Epub 2006 Aug 8. PMID: 16912372.

Cabot, E., Christ, A., Bühlmann, B., Zefferer, M., Chavannes, N., Bakker, J. F., van Rhoon, G. C., & Kuster, N. (2014). [Quantification Of RF-exposure of the Fetus Using Anatomical CAD-Models in Three Different Gestational Stages](#). *Health Physics*, 107(5), 369–381.

Varsier N, Dahdouh S, Serrurier A, De la Plata JP, Anquez J, Angelini ED, Bloch I, Wiart J. [Influence of pregnancy stage and fetus position on the whole-body and local exposure of the fetus to RF-EMF](#). *Phys Med Biol*. 2014 Sep 7;59(17):4913-26.

Children are Uniquely Vulnerable

Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019). [Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices](#). *Frontiers in Public Health*, 7.

Moon, J.-H. (2020). [Health effects of electromagnetic fields on children](#). *Clinical and Experimental Pediatrics*, 63(11), 422–428.

Redmayne, M., & Johansson, O. (2015). [Radiofrequency exposure in young and old: Different sensitivities in light of age-relevant natural differences](#). *Reviews on Environmental Health*, 30(4), 323–335.

Sage, C., & Burgio, E. (2018). [Electromagnetic Fields, Pulsed Radiofrequency Radiation, and Epigenetics: How Wireless Technologies May Affect Childhood Development](#). *Child Development*, 89(1), 129–136.

Frank, J. W. (2021). [Electromagnetic fields, 5G and health: What about the precautionary principle?](#) *J Epidemiol Community Health*, 75(6), 562–566. commentary

Hardell, L. (2018). [Effects of Mobile Phones on Children's and Adolescents' Health: A Commentary](#). *Child Development*, 89(1), 137–140.

Kashani, Z. A., Pakzad, R., Fakari, F. R., Haghparast, M. S., Abdi, F., Kiani, Z., Talebi, A., & Haghgoo, S. M. (2023). [Electromagnetic fields exposure on fetal and childhood abnormalities: Systematic review and meta-analysis](#). *Open Medicine*, 18(1).

McCredden, J. E., Cook, N., Weller, S., & Leach, V. (2022). [Wireless technology is an environmental stressor requiring new understanding and approaches in health care](#). *Frontiers in Public Health*, 10.

Fertility and Reproduction

- Adams, J. A., Galloway, T. S., Mondal, D., Esteves, S. C., & Mathews, F. (2014). [Effect of mobile telephones on sperm quality: A systematic review and meta-analysis](#). *Environment International*, 70, 106–112.
- Chu KY, Khodamoradi K, Dullea A, Ramasamy R. Swipe [Right on Male Infertility: Effect of cell phone radiation on sperm motility](#). *Fertility and Sterility*. 118(5 Suppl):e38-e39. 2022.
- Desai, N.R., Kesari, K.K. & Agarwal, A. [Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system](#). *Reprod Biol Endocrinol* 7, 114 (2009).
- Hassanzadeh-Taheri, M., Khalili, M. A., Hosseini, M., Palmerini, M. G., & Doostabadi, M. R. (2022). [The detrimental effect of cell phone radiation on sperm biological characteristics in normozoospermic](#). *Andrologia*, 54(1), e14257.
- Houston, B. J., Nixon, B., King, B. V., De Iuliis, G. N., & Aitken, R. J. (2016). [The effects of radiofrequency electromagnetic radiation on sperm function](#). *Reproduction (Cambridge, England)*, 152(6), R263–R276.
- Jangid, P., Rai, U., Sharma, R. S., & Singh, R. (2022). [The role of non-ionizing electromagnetic radiation on female fertility: A review](#). *International Journal of Environmental Health Research*, 0(0), 1–16.
- Kesari, K. K., & Behari, J. (2010). [Effects of microwave at 2.45 GHz radiations on reproductive system of male rats](#). *Toxicological & Environmental Chemistry*, 92(6), 1135–1147.
- Maluin, S. M., Osman, K., Jaffar, F. H. F., & Ibrahim, S. F. (2021). [Effect of Radiation Emitted by Wireless Devices on Male Reproductive Hormones: A Systematic Review](#). *Frontiers in Physiology*, 12.
- Okechukwu, C. E. (2020). [Does the Use of Mobile Phone Affect Male Fertility? A Mini-Review](#). *Journal of Human Reproductive Sciences*, 13(3), 174–183.
- Yu, G., Bai, Z., Song, C., Cheng, Q., Wang, G., Tang, Z., & Yang, S. (2021). [Current progress on the effect of mobile phone radiation on sperm quality: An updated systematic review and meta-analysis of human and animal studies](#). *Environmental Pollution*, 282, 116952.

Oxidative Stress

- Schuermann, D., & Mevissen, M. (2021). [Manmade Electromagnetic Fields and Oxidative Stress—Biological Effects and Consequences for Health](#). *International Journal of Molecular Sciences*, 22(7), 3772.
- Yakymenko, I., Tsybulin, O., Sidorik, E., Henshel, D., Kyrylenko, O., & Kyrylenko, S. (2016). [Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation](#). *Electromagnetic Biology and Medicine*, 35(2), 186–202.
- Georgiou, C. D., & Margaritis, L. H. (2021). [Oxidative Stress and NADPH Oxidase: Connecting Electromagnetic Fields, Cation Channels and Biological Effects](#). *International Journal of Molecular Sciences*, 22(18), 10041.
- Kamali, K., Taravati, A., Sayyadi, S., Gharib, F. Z., & Maftoon, H. (2018). [Evidence of oxidative stress after continuous exposure to Wi-Fi radiation in rat model](#). *Environmental Science and Pollution Research International*, 25(35), 35396–35403.
- Lai, H., & Levitt, B. B. (2023). [Cellular and molecular effects of non-ionizing electromagnetic fields](#)s. *Reviews on Environmental Health*.
- Manta, A. K., Stravopodis, D. J., Papassideri, I. S., & Margaritis, L. H. (2014). [Reactive oxygen species elevation and recovery in Drosophila bodies and ovaries following short-term and long-term exposure to DECT base EMF](#). *Electromagnetic Biology and Medicine*, 33(2), 118–131.
- Alkis, M. E., Bilgin, H. M., Akpolat, V., Dasdag, S., Yegin, K., Yavas, M. C., & Akdag, M. Z. (2019). [Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain](#). *Electromagnetic Biology and Medicine*, 38(1), 32–47.

Endocrine

Sangün, Ö., Dünder, B., Çömlekçi, S., & Büyükgebiz, A. (2015). [The Effects of Electromagnetic Field on the Endocrine System in Children and Adolescents.](#) *Pediatric Endocrinology Reviews: PER*, 13(2), 531–545.

Mahila. (2021). [Effect of Wi-Fi Radiation on Heart Rate Variability, Salivary Cortisol Level and Cognition.](#) *Journal of Pharmaceutical Research International*, 229–232

Alkayyali, T., Ochuba, O., Srivastava, K., Sandhu, J. K., Joseph, C., Ruo, S. W., Jain, A., Waqar, A., & Poudel, S. (2021). [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*, 13(8).

Siqueira, E. C., de Souza, F. T. A., Ferreira, E., Souza, R. P., Macedo, S. C., Friedman, E., Gomez, M. V., Gomes, C. C., & Gomez, R. S. (2016). [Cell phone use is associated with an inflammatory cytokine profile of parotid gland saliva.](#) *Journal of Oral Pathology & Medicine*, 45(9), 682–686.

Uluaydin, N. K., Cerezci, O., & Seker, S. S. (2020). [Can Mobile Phone Usage Affect Hypothalamus-Pituitary-Adrenal Axis Response?](#) 2020 10th Annual Computing and Communication Workshop and Conference (CCWC), 0780–0783.

Zufry, H., Rudijanto, A., Soeatmadji, D. W., Sakti, S. P., Munadi, K., Sujuti, H., & Mintaroem, K. (2023). [Effects of mobile phone electromagnetic radiation on thyroid glands and hormones in Rattus norvegicus brain: An analysis of thyroid function, reactive oxygen species, and monocarboxylate transporter 8.](#) *Journal of Advanced Pharmaceutical Technology & Research*, 14(2), 63–68.

Cantürk Tan, F., Yalçın, B., Yay, A. H., Tan, B., Yeğın, K., & Daşdağ, S. (2022). [Effects of pre and postnatal 2450 MHz continuous wave \(CW\) radiofrequency radiation on thymus: Four generation exposure.](#) *Electromagnetic Biology and Medicine*, 41(3), 315–324.

Cancer and Wireless Radio Frequency

Bevelacqua, J. J., Mehdizadeh, A. R., & Mortazavi, S. M. J. (2020). [A New Look at Three Potential Mechanisms Proposed for the Carcinogenesis of 5G Radiation](#). *Journal of Biomedical Physics and Engineering*, 10(6), 675-678. doi: 10.31661/jbpe.v0i0.2008-1157

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 Research International*, 2017, 9218486.

Carlberg, M., Hedendahl, L., Ahonen, M., Koppel, T., & Hardell, L. (2016). [Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data](#). *BMC Cancer*, 16(1), 426.

Carlberg, M., & Hardell, L. (2014). [Decreased Survival of Glioma Patients with Astrocytoma Grade IV \(Glioblastoma Multiforme\) Associated with Long-Term Use of Mobile and Cordless Phones](#). *International Journal of Environmental Research and Public Health*, 11(10), 10790–10805.

Choi, Y.-J., Moskowitz, J. M., Myung, S.-K., Lee, Y.-R., & Hong, Y.-C. (2020). [Cellular Phone Use and Risk of Tumors: Systematic Review and Meta-Analysis](#). *International Journal of Environmental Research and Public Health*, 17(21), 8079.

Coureau, G., Bouvier, G., Lebaillly, P., Fabbro-Peray, P., Gruber, A., Leffondre, K., Guillamo, J.-S., Loiseau, H., Mathoulin-Pélissier, S., Salamon, R., & Baldi, I. (2014). [Mobile phone use and brain tumours in the CERENAT case-control study](#). *Occupational and Environmental Medicine*, 71(7), 514–522.

Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (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](#). (PDF) Publications Office of the European Union.

Marková, E., Malmgren, L. O. G., & Belyaev, I. Y. (2010). [Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk](#). *Environmental Health Perspectives*, 118(3), 394–399.

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](#). *Environmental Research*, 168, 1–6.

Cancer and Wireless Radio Frequency cont.

Falcioni, L., Bua, L., Tibaldi, E., Lauriola, M., De Angelis, L., Gnudi, F., Mandrioli, D., Manservigi, M., Manservisi, F., Manzoli, I., Menghetti, I., Montella, R., Panzacchi, S., Sgargi, D., Strollo, V., Vornoli, A., & 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.](#) *Environmental Research*, 165, 496–503.

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*, 54(1), 111–127.

Hardell, L., & Carlberg, M. (2013). [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.](#) *Reviews on Environmental Health*, 28(2–3), 97–106.

Hardell, L. (2017). [World Health Organization. radiofrequency radiation and health—A hard nut to crack \(Review\).](#) *International Journal of Oncology*, 51(2), 405–413.

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. (2013). Non-ionizing radiation, Part 2: Radiofrequency electromagnetic fields. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, 102(Pt 2), 1–460.

Lerchl, A., Klose, M., Grote, K., Wilhelm, A. F. X., Spathmann, O., Fiedler, T., Streckert, J., Hansen, V., & Clemens, M. (2015). [Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans.](#) *Biochemical and Biophysical Research Communications*, 459(4), 585–590.

James C. Lin. (2022) [Carcinogenesis from chronic exposure to radio-frequency radiation.](#) *Front. Public Health*, Sec. Radiation and Health. 31 October

Cancer and Wireless Radio Frequency cont.

Luo, J., Li, H., Deziel, N. C., Huang, H., Zhao, N., Ma, S., Ni, X., Udelsman, R., & Zhang, Y. (2020). [Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut](#). *Environmental Research*, 182, 109013.

Markovà, E., Malmgren, L. O. G., & Belyaev, I. Y. (2010). [Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells: Possible Mechanistic Link to Cancer Risk](#). *Environmental Health Perspectives*, 118(3), 394–399.

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](#). *Environmental Research*, 168, 1–6.

Miller, A. B., Morgan, L. L., Udasin, I., & Davis, D. L. (2018). [Cancer epidemiology update. following the 2011 IARC evaluation of radiofrequency electromagnetic fields \(Monograph 102\)](#). *Environmental Research*, 167, 673–683.

Prasad, M., Kathuria, P., Nair, P., Kumar, A., & Prasad, K. (2017). [Mobile phone use and risk of brain tumours: A systematic review of association between study quality, source of funding, and research outcomes](#). *Neurological Sciences: Official Journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology*, 38(5), 797–810.

Peleg, M., Nativ, O., & Richter, E. D. (2018). [Radio frequency radiation-related cancer: Assessing causation in the occupational/military setting](#). *Environmental Research*, 163, 123–133.

Peleg M, Berry EM, Deitch M, Nativ O, Richter E.(2022) [On radar and radio exposure and cancer in the military setting](#). *Environ Res*. 2022 Oct 21:114610

Shih, Y.-W., Hung, C.-S., Huang, C.-C., Chou, K.-R., Niu, S.-F., Chan, S., & Tsai, H.-T. (2020). [The Association Between Smartphone Use and Breast Cancer Risk Among Taiwanese Women: A Case-Control Study](#). *Cancer Management and Research*, 12, 10799–10807.

West, J. G., Kapoor, N. S., Liao, S.-Y., Chen, J. W., Bailey, L., & Nagourney, R. A. (2013). [Multifocal Breast Cancer in Young Women with Prolonged Contact between Their Breasts and Their Cellular Phones](#). *Case Reports in Medicine*, 2013, e354682.

Headaches

Butt, M., Chavarria, Y., Ninmol, J., Arif, A., Tebha, S. S., Daniyal, M., Siddiqui, U. M., Shams, S. S., Sarfaraz, Q., Haider, S. F., & Essar, M. Y. (2022). [Association of increased pain intensity, daytime sleepiness, poor sleep quality, and quality of life with mobile phone overuse in patients with migraine: A multicenter, cross-sectional comparative study](#). *Brain and Behavior*, e2760.

Chia, S. E., Chia, H. P., & Tan, J. S. (2000). [Prevalence of headache among handheld cellular telephone users in Singapore: A community study](#). *Environmental Health Perspectives*, 108(11), 1059–1062.

Chongchitpaisan, W., Wiwatanadate, P., Tanprawate, S., Narkpongphan, A., & Siripon, N. (2021). [Trigger of a migraine headache among Thai adolescents smartphone users: A time series study](#). *Environmental Analysis Health and Toxicology*, 36(1).

Demir YP, Sumer MM. (2019). [Effects of smartphone overuse on headache, sleep and quality of life in migraine patients](#). *Neurosciences (Riyadh)*. Apr;24(2):115-121

Durusoy, R., Hassoy, H., Özkurt, A., & Karababa, A. O. (2017). [Mobile phone use, school electromagnetic field levels and related symptoms: A cross-sectional survey among 2150 high school students in Izmir](#). *Environmental Health: A Global Access Science Source*, 16(1), 51.

Farashi, S., Bashirian, S., Khazaei, S., Khazaei, M., & Farhadinasab, A. (2022). [Mobile phone electromagnetic radiation and the risk of headache: A systematic review and meta-analysis](#). *International Archives of Occupational and Environmental Health*, 95(7), 1587–1601.

Sudan, M., Kheifets, L., Arah, O., Olsen, J., & Zeltzer, L. (2012). [Prenatal and Postnatal Cell Phone Exposures and Headaches in Children](#). *The Open Pediatric Medicine Journal*, 6(2012), 46–52.

Tumor Promotion and Synergistic Effects

Ansarihadipour, H., & Bayatiani, M. (2016). [Influence of Electromagnetic Fields on Lead Toxicity: A Study of Conformational Changes in Human Blood Proteins](#). *Iranian Red Crescent Medical Journal*, 18(7), e28050.

Baohong, W., Jiliang, H., Lifan, J., Deqiang, L., Wei, Z., Jianlin, L., & Hongping, D. (2005). [Studying the synergistic damage effects induced by 1.8 GHz radiofrequency field radiation \(RFR\) with four chemical mutagens on human lymphocyte DNA using comet assay in vitro](#). *Mutation Research*, 578(1–2), 149–157.

Benavides, R. A. S., Leiro-Vidal, J. M., Rodriguez-Gonzalez, J. A., Ares-Pena, F. J., & López-Martín, E. (2023). [The HL-60 human promyelocytic cell line constitutes an effective in vitro model for evaluating toxicity, oxidative stress and necrosis/apoptosis after exposure to black carbon particles and 2.45 GHz radio frequency](#). *The Science of the Total Environment*, 867, 161475.

Boga, A., Emre, M., Sertdemir, Y., Akillioglu, K., Binokay, S., & Demirhan, O. (2015). [The effect of 900 and 1800 MHz GSM-like radiofrequency irradiation and nicotine sulfate administration on the embryonic development of *Xenopus laevis*](#). *Ecotoxicology and Environmental Safety*, 113, 378–390.

Byun, Y.-H., Ha, M., Kwon, H.-J., Hong, Y.-C., Leem, J.-H., Sakong, J., Kim, S. Y., Lee, C. G., Kang, D., Choi, H.-D., & Kim, N. (2013). [Mobile Phone Use, Blood Lead Levels, and Attention Deficit Hyperactivity Symptoms in Children: A Longitudinal Study](#). *PLOS ONE*, 8(3), e59742.

Chen, L., Ye, A., Liu, X., Lu, J., Xie, Q., Guo, Y., & Sun, W. (2021). [Combined effect of co-exposure to di \(2-ethylhexyl\) phthalates and 50-Hz magnetic-fields on promoting human amniotic cells proliferation](#). *Ecotoxicology and Environmental Safety*, 224, 112704.

Choi, K.-H., Ha, M., Ha, E.-H., Park, H., Kim, Y., Hong, Y.-C., Lee, A.-K., Hwa Kwon, J., Choi, H.-D., Kim, N., Kim, S., & Park, C. (2017). [Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure](#). *Environmental Research*, 156, 810–817.

Tumor Promotion and Synergistic Effects cont.

- Kostoff, R.N. and Clifford G.Y. Lau. 2017. [“Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature.”](#) Microwave Effects on DNA and Proteins (2017): 97-158.
- Lerchl, A., Klose, M., Grote, K., Wilhelm, A. F. X., Spathmann, O., Fiedler, T., Streckert, J., Hansen, V., & Clemens, M. (2015). [Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans](#). *Biochemical and Biophysical Research Communications*, 459(4), 585–590.
- Soffritti, M., & Giuliani, L. (2019). [The carcinogenic potential of non-ionizing radiations: The cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation](#). *Basic & Clinical Pharmacology & Toxicology*, 125 Suppl 3, 58–69.
- Sueiro-Benavides, R. A., Leiro-Vidal, J. M., Salas-Sánchez, A. Á., Rodríguez-González, J. A., Ares-Pena, F. J., & López-Martín, M. E. (2021). [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](#). *Science of The Total Environment*, 765, 142681.
- Szilágyi, Z., Németh, Z., Bakos, J., Necz, P. P., Sáfár, A., Kubinyi, G., Selmaoui, B., & Thuróczy, G. (2020). [Evaluation of Inflammation by Cytokine Production Following Combined Exposure to Ultraviolet and Radiofrequency Radiation of Mobile Phones on 3D Reconstructed Human Skin In Vitro](#). *International Journal of Environmental Research and Public Health*, 17(12), Article 12.
- Szudziński, A., Pietraszek, A., Janiak, M., Wrembel, J., Kałczak, M., & Szmigielski, S. (1982). [Acceleration of the development of benzopyrene-induced skin cancer in mice by microwave radiation](#). *Archives of Dermatological Research*, 274(3–4), 303–312.
- Wang, H., Liu, Y., Sun, Y., Zhao, L., Dong, J., Xu, X., Wang, H., Zhang, J., Yao, B., Zhao, X., Liu, S., Zhang, K., & Peng, R. (2022). [Changes in rat spatial learning and memory as well as serum exosome proteins after simultaneous exposure to 1.5 GHz and 4.3 GHz microwaves](#). *Ecotoxicology and Environmental Safety*, 243, 113983.
- Zhao, L., Yao, C., Wang, H., Dong, J., Zhang, J., Xu, X., Wang, H., Yao, B., Ren, K., Sun, L., & Peng, R. (2022). [Immune Responses to Multi-Frequencies of 1.5 GHz and 4.3 GHz Microwave Exposure in Rats: Transcriptomic and Proteomic Analysis](#). *International Journal of Molecular Sciences*, 23(13), 6949.
- Zhu, R., Wang, H., Xu, X., Zhao, L., Zhang, J., Dong, J., Yao, B., Wang, H., Zhou, H., Gao, Y., & Peng, R. (2021). [Effects of 1.5 and 4.3 GHz microwave radiation on cognitive function and hippocampal tissue structure in Wistar rats](#). *Scientific Reports*, 11(1), 10061.

The Majority of Studies Find Harm

McCredden, J. E., Weller, S., & Leach, V. (2023). [The assumption of safety is being used to justify the rollout of 5G technologies](#). *Frontiers in public health*, 11, 1058454.

5G and Novel Frequencies Case Reports

Hardell L. and Nilsson M. (2023). Case Report: [A 52-Year Healthy Woman Developed Severe Microwave Syndrome Shortly After Installation of a 5G Base Station Close to Her Apartment](#). *Annals of Clinical and Medical Case Reports*. V10(16): 1-10

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*.

Hardell, L., & Nilsson, M. (2023). [Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office](#). *Annals of Clinical Case Reports*, 8(1).

5G and New Networks

Belyaev, I. (2019). [Main Regularities and Health Risks from Exposure to Non-Thermal Microwaves of Mobile Communication](#). 2019 14th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS), 111–116.

Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (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](#). Publications Office of the European Union.

Di Ciaula, A. (2018). [Towards 5G communication systems: Are there health implications?](#) *International Journal of Hygiene and Environmental Health*, 221(3), 367–375.

Dasgupta, S., Leong, C., Simonich, M. T., Truong, L., Liu, H., & Tanguay, R. L. (2022). [Transcriptomic and Long-Term Behavioral Deficits Associated with Developmental 3.5 GHz Radiofrequency Radiation Exposures in Zebrafish](#). *Environmental Science & Technology Letters*, 9(4), 327–332.

Wang, Y., Jiang, Z., Zhang, L., Zhang, Z., Liao, Y., & Cai, P. (2022). [3.5-GHz radiofrequency electromagnetic radiation promotes the development of Drosophila melanogaster](#). *Environmental pollution (Barking, Essex : 1987)*, 294, 118646.

Frank, J. W. (2021). [Electromagnetic fields. 5G and health: What about the precautionary principle?](#) *J Epidemiol Community Health*, 75(6), 562–566.

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*, 20(4), 1–1.

Hinrikus, H., Koppel, T., Lass, J., Orru, H., Roosipuu, P., & Bachmann, M. (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*, 98(7), 1210–1221.

Kostoff, R. N., Heroux, P., Aschner, M., & Tsatsakis, A. (2020). [Adverse health effects of 5G mobile networking technology under real-life conditions](#). *Toxicology Letters*, 323, 35–40.

Matthew, U. O., & Kazaure, J. S. (2021). [Chemical polarization effects of electromagnetic field radiation from the novel 5G network deployment at ultra high frequency](#). *Health and Technology*, 11(2), 305–317.

Raveendran, R.; Tabet Aoul, K.A. [A Meta-Integrative Qualitative Study on the Hidden Threats of Smart Buildings/Cities and Their Associated Impacts on Humans and the Environment](#). *Buildings* 2021, 11, 251.

Russell, C. L. (2018). [5 G wireless telecommunications expansion: Public health and environmental implications](#). *Environmental Research*, 165, 484–495.

4G LTE

Islam, M. S., Islam, M. M., Rahman, M. M., & Islam, K. (2023). [4G mobile phone radiation alters some immunogenic and vascular gene expressions, and gross and microscopic and biochemical parameters in the chick embryo model](#). *Veterinary medicine and science*, 10.1002/vms3.1273. Advance online publication.

Broom, K. A., Findlay, R., Addison, D. S., Goiceanu, C., & Sienkiewicz, Z. (2019). [Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6 J Mice](#). *Bioelectromagnetics*, 40(7), 498–511.

Choi, J., Min, K., Jeon, S., Kim, N., Pack, J.-K., & Song, K. (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*, 10(1), 9238.

Lv, B., Chen, Z., Wu, T., Shao, Q., Yan, D., Ma, L., Lu, K., & Xie, Y. (2014). [The alteration of spontaneous low frequency oscillations caused by acute electromagnetic fields exposure](#). *Clinical Neurophysiology*, 125(2), 277–286.

Malik, S., Pati, A. K., & Parganiha, A. (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*, 52(10), 1560–1575.

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, E., Çömelekoğlu, Ü., Degirmenci, E., Bayrak, G., Yıldırım, M., Ergenoglu, T., Coşkun Yılmaz, B., Korunur Engiz, B., Yalin, S., Koyuncu, D. D., & Ozbay, E. (2021). [The effect of 4.5 G \(LTE Advanced-Pro network\) mobile phone radiation on the optic nerve](#). *Cutaneous and Ocular Toxicology*, 40(3), 198–206. <https://doi.org/10.1080/15569527.2021.1895825>

Souffli, S., Lameth, J., Gaucher, Q., Arnaud-Cormos, D., Lévêque, P., Edeline, J.-M., & Mallat, M. (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*, 12(1), 4063.

Wei, Y., Yang, J., Chen, Z., Wu, T., & Lv, B. (2019). [Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study](#). *Bioelectromagnetics*, 40(1), 42–51.

Yang, L., Zhang, C., Chen, Z., Li, C., & Wu, T. (2021). [Functional and network analyses of human exposure to long-term evolution signal](#). *Environmental Science and Pollution Research International*, 28(5), 5755–5773.

Yang, L., Chen, Q., Lv, B., & Wu, T. (2017). [Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands](#). *Clinical EEG and Neuroscience*, 48(3), 168–175.

Yu, G., Tang, Z., Chen, H., Chen, Z., Wang, L., Cao, H., Wang, G., Xing, J., Shen, H., Cheng, Q., Li, D., Wang, G., Xiang, Y., Guan, Y., Zhu, Y., Liu, Z., & Bai, Z. (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*, 698, 133860.

Cell Towers

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 Nov; 214

Dode, A. C., Leão, M. M. D., Tejo, F. de A. F., Gomes, A. C. R., 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](#). *Science of The Total Environment*, 409(19), 3649–3665.

Hardell, L., & Koppel, T. (2022). [Electromagnetic hypersensitivity close to mobile phone base stations – a case study in Stockholm, Sweden](#). *Reviews on Environmental Health*.

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](#). *International Journal of Occupational and Environmental Health*, 16(3), 263–267.

Koppel, T., Ahonen, M., Carlberg, M., & Hardell, L. (2022). [Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads](#). *Environmental Research*, 208, 112627.

Levitt, B. B., & Lai, H. (2011). [Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays](#). *Environmental Reviews*, 19(NA), 495–495.

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](#). *Environmental Research*, 194, 110734.

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](#). *American Journal of Men's Health*, 13(1), 1557988318816914.

Meo, S. A., Alsubaie, Y., Almubarak, Z., Almutawa, H., AlQasem, Y., & Hasanato, R. M. (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*, 12(11), 14519–14528.

Pearce, J. M. (2020). [Limiting liability with positioning to minimize negative health effects of cellular phone towers](#). *Environmental Research*, 181, 108845.

Roda, C., & Perry, S. (2014). [Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection](#). *Environmental Science & Policy*, 37, 204–214.

Rodrigues, N. C. P., Dode, A. C., de Noronha Andrade, M. K., O'Dwyer, G., Monteiro, D. L. M., Reis, I. N. C., Rodrigues, R. P., Frossard, V. C., & Lino, V. T. S. (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*, 18(3), 1229.

Thamilselvan S, Behera A, Nair SK, Chandru CS, Krishnakumar M, Ramani P. (2021) [Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study](#). J Int Oral Health 13:350-5

Yakymenko, I., Sidorik, E., Kyrilenko, S., & Chekhun, V. (2011). [Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems](#). *Experimental Oncology*, 33(2), 62–70.

Zothansiam, Zosangzuali, M., Lalramdinpuui, 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](#). *Electromagnetic Biology and Medicine*. 36(3) 295–305

Thankful.

Theodora.Scarato@ehtrust.org
References at speakers corner

ehtrust.org



healthytechhome.org



We have a newsletter !