Environmental Health Trust Submission to FCC RE No. 22-69

1. The FCC must ensure that the definitions of "consumer" and "subscriber" include the electromagnetic sensitive (EMS) disabled.
2. Digital discrimination characteristics should include disability;
3. Commission rules and policies are exacerbating digital discrimination of the EMS Disabled and must be re-examined and reversed;
4. Digital discrimination of access against the EMS Disabled must end and the EMS Disabled must be afforded "equal access";
5. Fiber optics should be given priority for the disabled; and
6. There should be a dedicated portal for consumer complaints related to digital discrimination.
7. Telecommunications deployment and FCC actions must be compliant with NEPA and a full environmental review is needed of the 5G and all new wireless networks being deployed in the United States.

Verizon states in its February 21, 2023 comments to GN Docket No. 22-69 that it “has invested billions of dollars over many years in its wireless and wireline broadband networks, and in initiatives to promote digital education and inclusion.” However, people with electromagnetic associated illness and sensitivities have not been included in such industry projects and are being impacted by the proliferation of wireless networks. Further, the degree to which wireless industry programs to promote digital equity are successful is highly questionable.

Verison states that “ the Commission should interpret the phrase “digital discrimination of access” to mean intentionally denying consumers “in a given area” the “opportunity to subscribe to an offered [broadband] service” based on any of the six characteristics listed in the statute.” which basically means that Verizn wants to be able to offer its paid services in an area but this not address the underlying issues that have caused and perpetuated inequity regarding access. In many communities, especially urban areas, the issue is affordability for service and equipment, not accessibility. Service exists. People cannot afford it. Some people choose not to

pay for a smartphone and for home service because it's a double bill. Others want to, but are told it's not possible to get the latest technology. For example, in some communities such as New York City in Harlem, fiber has been laid in the street, yet consumers are told they cannot get it run to their home due to the complexity of running the wire though row houses.

All links submitted by reference.

Resources on Electromagnetic Sensitivity and Accommodations

1. Government Agency Recognition
    a. U.S. Access Board
    b. National Institute of Building Sciences Indoor Environmental Quality Report
    c. U.S. National Council on Disabilities Health Equity Framework for People with Disabilities.
    d. Job Accommodations Network
2. Diagnosis and Treatment Clinical Resources
    a. CDC Implements International Classification of Diseases
    b. Clinical Practice Guidelines To Assess and Treat Patients.
    c. EMF Medical Conference 2021
    d. Scientific Declarations
3. **Filing for ADA Accomodations**
    a. How to File ADA Accommodations
    b. U.S. Dept of Education, Office of Civil Rights Guide to Section 504
    c. Report Your Issue With Phones or Devices to the FDA

4. Policy
    a. Peterborough Canada Information Sheet
    b. USA Proclamations on Electromagnetic Sensitivity
    c. Letters and Documents Regarding HUD Denying Assistance to People on EMFs
    d. Court Rulings and Accommodations in USA and Internationally
5. Selected Readings and Video Resources
6. **Selected Scientific Research on Electromagnetic Sensitivity and Radiofrequency Radiation**

U.S. Government Agency Recognition

Social Security Administration: Letter- Electromagnetic Sensitivity Found to be a Severe Impairment by the Social Security Administration 2003 and 2020

General Council Architectural and Transportation Barriers Compliance Board Need for Housing Electromagnetic Sensitive Disabled Letter

U.S. Access Board

In 2002, the "U.S. Access Board," an independent federal agency responsible for publishing Accessibility Guidelines used by the U.S.=Department of Justice to enforce the Americans with Disabilities Act ("ADA"), recognized that "electromagnetic sensitivities may be considered disabilities under the ADA."

National Institute of Building Sciences Indoor Environmental Quality Report:

2005 National Institute of Building Sciences (NIBS) Indoor Environmental Quality (IEQ) Report: The U.S. Access Board contracted the National Institute of Building Sciences (NIBS) to examine how to accommodate the needs of the electro-sensitive in federally funded buildings. See IEQ Indoor Environmental Quality Project

> On p. 51-52:
> " Cell Phones Turned Off: Protect those with electromagnetic sensitivities and others who may be adversely affected by electrical equipment."
> "Ability to turn off or unplug computers and other electrical equipment by occupant or staff: Protect those with electromagnetic sensitivities."
> "People with electromagnetic sensitivities can experience debilitating reactions… from electromagnetic fields emitted by computers, cell phones, and other electrical equipment. The severity of sensitivities varies among people with electromagnetic sensitivities...According to the Americans with Disabilities Act (ADA) and other disability laws, public and commercial buildings are required to provide reasonable accommodations for those disabled by electromagnetic sensitivities. These accommodations are best achieved on a case-by-case basis"

The U.S. National Council on Disabilities Health Equity Framework for People with Disabilities.

This policy framework embraces all categories of disability and includes electromagnetic hypersensitivity (EHS).
NCD 's Health Equity Framework Page 10, Sub-Component 6 states:

> "Provide mandatory industry guidance, including recommended policies, training and best practices, to address the needs of people disabled by exposure to low level

chemical, electromagnetic, and other environmental exposures that preclude access to care and treatment at medical, dental and at other providers' offices, hospitals, surgical centers, and other healthcare and healthcare–related facilities, as a result of their use of chemical, fragranced and other scented products, and also as a result of the usage of wireless communications and electrical technologies and other sources of non-ionizing radiation, which may trigger disabling and life-threatening cardiac, respiratory, neurological, and other adverse physical reactions. (Requires administrative action through HHS Office of Civil Rights, and further research concerning this matter should be conducted by the FDA, NIH, HHS, and HUD.)

Job Accommodations Network

Job Accommodations Network (JAN) funded by the U.S. Department of Labor's Office of Disability Employment Policy (DOL/DEP) has issued a list of guidelines for accommodations of electromagnetic sensitivity (AKA microwave illness) and has posted the EMF Medical Conference as a resource.

- Job Accommodations Network (JAN) Webpage which Electrical Sensitivity
- The EMF Medical Conference 2021 is posted as a top resource on the JAN webpage on electromagnetic sensitivity. See JAN resources that include the EMF Medical Conference here.
- U.S. Department of Labor Office of Disability Employment Policy Accommodations Webpage that links to JAN
- JAN: Accommodation and Compliance Series: Employees with Electrical Sensitivity Publication Download

How JAN is referenced by US Government:

- On the page: ``Employees' Practical Guide to Requesting and Negotiating Reasonable Accommodation Under the Americans with Disabilities Act "Introduction: The Job Accommodation Network (JAN) is a free service of the U.S. Department of Labor's Office of Disability Employment Policy.
- The DOE page Reasonable Accommodations for Employees and Applicants with Disabilities | US Department of Labor links to JAN.
- Job Accommodation Network has the logo for the U.S. Department of Labor's Office of Disability Employment Policy at the bottom of every page.
- The US Department of Labor under the section "Policy Development & Technical Assistance Resource states, "To develop and influence disability employment-related policies and practices, ODEP sponsors the following five policy development and technical assistance resources." JAN is listed.
- The US Department of Labor stated "ODEP's Job Accommodation Network (JAN) continues to provide assistance to employers and workers on effective job accommodations for people with disabilities…"

- On the page Policy Development and Technical Assistance The US Department of Labor JAN is at the top as a resource. “JAN continues to share information on the best practices on accommodations and the ADA through its outreach campaigns.”
- JAN is listed on the webpage Appendix B: Resources | US Department of Labor underneath the Department of Labor heading.
- Frequently Asked Questions - General The US Department of Labor states, “Where can I find more information on specific disabilities or medical conditions? If you are seeking information about job accommodations for specific disabilities, please visit the Job Accommodation Network's (JAN) A to Z of Disabilities and Accommodations index.”
- US Department of Labor references the “the Office of Disability Employment Policy-supported Job Accommodation Network (JAN)”
- US Department of Labor States “Job Accommodation Network ODEP's Job Accommodation Network (JAN) continues to serve as the leading source of expert guidance on workplace accommodations, offering one-on-one guidance to employers and employees with disabilities…”

How to File ADA Accommodations

USA: How to File an ADA Accommodation by the Center for Electrosmog Prevention, 2019

- Link: How to File an ADA Accommodations Request for Electrosensitivity to Avoid Small Cells and Wi-Fi: The following ADA Accommodations Request Packet may be used by ES (electrosensitivity) sufferers to apply for reasonable accommodations to help avoid RF radiation from “small cells” and wifi in public government areas, related to accessibility or any other Title II application. “Title II of the Americans with Disabilities Act applies to State and Local Governments.
- The Center for Electrosmog Prevention packet is freely available for use only under Fair Use (non-commercial) terms and agreement with the CEP & Packet Disclaimers. It does not substitute for legal advice and there is no guarantee of a successful outcome.

U.S. Dept of Education, Office of Civil Rights Guide to Section 504

US Dept of Education, Office of Civil Rights updated guide to section 504 accommodations
This does not address electromagnetic sensitivities but explains what rights a parent has regarding accommodations for impairments and what is considered an impairment.

Diagnosis and Treatment

CDC Implements International Classification of Diseases

The Centers for Disease Control's 2022 Classification of Diseases Codes Clinical Modification and Procedural Classification System implements the International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM).

CDC webpage https://icd10cmtool.cdc.gov/?fy=FY2023&query=radiation

- The ICD-10-CM "diagnosis code" for Radiation Sickness" is "T66."
- The ICD-10-CM "injury" code for "Exposure to Other Non Ionizing Radiation" is "W90." These codes can cover electro-sensitivity along with other RF exposure-related injuries and maladies.

The next revision ICD-11 for Mortality and Morbidity Statistics (Version : 02/2022) also has codes for non ionizing radiation:

- XE6JQ Exposure to other non-ionizing radiation
- PB53 Unintentional exposure to radiation
- PF13 Assault by exposure to radiation
- PH73 Exposure to radiation with undetermined intent

EMF Medical Conference 2021

- This conference was convened online in January 2021 and was attended by over 800 people from 30+ nations. Presentations made by internationally recognized scientists who have published in the field of bioelectromagnetics; by knowledgeable health practitioners who treat people for EMF associated illness and injuries; and, by healthy building engineers who test EMF exposures and mitigate hazards provide a high quality education and training experience. See the program schedule and the list of faculty members.
- The Conference is offering two CME/CE accredited courses designed for health practitioners until May 2023. In addition, they offer subscriptions to access VIMEO on Demand for viewing and sharing the entire Conference proceedings.
- EMF Medical Conference 2021

Health Care

Environmental Health Clinic | Women's College Hospital

Environmental Health Trust ehtrust.org

The Environmental Health Clinic (EHC) is a unique multidisciplinary clinic and the only one of its kind in Ontario. It was established in 1996 by the Ministry of Health and Long-Term Care to be a provincial resource in promoting environmental health and to improve health care for people with chronic complex environmentally-linked conditions such as Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS), Fibromyalgia Syndrome (FMS) and Environmental Sensitivities, including both Multiple Chemical Sensitivity (ES/MCS) and Electromagnetic Hypersensitivity.
The Environmental Health Clinic was established to be the clinical part of a joint clinical and research program of Women's College Hospital and the University of Toronto.

Clinical Practice Guidelines To Assess and Treat Patients.

- PRELIMINARY Clinical Practice Guidelines in the Diagnosis and Management of Electromagnetic Field Hypersensitivity (EHS) by Dr. Riina Ines Bray BASc, MSc, MD, FCFP, MHSc Medical Director, Environmental Health Clinic, Women's College Hospital Assistant Professor, Department of Family and Community Medicine and Dalla Lana School of Public Health, University of Toronto
- Patient Questionnaire on Electrical Sensitivity by Physicians for Safe Technology is an assessment tool to understand EMF exposures.
- The Austrian Medical Association has developed a guideline for differential diagnosis and treatment of health problems associated with outdoor and indoor electrosmog. Guidelines of the Austrian Medical Association for the diagnosis and treatment of EMF related health problems and illnesses (EMF syndrome)
- Erica Mallery-Blythe MD Working Draft: A Summary of EHS detailing science and legal issues related to electrical sensitivity.
- Belyaev, I., Dean, A., Eger, H., Hubmann, G., Jandrisovits, R., Kern, M., Kundi, M., Moshammer, H., Lercher, P., Müller, K., Oberfeld, G., Ohnsorge, P., Pelzmann, P., Scheingraber, C., & Thill, R. (2016). EUROPAEM EMF Guideline 2016 for the prevention, diagnosis and treatment of EMF-related health problems and illnesses. *Reviews on Environmental Health*, *31*(3), 363–397. https://doi.org/10.1515/reveh-2016-0011
- Microwave/Radiofrequency Radiation and Human Health: Clinical Management in the Digital Age by Devra Davis, Margaret E. Sears, Anthony B. Miller and Riina Bray. Chapter 10 in Integrative Environmental Medicine Edited by Aly Cohen and Frederick S. vom Saal Oxford Press Link

Scientific Presentations

- Diagnosis, Treatment and Reversal of Electromagnetic Hypersensitivity by Erica Mallery-Blythe MD

- Dr. Erica Mallery-Blythe - Electromagnetic Radiation, Health and Children 2014
- Magda Havas talks at NIEHS May 9, 2016 on Electrosmog and Electrohypersensitivity,
- Dr. Yael Stein MD, at UNESCO Chair in Bioethics 10th World Conference Slideshare
- ELECTROHYPERSENSITIVITY: INPUT OF MECHANISTIC STUDIES WITH LOW-INTENSITY RADIOFREQUENCY AND EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS by Igor Belyaev PhD Russian Academy of Science, Moscow, Russia
- Dr. Olle Johansson and Dr. Isaac Jamieson 2014 EESC, Brussels Presentation
- Andrew A Marino PhD The peer reviewed research of electromagnetic sensitivity
- 5th Paris Appeal Congress, 18th of May, 2015, Royal Academy of Medicine, Belgium, Abstracts WHAT ROLE FOR ELECTROMAGNETIC FIELDS AND CHEMICALS?

Additional Resources on How to Manage Symptoms

- Electrical Pollution's EMF Solutions page
- Electrosensitivity UK: NATIONAL POLICY FOR THE BUILT ENVIRONMENT 2016

Scientific Declarations

2015 Brussels International Scientific Declaration on Electromagnetic Hypersensitivity and Multiple Chemical Sensitivity. Download

> "We, physicians, acting in accordance with the Hippocratic Oath, we, scientists, acting in the name of scientific truth, we all, medical doctors and researchers working in different countries worldwide, hereby state in full independence of judgment,
> that a high and growing number of persons are suffering from EHS and MCS worldwide;
> that EHS and MCS affect women, men and children;
> that on the basis of the presently available peer-reviewed scientific evidence of adverse health effects of electromagnetic fields (EMFs) and various chemicals, and on the basis of clinical and biological investigations of patients, EHS is associated with exposure to EMFs and MCS with chemical exposure…"

Peterborough Canada Information Sheet to Accommodate

Peterborough Canada has an information sheet to help organizations accommodate individuals who have electromagnetic hypersensitivity. They recommend – among other things:

- Temporarily disable City owned WAP devices.
- Turn off or minimize fluorescent and LED.
- Notify attendees to set mobile phones to airplane mode.

Policy

USA Proclamations on Electromagnetic Sensitivity

- Alabama State Proclamation on Electromagnetic Sensitivity
- Colorado State Proclamation on Electromagnetic Sensitivity
- Florida State Proclamation on Electromagnetic Sensitivity
- Connecticut State Proclamation on Electromagnetic Sensitivity
- Broward County Florida Proclamation on Electromagnetic Sensitivity
- Portland City Council Proclamation on Electromagnetic Sensitivity

Pittsfield Massachusetts Board of Health Order Regarding Injury From Verizon Cell Tower

- On April 6, 2022, the Pittsfield, Massachusetts Board of Health voted to send a cease and desist order to shut down a Verizon cell tower if Verizon does not respond with meaningful action regarding a cell tower. The Board took action after families living in the neighborhood of Shacktown near a Verizon cell tower reported wireless radiation-related health issues soon after the tower became operational in 2020. Seventeen people are reporting injuries linked to the radiation. After sending the Order, the situation became embroiled in a legal battle.
- Letter from Dr. Kulberg Board of Health in Support of MA Commission on Wireless Radiation regarding residents that became ill after the cell tower installation.

Letters and Documents Regarding HUD Denying Assistance to People on EMFs

- Social Security Administration: Letter- Electromagnetic Sensitivity Found to be a Severe Impairment by the Social Security Administration 2003 and 2020
- General Council Architectural and Transportation Barriers Compliance Board States the Need for Housing for the Electromagnetic Sensitive Disabled
- Letter from the Department of Justice to HUD shows EMF Housing is Jurisdictional to HUD

- HUD FHEO Memo Singles Out the Electrically Disabled for Discrimination

  FYI, After consultation with OGC-Fair Housing, it has been decided that, at this time, FHEO will not accept, as jurisdictional, allegations dealing with Smart Meters, RF and/or EMF issues

- HUD FHEO Memo to Local Housing Authorities Singles Out the Electrically Disabled for Discrimination
- HUD FHEO Form Letter Denies Assistance to People Inquiring About Accommodation Regarding Wireless Smart Meters
- HUD FHEO Form Letter Denies Assistance to People Whose Accommodation Request Regarding Wireless Smart Meters Was Already Accepted
- HUD FHEO FOIA Response Regarding RF and EMF Disability Complaints 2000-2020
- Summary of HUD FHEO RF and EMF Disability Complaints 2000-2020
- Letter from the Department of Justice to HUD shows EMF Housing is Jurisdictional to HUD

Accommodations and Court Rulings

United States

2021: A Los Angeles School District Teacher Can Move Forward With Wi-Fi Effects Lawsuit After A California Court Ruling That She Can Proceed With Her Case

- In the majority opinion handed down in the case, Brown v. LAUSD (Appeal No. B294240), the Court of Appeal recognized that it doesn't matter whether or not other courts in the United States have recognized "electromagnetic hypersensitivity" as a disability under the federal Americans with Disabilities Act ("ADA") because JML Law's client, Laurie Brown, has brought her case not under the ADA, but under FEHA, which is broader in scope. The Court of Appeal held that Brown sufficiently alleged that she suffered from a physical disability under the FEHA and that she sufficiently stated a cause of action for failure to accommodate, where she alleged that LAUSD refused to honor an accommodation which LAUSD had agreed to provide to Brown. The Court of Appeal stated that based on their reading of Brown's First Amended Complaint, "LAUSD's actions here do not align with those of an employer taking positive steps to accommodate the employee's limitations."
- JML Law Wins Appeal in 'Unprecedented' Disability Case Against LAUSD For Failure to Accommodate Teacher With Electromagnetic Hypersensitivity

2014: US Resident Provided Accommodations in Housing Case Regarding "Smart" Water Meters: A resident provided a mechanical meter after filing in court and coming to an agreement with the water authority. In addition the neighbors of three adjacent properties also were provided free opt outs for the switch to mechanical meters. The legal filing says that the Fair Housing Act prohibits discrimination based on disability.

- Redacted HUD water meter agreement

2014: Los Angeles Unified School District Accommodated a Teacher Who Fell Ill After Wireless Installation.

On September 18, 2014, LAUSD, the second largest public school district in the US, officially accommodated a teacher by approving her request to have the Wi-Fi turned off in her classroom during the 2014-2015 school year and alternatively approving a reassignment to a different school site where Wi-Fi has yet to be installed.

- Video of her testimony to the LAUSD School District
- Teacher letter of accommodation

2022: Long Beach California Small Cell decision: In a hearing examiner determination of Long Beach California proceedings regarding the placement of a cell tower in front of a home with a woman with electromagnetic sensitivity , the hearing examiner findings included that FCC radio-frequency (RF) radiation limits were outdated and not protective. Although the ruling was not in favor of the couple living in the home who wanted a halt to the installation,the statements regarding FCC RF emission limits are important to share.

Excerpts from the determination regarding FCC limits:

> " It does appear through reliable, credible evidence that the FCC regulations as to what are safe RF emission standards are outmoded and inadequate to safeguard the public…"
>
> "by way of said scientific medical evidence Appellants have shown that the FCC's determination as to what are safe and acceptable RF emission exposure levels are antiquated and not based on current scientific evidence and that the FCC regulations are instead industry sponsored, outdated, and just plain wrong, causing the public to be exposed to unnecessary and harmful radiation."
>
> " the evidence sufficiently established to this hearing officer that RF emissions may and can injure animals and humans and may very well cause further injury to Appellant Hahn if the WCF is installed. These articles [referring to published science submitted to the record as well as the judgment of the EHT et al. v FCC case] call into question the scientific and medical legitimacy of the legally controlling Federal Communications Commission regulations cited and relied upon jointly by the city and AT&T here as to what is safe and acceptable RF emission exposure levels to which the public in general and Appellant Hahn in particular can and should be allowed to be exposed , especially where, as here, a WCF is projected to be erected a few yards from Appellants home."

United Kingdom

Education Health Care Plan (EHCP) awarded for children on the basis of Electromagnetic Hypersensitivity (EHS) (2022). Parents have now won a 5 year legal battle against 2 local authorities to have their child accommodated in school for EHS. They won in the Upper Tribunal, thus the ruling is also precedent setting. We believe this is the first case in the world where a government body is legally mandated to make low EMF educational provisions to accommodate a child with EHS

Early ill-health retirement' and 'Employment Support Allowance' awarded on the basis of Electromagnetic Hypersensitivity(2022): Sally Burns, a 59 year old social worker successfully won her appeal for early ill-health retirement and will now receive full pension due to disabling Electromagnetic Hypersensitivity (EHS).

British Tribunal Case: Claimant was awarded Employment and Support Allowance under ESA Regulation 29 (Exceptional Circumstances): The Judge stated that "were it not for EMR the appellant would lead a normal life with little or no functional impairment".....Considerations included the fact that the appellant would be unable to work in any 'normal' working environment indoors or outside- anywhere there was Wi-fi, mobile phones or mobile phone masts…"

Australia

2013, Court Ruling in McDonald and Comcare: The AAT ruling means McDonald will continue to be paid 75% of his salary, as compensation for his illness. Administrative filing, News coverage.

France:
13 Plaintiffs Win: The Tribunal de Grand Instance of Bordeaux ordered in favor of 13 of the 206 plaintiffs who had initiated a lawsuit against the installation of the electric meter created by Enedis.

- BBC News- French court recognizes EHS as a handicap: BBC NEWS
- France orders removal of Smartmeter because of electromagnetic radiation

Spain
High Court of Madrid Ruling Recognizes "Electrosensitivity" as Grounds for Total Permanent Disability – Towards Better Health, 4th August 2016 Legal Ruling (in Spanish). In Spain there have been multiple judgments in favor of people disabled by EMF exposure.

Teacher Union Action

- In 2013, Canadian Teacher Federation issued a briefing document, "The Use of Wi-Fi in Schools," recommending an education program to educate the public regarding ways to avoid potential exposure risks of Wi-Fi access points and devices."They also briefed the Royal Society of Canada and presented testimony in person. Bob McGahey Acting Director, Research and Information, at the Canadian Teachers' Federation Presentation to the Royal Society of Canada

- In 2012, the Ontario English Catholic Teachers Association released a Position Statement recommending wired classroom infrastructure as WIFI "may present a potential health and safety risk or hazard in the workplace."
- In 2010, the Greater Victoria Teachers' Association recommended a precautionary approach and their Webpage states Wi-Fi free zones should be available, On/Off routers recommended to turn the Wi-Fi OFF and the minimal or non-use within elementary schools.
- In 2018, United Educators of San Francisco passed a Resolution on Safer Technology that calls for the California cell phone guidance to be disseminated to students and staff. They also hosted webinars on Safe Technology in schools.
- 2016 the Elementary Teachers Federation of Ontario called for a "WI-FI moratorium until further health studies are done, and lawmakers can catch up with new regulations."
- In 2016, the New Jersey Education Association (NJEA) published an article "Minimize health risks from electronic devices" with details on how to reduce physical health risks from devices including risks from radiation exposure.
- In 2014, the New York State Teachers Union passed a Resolution "Hazards of Wireless Radiation Emission," hosted a webinar "Risks of wireless technologies and protecting children and staff in schools" issued a press release on the "Best Practices For Schools."

Selected Readings and Video Resources

Articles on Electromagnetic Sensitivity

- Notre Dame Magazine I Am an EMF Refugee
- What It's Like to Be Allergic to Wi-Fi NY Magazine By Alexa Tsoulis-Reay
- Allergic to life: the Arizona residents 'sensitive to the whole world'
- Two Articles by Dr. Scott Eberle An Underworld Journey: Learning to Cope With Electromagnetic Hypersensitivity and What's the Diagnosis Doctor?
- Men's Health Magazine: The Quiet House: About a man with lymes- chemical, mold and EMF sensitivity
- Rio Times Swedish study says 5G causes Microwave Syndrome
- Acupuncture Today EMF Exposures: Adverse Effects on Patient Health and Outcomes

Videos on Electromagnetic Sensitivity

- Wireless wake-up call | Jeromy Johnson | TEDxBerkeley
- Jolie Jones Interview with Professor Olle Johansson about EHS / EMF effects.
- Scientist with EMF Sensitivity in Australia: Received Court Ruling Accommodations
- Searching for a Golden Cage
- Interview with EHS Sufferer in France
- Interview with Directors of the Film Prisons Without Bars: Nicole Giguère and Isabelle Hayeur
- Woman Cuts Family Off From WiFi, Cell Phones Because Of Health Concerns
- Interview With Solveig on Electrosensitivity, Wireless Radiation and Hope

- Electrical Hypersensitivity Presentation by Nicole Bijlsma
- Is electromagnetic hypersensitivity real?
- Bob McGahey Acting Director, Research and Information, at the Canadian Teachers' Federation Presentation to the Royal Society of Canada

Films and Movies on Electromagnetic Sensitivity

- PRISONS WITHOUT BARS
- ELETTRA - Italian short movie
- Ubiquity
- Generation Zapped
- Environmental Health Trust Films on Electromagnetic Radiation
- Videos for Doctors and Scientists – Phire Medical

Selected Scientific Research on Electromagnetic Sensitivity and Radiofrequency Radiation

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NEW YORK CITY



5G Jumbo Poles in New York City



2,000 5G Jumbo Poles planned for initial deployment

32 feet high

10 feet from bedroom windows

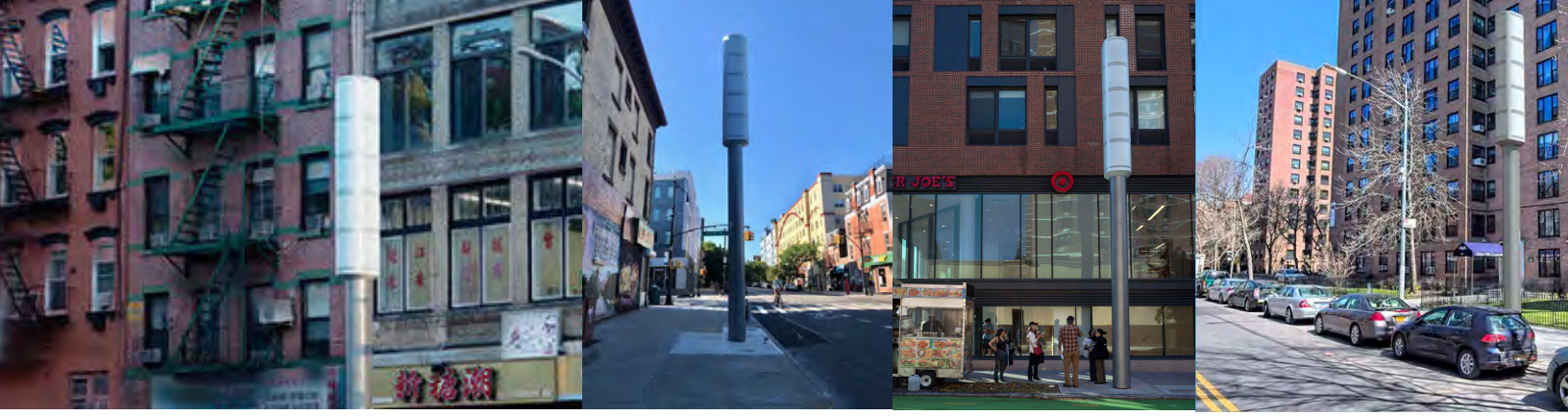
5 levels for different types of transmitting antennas.

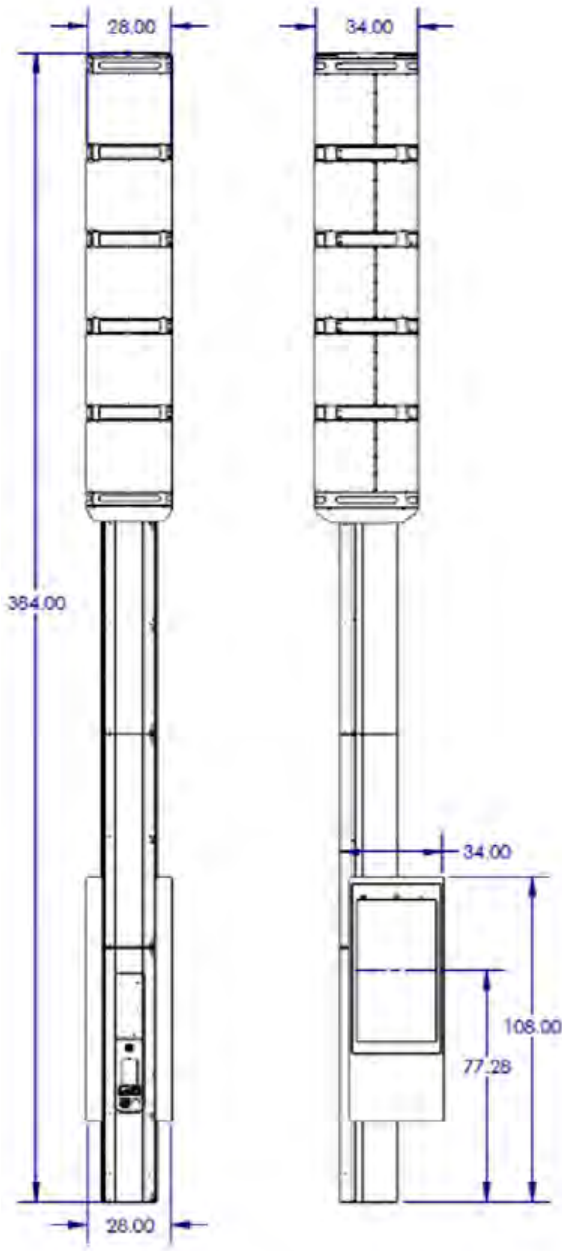
12 NYC Community Boards have issued moratoriums or disapprovals

3,500 Experts Calling To Halt 5G

"The main risks associated with exposure to such (wireless) non-ionising radiation in the peer-reviewed scientific literature include: increased cancer risk, cellular stress, increase in harmful free radicals, genetic damage, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans."

-Consensus Statement of 3,500 UK and International Medical and Scientific Experts





Link5G (with screen)

Letters on 5G Jumbo Poles

New York State Legislature
State Senator Liz Krueger
Assembly Member Rebecca Seawright
Assembly Member Alex Bores

United States Congress
Congressmember Jerrold Nadler

City of New York
Manhattan Borough President Mark Levine
City Council Majority Leader Keith Powers
City Council Member Julie Menin

"The siting of massive cellular towers in historic districts is antithetical to the purpose of preserving these districts, as they are meant to have "coherent streetscapes" that reflect particular historic periods and styles of architecture."

Letter from Jerrold Nadler Congress Member, Keith Powers City Council Majority Leader, Mark Levine, Manhattan Borough President, Rebecca Seawright Assembly Member, Julie Menin, City Council Member, Alex Bores Assembly Member, Liz Krueger State Senator to Landmark Preservation Commission, January 23, 2023

MASNYC
THE NEW YORK LANDMARKS CONSERVANCY
40 FRIENDS
LANDMARK WEST!
VILLAGE PRESERVATION
CARNEGIE HILL Neighbors
CIVITAS

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

Letter from Conservation Societies: Historic Districts Council, Friends of the Upper East Side Historic Districts, Carnegie Hill Neighbors, Landmark West! , CIVITAS NYC, Village Preservation, The New York Landmarks Conservancy
January 12, 2023

ENVIRONMENTAL HEALTH TRUST

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES





When a new cell tower or wireless network is proposed, the first question to ask is: "Do you have insurance for damages from long-term exposure to the radiofrequency radiation (RFR)?" Usually the answer is "No."

An Uninsurable Risk?

- Insurers rank wireless, cell tower, and 5G RFR non-ionizing electromagnetic field (EMF) radiation as a "high" risk, comparing the issue to lead and asbestos.
- Most insurance plans have "electromagnetic field exclusions" and do not insure for long-term RFR damages.
- Additionally, some insurance plans will not provide a defense for any supervision instruction or recommendation given *"or which should have been given"* in connection to EMFs.
- Wireless RFR and non-ionizing electromagnetic radiation are defined as a type of "pollution" by wireless companies themselves.
- U.S. mobile operators have been unable to get insurance to cover liabilities related to damages from long-term RFR exposure.
- Wireless companies warn their shareholders of RFR risk but do not warn users of their products, nor do the companies warn the people exposed to emissions from their infrastructure.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

T-Mobile on 5G: Possible Changes to FCC Human Exposure Limits for RF Could Impact Cash Flow



T-Mobile advertises to the public about going "live" but omits the warnings they give to shareholders regarding 5G, regulatory changes and risk perception.

T-Mobile

T-Mobile 10-K Report 2/2023

"Negative public perception of, and regulations regarding, the perceived health risks relating to 5G networks could undermine market acceptance of our 5G services" (page 13)

"We, along with equipment manufacturers and other carriers, are subject to current and potential future lawsuits **alleging adverse health effects arising from the use of wireless handsets or from wireless transmission equipment such as cell towers."**

"In addition, **the FCC has from time to time gathered data regarding wireless device emissions, and its assessment of the risks associated with using wireless devices may evolve based on its findings.** Any of these allegations or changes in risk assessments could result in customers purchasing fewer devices and wireless services, could result in significant legal and regulatory liability, and could have a material adverse effect on our business, reputation, financial condition, cash flows and operating results." (T- Mobile 10-K Report page 21)


Mobile Telecommunications and Health

Review of the Current Scientific Research in view of Precautionary Health Protection

A 2000 Ecolog Institute Report commissioned by T-Mobile and DeTeMobil Deutsche Telekom MobilNet recommended an exposure limit 1000x lower than the FCC's current power density limit after reviewing the research on biological effects, including impacts to the immune system, central nervous system, hormones, cancer, neurotransmitters and fertility.

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

Verizon 10-K Report

"Our wireless business also faces personal injury and wrongful death lawsuits relating to alleged health effects of wireless phones or radio frequency transmitters. We may incur significant expenses in defending these lawsuits. In addition, we may be required to pay significant awards or settlements."

Crown Castle 10-K Report

"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

AT&T 10-K Report

"In the wireless area, we also face current and potential litigation relating to alleged adverse health effects on customers or employees who use such technologies including, for example, wireless devices. We may incur significant expenses defending such suits or government charges and may be required to pay amounts or otherwise change our operations in ways that could materially adversely affect our operations or financial results."

T- MOBILE 10-K Report

"Our business could be adversely affected by findings of product liability for health or safety risks from wireless devices and transmission equipment, as well as by changes to regulations or radio frequency emission standards."

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

Cell Tower Companies Warn Shareholders of Risk From Cell Tower Radiation

Why Don't They Warn Families Living Near Cell Towers?

American Tower 10-K

"If a scientific study or court decision resulted in a finding that radio frequency emissions pose health risks to consumers, it could negatively impact our tenants and the market for wireless services, which could materially and adversely affect our business, results of operations or financial condition. We do not maintain any significant insurance with respect to these matters."

Nokia 10-K

"Although our products are designed to meet all relevant safety standards and other recommendations and regulatory requirements globally, we cannot guarantee we will not become subject to product liability claims or be held liable for such claims, which could have a material adverse effect on us."

Qualcomm 10-K

"If wireless handsets pose health and safety risks, we may be subject to new regulations, and demand for our products and those of our licensees and customers may decrease."

Ericsson Annual Report

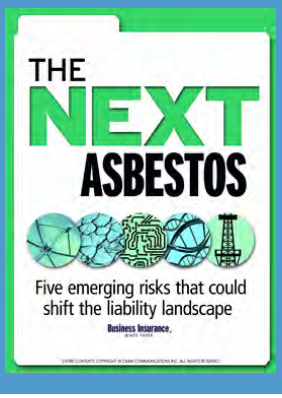
"Any perceived risk or new scientific findings of adverse health effects from mobile communication devices and equipment could adversely affect us through a reduction in sales or through liability claims."

This PDF is hyperlinked. For more on legal liability issues go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

5G, CELL TOWERS AND WIRELESS

LEGAL & LIABILITY ISSUES SHAREHOLDER WARNINGS



"Some research has shown biological effects from lower -level "non thermal" exposure and people exposed at lower levels have reported headaches, dizziness, nausea, mood disorders, mental slowing and memory loss."
Business Insurance White Paper, The Next Asbestos: Five Emerging Risks That Could Shift the Liability Landscape

Insurance Companies Have Electromagnetic Field Exclusions
Electromagnetic field exclusions" are clear and common in most insurance companies. It is applied as a market standard. This exclusion serves to exclude cover for illnesses caused by long-term EMF (non-ionizing radiation) exposure." — Complete Markets

"Exclusions: This insurance does not apply to: Bodily injury, personal injury, advertising injury, or property damage arising directly or indirectly out of, resulting from, caused or contributed to by electromagnetic radiation, provided that such loss, cost or expense results from or is contributed to by the hazardous properties of electromagnetic radiation.
— Portland Oregon Public School Insurance (page 30)

Insurance Plans Not Only Exclude EMF Damages, But Some Even Exclude Defending Decision Makers From Their Actions in Regards to Their Actions on EMFS

"This policy does not apply to and we will not provide a defense for: a. bodily injury... arising out of ... exposure to or contact with electromagnetic radiation... b. costs of abatement .. of EMF" or c. any supervision, instruction, recommendation, warning or advice given or which should have been given in connection with a or b. above."- City of Ann Arbor Michigan Insurance Policy page 14.

Insurance Authorities Rate 5G as "High Risk."
5G mobile networks are classified as a "high," "off-the-leash" risk. "Existing concerns regarding potential negative health effects from electromagnetic fields (EMF) are only likely to increase. An uptick in liability claims could be a potential long-term consequence" and "[a]s the biological effects of EMF in general and 5G in particular are still being debated, potential claims for health impairments may come with a long latency."
— Swiss Re Institute (2019)

Wireless Companies Rank EMF as a Risk with High Impact
"Electro-magnetic signals emitted by mobile devices and base stations may be found to pose health risks, with potential impacts including: changes to national legislation, a reduction in mobile phone usage or litigation."
— Vodaphone 2017 Report ranks EMF as a "Principal Risk with "High" impact.

Wireless Companies Warn Shareholder About Risk But Not People Living Near Their Wireless Infrastructure

Crown Castle says:
"We cannot guarantee that claims relating to radio frequency emissions will not arise in the future or that the results of such studies will not be adverse to us...If a connection between radio frequency emissions and possible negative health effects were established, our operations, costs, or revenues may be materially and adversely affected. We currently do not maintain any significant insurance with respect to these matters."

Wireless Companies Define Pollution in Their Own Policies as Including EMFs, Microwaves and Non-ionizing Radiation.

Verizons Total Mobile Protection Plan says: "Pollution" is defined as "any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste."

ENVIRONMENTAL HEALTH TRUST

CELL TOWERS NEAR SCHOOLS

SCHOOL CELL TOWER SETBACKS

Many communities have policies, ordinances or zoning that ensures cellular antennas are restricted to a specific minimum distance from schools. Hempstead, New York requires a special use permit for cell towers near schools.

Examples of cell tower/4G/5G small cell setbacks/preferred placements for schools:

- Palo Alto, California: 1,500 feet
- Copake, NewYork :1500 feet
- Los Altos , California: 500 feet
- Walnut City, California: 1,500 feet
- Bar Harbor, Maine: 1,500 feet
- Sallisaw, Oklahoma: 1,500 feet
- Shelbourne , Massachusetts: 1,500 feet
- Stockbridge, Massachusetts: 1,500 feet
- San Diego County California 1,000 feet
- Encinitas California:500 feet
- Scarsdale New York: 500 feet
- Ithaca, New York: 250 feet

CELL TOWERS REMOVED FROM SCHOOL GROUNDS

- Milpitas California: School Board asked Crown Castle and T-Mobile to relocate the cell tower to remote location.
- Ripon California: Sprint moved the cell tower at elementary after students and staff developed cancer and parents argued children should not be guinea pigs.
- Alameda California cancelled cell tower contracts.
- Dekalb County Georgia dropped school tower plan.

SCHOOL BOARDS

- Palo Alto Unified School District Cell Tower Resolution supports the City 1,500 setback and opposes cell tower "on or in close proximity to schools to ensure individuals, especially children, are protected from the potential negative effects associated with radiation exposure."
- West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
- Vancouver School Boards Resolution: 1,000 feet
- Greenbelt Maryland Council opposes school towers.

DID YOU KNOW?

- The International Association of Firefighters passed a Resolution opposing cell towers on its stations in 2004 after a study found neurological damage in firefighters with antennas on their fire stations.

LOS ANGELES UNIFIED CA SCHOOL DISTRICT

- 3 resolutions opposing cell towers on school property.
- The District Office of Health and Safety developed a "cautionary level" for radiofrequency radiation 10,000 times lower than FCC regulations because, *"it is believed that a more conservative level is necessary to protect children, who represent a potentially vulnerable and sensitive population."*

SCHOOL BOARDS THAT REVERSED COURSE

- Montgomery County Maryland Schools policy does not allow cell towers on elementary schools.
- Prince George's County Maryland School Board decided not to renew a cell tower construction master leasing agreement that had allowed over 60 schools to be marketed as cell tower sites.
- Portland Oregon Schools ended new leases for cell towers.

EXPERT RECOMMENDATIONS

- The New Hampshire State Commission 5G Health and Environment Report recommends a setback of 1640 feet for schools.
- The Collaborative For High Performance Schools (Green building rating program) has LOW EMF Criteria which includes no cell towers on school property.

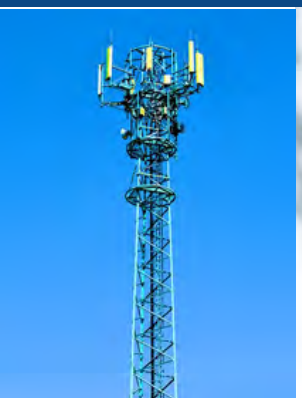
THE EPA SCHOOL SITING GUIDELINES

Lists exposure to electromagnetic fields and the fall distance as "potential hazards" from cell towers. The EPA guidelines recommend schools "identify and evaluate cell towers within ~200 feet of prospective school locations."

PUBLISHED RESEARCH

- 500 meter buffer recommended for schools to reduce liability and minimize risk (Pearce 2019)
- A moratorium on 5G pending safety research (Frank 2020)
- A precautionary approach is better suited to State obligations under international human rights law (Roda and Perry 2014)
- Increased cancer deaths near cell antennas (Rodrigues 2021)
- Studies find: DNA Damage(Zothansiama 2017), Diabetes (Meo 2015), Cognitive effects (Meo 2018), sleep problems and headaches (Abdel-Rassoul 2007, Levitt & Lai 2010, Shahbazi-Gahrouei 2013)

CHILDREN'S VULNERABILITY TO WIRELESS RADIOFREQUENCY (RF) RADIATION





The American Academy of Pediatrics states:

"In recent years, concern has increased about exposure to radio frequency (RF) electromagnetic radiation emitted from cell phones and phone station antennas. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment."

–American Academy of Pediatrics
HealthyChildren.org

Cell towers and cell phones emit wireless radiofrequency (RF) radiation.

Children are more vulnerable to RF radiation, just as they are to other environmental exposures. They have proportionately more exposures to RF compared to adults. More importantly, even very low exposures to children can have serious impacts later in life because their nervous and immune systems are still in development.

Children absorb higher levels of RF radiation deeper into their brains and bodies because they have:

- Thinner skulls allow RF radiation to move easier into the brain.
- Higher water content in brain tissue which is more conductive to electricity.
- Smaller heads result in a shorter distance for the RF to travel from the skull to critical brain regions important for learning and memory.

Children are more sensitive to RF impacts because:

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

CELL TOWER RF RADIATION AND CANCER



International Agency for Research on Cancer

World Health Organization

PRESS RELEASE
N° 208

31 May 2011

IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 – The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.

The World Health Organization International Agency for Research on Cancer Classified Radiofrequency Radiation as a "Possible" Carcinogen in 2011

In 2011, radiofrequency electromagnetic fields (RF-EMF) were classified as a Group 2B possible carcinogen by the World Health Organization's International Agency for Research on Cancer (WHO/IARC).

The WHO/IARC scientists clarified that this determination was for RF-EMF from any source be it cell phones, wireless devices, cell towers or any other type of wireless equipment.

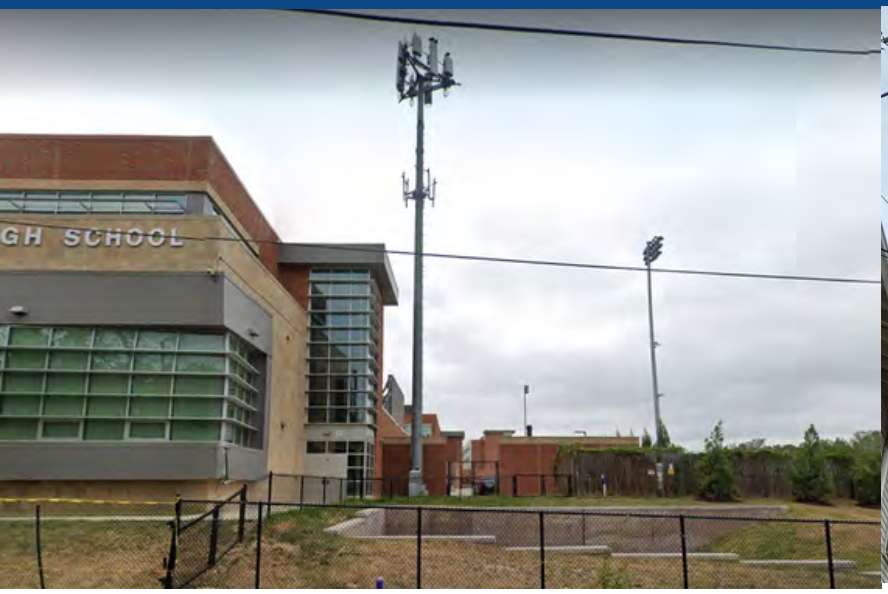
Since 2011, the published peer-reviewed scientific evidence associating RF-EMF (also known as RF-EMR and RFR) to cancer and other adverse effects has significantly increased.

A large-scale animal study published in Environmental Research found rats exposed to RF levels comparable to cell tower emissions had elevated cancers, the very same cancers also found in the US National Toxicology Program animal study of cell phone level RF that found "clear evidence" of cancer in carefully controlled conditions (Falcioni 2018).

In 2019, the WHO/IARC advisory committee recommended that radiofrequency radiation be re-evaluated as a "high" priority in light of the new research. The date of the re-evaluation has not been set.

Currently, several scientists conclude that the weight of currently available, peer-reviewed evidence supports the conclusion that radiofrequency radiation is a proven human carcinogen (Hardell and Carlberg 2017, Peleg et al. 2022, Miller et al. 2018).

PUBLISHED RESEARCH STUDIES





RESEARCHERS RECOMMEND CELL TOWERS BE DISTANCED AWAY FROM HOMES AND SCHOOLS

The review paper entitled "**Limiting liability with positioning to minimize negative health effects of cellular phone towers**" reviewed the "large and growing body of evidence that human exposure to RFR from cellular phone base stations causes negative health effects." The authors recommend restricting antennas near homes, and restricting antennas within 500 meters of schools and hospitals to protect companies from future liability (**Pearce 2020**).

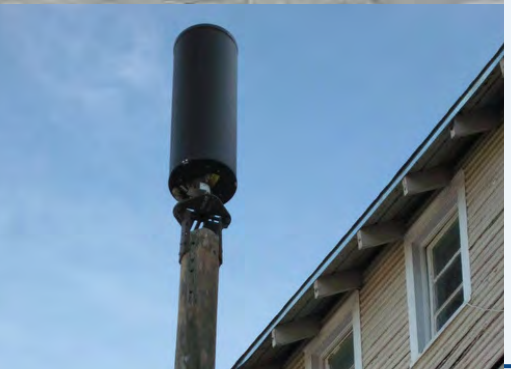
An **analysis** of 100 studies published in *Environmental Reviews* found approximately 80% showed biological effects near towers. "As a general guideline, cell base stations should not be located less than 1500 ft from the population, and at a height of about 150 ft" (**Levitt 2010**).

A **review** published in the *International Journal of Occupational and Environmental Health* found people living less than 500 meters from base station antennas had increased adverse neuro-behavioral symptoms and cancer in eight of the ten epidemiological studies (**Khurana 2010**).

A **paper** by human rights experts published in *Environment Science and Policy* documented the accumulating science indicating safety is not assured, and considered the issue within a human rights framework to protect vulnerable populations from environmental pollution. "We conclude that, because scientific knowledge is incomplete, a precautionary approach is better suited to State obligations under international human rights law" (**Roda and Perry 2014**, **PDF**).

APARTMENTS & CONDO BUILDINGS
INCREASED RF RADIATION FROM CELL ANTENNAS





The study "**Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment**" published in *Oncology Letters* by **Koppel et al. (2019)** measured 2 apartments and found that the apartment with high RF levels had outdoor areas as close as 6 meters (about 19.6 feet) from transmitting base station cell antennas. In contrast, the apartment with low RF exposure had cell antennas at 40 meters (about 131 feet) away from the balcony.

Furthermore, the researchers also found that both high- and low-RF apartments had good mobile phone reception, and they concluded,"therefore, installation of base stations to risky places cannot be justified using the good reception requirement argument."

A measurement study by **Baltrėnas et al. (2012)** published in *Journal of Environmental Engineering and Landscape Management* investigated RF power density levels from cell phone antennas located 35 meters away from a 10-story apartment building. The transmitting antennas were approximately at the same height as the 6th floor of the building. The researchers found the highest RF levels at floors 5, 6 and 7. The RF at the 6th floor balcony was three times higher than the 3rd floor balcony. The RF power density at the 6th floor was about 15 times the RF measured at the first floor.

A **case report by Hardell et al. (2017)** of RF levels in an apartment in close proximity to rooftop cellular network antennas used an exposimeter to measure levels of different types of RF in the apartment and balconies including TV, FM, TETRA emergency services, 2G GSM, 3G UMTS, 4G LTE, DECT cordless, Wi-Fi 2.4 GHz and 5 GHz and WiMAX. The closest transmitting antennas were 6 meters away from the balcony. The researchers found 97.9% of the mean RF radiation was caused by downlink from the 2G, 3G and 4G base stations. (Downlink means frequencies emitted "down" from the base station cellular antennas.) The researchers found that if the base station RF emissions were excluded, the RF radiation in the children's bedrooms was reduced approximately 99%.

The researchers conclude, "due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults."

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ENVIRONMENTAL HEALTH TRUST

INCREASED EXPOSURE FROM 5G/4G "SMALL" CELL ANTENNAS LOCATED CLOSE TO PEOPLE

A study entitled "**Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads**" published in *Environmental Research* by Koppel et al. (2022) created an RF heat map of RF measurements, finding that the highest RF measurements were in areas of close proximity to the base station antennas. The researchers concluded with recommendations to reduce close proximity placements such as positioning antennas "as far as possible from the general public" like in high-elevation locations or more remote areas.

A study entitled "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in the *World Academy of Sciences* Journal found the highest RF levels in areas where the cell phone base station antennas were placed on top of utility poles, street lamps, traffic lights or other posts near to the street. The scientists compared their **2022 findings** to an earlier **2019 published review** on the mean outdoor exposure level of European cities and they found the South Carolina measurements to be higher.

The researchers concluded that the highest exposure areas were due to two reasons: cell phone base antennas on top of high-rise buildings provide "good cell coverage reaching far away, but creating elevated exposure to the radiofrequency electromagnetic fields at the immediate vicinity; and cell phone base station antennas installed on top of utility poles have placed the radiation source closer to humans walking on street level."



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.

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ENVIRONMENTAL HEALTH TRUST

HEALTH SYMPTOMS REPORTED BY PEOPLE LIVING CLOSE TO CELL ANTENNAS



Image: Figure 1: Top floor apartment adjacent to base stations. Nilsson M, Hardell L. (2023) Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office. Ann Clin Case Rep

RESEARCH ON ANTENNAS CLOSE TO HOMES, SCHOOL AND WORK

Surveys of people living near cell tower antennas in **France**, **Spain**, **Iraq**, **India**, **Germany**, **Egypt**, **Poland** have found significantly higher reports of health issues including sleep issues, fatigue and headaches (See **Santini et al. 2003**, **López 2021**, **Alazawi 2011**, **Pachuau and Pachuaua 2016**, **Eger et al. 2004**, **Abdel-Rassoul et al. 2007**, **Bortkiewicz et al., 2004**).

A **study** published in *American Journal of Men's Health* linked higher cell tower RFR exposures to delayed fine and gross motor skills and to deficits in spatial working memory and attention in school adolescents (**Meo 2018**).

A **study** published in *Environmental Research and Public Health* found higher exposures linked to higher risk of type 2 diabetes (**Meo 2015**).

A study following people for 6 years linked increased cell phone and cell phone tower antenna exposure to altered levels of hormones including cortisol, thyroid, prolactin and testosterone (**Eskander et al. 2021**).

A **study** that followed people in a German town after a cell tower was erected found stress hormones adrenaline and noradrenaline significantly increased over the first 6 months after the antenna activation and decreased dopamine and PEA levels after 18 months (**Buchner 2011**).

Two published case report document illness that developed after 5G antennas were installed. In **Hardell and Nilsson 2023,** a couple developed microwave syndrome symptoms (e.g., neurological symptoms, tinnitus, fatigue, insomnia, emotional distress, skin disorders, and blood pressure variability) after a 5G base station was installed on the roof above their apartment.

Similarly, in **"Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office**" two men developed symptoms after 5G antennas were activated on the roof of their workplace. The symptoms disappeared in both men within a couple of weeks (case 1) or immediately (case 2) after leaving the office.

PUBLISHED RESEARCH ON 5G



New York City Jumbo 5G poles with 5 tiers to house transmitting antennas from numerous carriers.



New York City "small cell" antennas in front of living room window.

Scientists state that 5G's higher frequencies cannot be assumed safe.

5G systems are using low band frequencies well associated with harmful effects **(ICBE-EMF 2022, European Parliament 2021, Panagopoulos et al. 2021)**. However 5G networks are *also using higher frequencies* such as 3.5 GHz and into the mmWave range with 24 GHz and higher.

Contrary to claims that the 5G's higher frequencies simply "bounce" off the skin, researchers have documented that the coiled portion of the skin's sweat duct can be regarded as a helical antenna in the sub-THz band and the skin, our largest organ, can intensely absorb the higher 5G frequencies **(Feldman and Ben Ishai 2017).**

Reviews of 5G health effects caution that the expected real-world impact would be far more serious due to the complex waveforms and other combinations with other toxic stimuli in the environment **(Kostoff et al 2020, Russell, 2018, Belyaev 2019, McCredden et al 2023).**

Researchers will often experiment with zebrafish, rodents and fruit flies to gain data on potential health effects to humans. An Oregon State University study on zebrafish exposed to 3.5 GHz **(Dasgupta et al. 2022)** found "significant abnormal responses in RFR-exposed fish" which "suggest potential long-term behavioral effects. Yang et al 2022 found 3.5 GHZ induced oxidative stress in guinea pigs.

A study on 3.5 GHz exposure to both diabetic and healthy rats (**Bektas et al 2022)** found an increase in degenerated neurons in the hippocampus of the brains, changes in oxidative stress parameters and changes in the energy metabolism and appetite of both healthy and diabetic rats. The researchers conclude that, "5G may not be innocent in terms of its biological effects, especially in the presence of diabetes."

PUBLISHED RESEARCH ON 5G



5G's higher frequencies will be combined with the lower frequencies from current networks already present in the environment.

Studies on rats have found exposure to both 1.5 and 4.3 GHz microwaves induced: cognitive impairment and hippocampal tissue damage **(Zhu et al 2921)**; impairments in spatial learning and memory, *with the combined simultaneous exposures* resulting in the most most severe effects **(Wang et al 2022)**; and immune suppressive responses **(Zhao 2022)**.

Long-term exposure to 2.856 and 9.375 GHz microwaves impaired learning and memory abilities as well as EEG disturbance, structural damage to the hippocampus, and differential expression of hippocampal tissue and serum exosomes **Wang et al. 2023)**.

Studies on fruit flies exposed to 3.5 GHz have found the exposure led to increases in oxidative stress, changes in the microbial community **(Wang et al 2022)** and alterations of the expression of several types of genes (Wang et al 2021).

A review by **Russell 2018** found evidence for millimeter wave effects to the skin, eyes, immune system, gene expression, and bacterial antibiotic resistance.

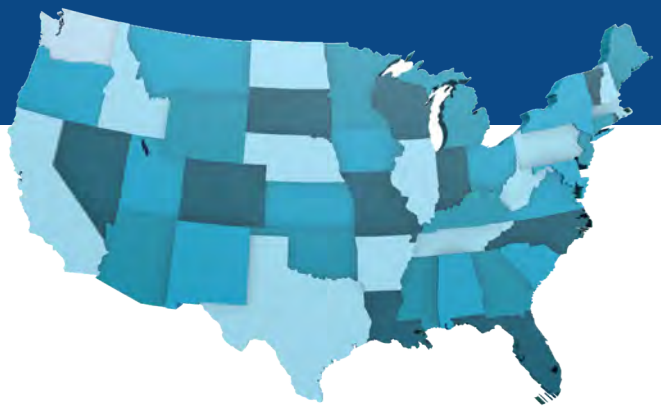
Recent experimental research on high-band 5G impacts to animal fertility found that 27 GHz damages sperm quality in mussels **(Pecoraro et al 2023).**

Yet the US government is not funding any research on biological effects of frequencies at 3.5 GHz or above 6 GHz to humans.

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UNITED STATES OF AMERICA

5G & CELL TOWERS



CALIFORNIA

Numerous CA cities restrict cell antennas near homes with setbacks and strict ordinances including: Los Altos, Petaluma, Mill Valley, Malibu, Santa Barbara, Nevada City, Suisin, Calabasas, San Clemente, Westlake, Sonoma, Sebastopol, San Rafael, Ross Valley, Encinitas, Fairfax, Palo Alto, Walnut City and San Diego County.

As an example of CA ordinances, the Los Altos City ordinance:

- prohibits installation of small cells on public utility easements in residential neighborhoods
- 500 foot setbacks for small cells for multi-family residences in commercial districts
- 500 ft separation from schools
- 1500 ft separation between nodes

San Diego County, California

- "SCWs shall not be located within 1,000 feet of schools, child care centers, hospitals, or churches."

CONNECTICUT

- Easton CN City Council passed a 5G cease and desist resolution
- Warren, Connecticut Policy defines "adequate coverage" and "adequate capacity." and was designed "to locate towers and/or antennas in a manner which protects property values, as well as the general safety, health, welfare and quality of life of the citizens." Coverage is considered to be "adequate" within that area surrounding a Base Station where the predicted or measured median field strength of the transmitted signal is such that the majority of the time, transceivers properly installed and operated will be able to communicate with the base station.

FLORIDA

- Coconut Creek FL Commission adopted a Resolution on 5G and radio-frequency radiation.
- Hallandale Beach FL Resolution urges the federal government to initiate independent health studies on 5G.
- Lavallette FL Resolution 2021-58: Applicant shall obtain certification from the Federal Aviation Administration and the United States Dept. of Defense demonstrating that the installation does not emit RF frequencies which may interfere with avionics of any approaching civil or military aircraft." The City also requires the applicant to provide RF meters used by their technicians and train City employees. Verizon cannot install more than a total of 20 "small cell" nodes throughout the Borough to support 5G.

HAWAI'I

- Hawai'i County Council passed a Resolution to halt 5G

IILLINOIS

- Oak Brook IL Resolution calls for local control re small cels.

INDIANA

Carmel City IN Council resolution asks state lawmakers, FCC and Congress to limit 5G until health effects fully understood.

MASSACHUSETTS

Randolph MA 500 ft setback. Yearly RFR measurements. Lunenburg and Great Barrington MA 500 ft setback Stockbridge MA prohibits a tower from being built 1000 feet from a school, park or athletic field and 600 ft from residence.

NEW JERSEY

- Little Silver, NJ Carriers should provide notice to property owners within 500 feet of proposed facility.

NEW YORK

- Scarsdale NY: 500 foot setbacks to homes preferred.
- Copake NY: Pre/post testing by RF engineer. No repeater closer than 200 ft to dwelling. No tower closer than 1500 ft to residence/church.
- Community Boards issuing Moratoriums on 5G poles

NEW HAMPSHIRE

- Proposed State Bill - 1640 ft setbacks.
- Keene NH Resolution to halt 5G
- Bedford NH 750 ft. setback

OHIO

- Mason OH Zoning Ordinance No small cells in residential areas or within 100 feet of residential prop; 2000 feet apart (unless colocated); equipment should be underground or wholly contained.

OKLAHOMA

- Sallisaw OK 1,500 feet setback

TENNESSEE

- Farragut City Resolution to halt 5G

WISCONSIN

- Greendale WI passed Resolution R2018-20 referring to the FCC's actions stripping local authority as "an unprecedented attack on local control."

WORLDWIDE POLICY

5G & CELL TOWERS



EUROPE

- Resolutions to halt 5G in numerous European cities including Trafford, UK, Lille, France, Ormidia, Cyprus, Councils in Ireland and more.

ITALY

- 600 municipalities have passed resolution to halt 5G.

UNITED STATES

- Los Angeles CA Public Schools: RFR Limit 10,000x less than FCC.
- Resolutions to halt 5G passed in Hawaii County HI, Farragut TN, Keene NH & Easton CT.
- Numerous cities restrict cell antennas near homes including: Los Altos, Petaluma, Mill Valley, Malibu and San Diego County CA, Bedford NH and more.
- New Hampshire 5G Commission's 15 Recommendations include increasing transparency, reduce public exposure, research health effects and protect wildlife and trees.
- Oregon investigating health effects of wireless.
- Palo Alto, Los Angeles LA Schools Greenbelt MD, Bar Harbor ME; No school cell towers

CHILE

- Cell antennas prohibited in “sensitive areas" - kindergartens, hospitals and nursing homes.

BANGLADESH

- No cell towers on homes, schools, colleges, playing fields, populated areas and heritage areas.

FRANCE

- 60 mayors/officials petition to halt 5G.
- Federal health agency investigating 5G
- 5G antenna RFR is measured.

SWITZERLAND

- Parliament refused to weaken radio frequency radiation (RFR) limits after 5G Report.

NETHERLANDS

- Health Council recommends against 26 GHz for 5G due to lack of safety data.

RUSSIA

- No cell towers near schools.

ISRAEL

- Cell tower setback 100m from schools/ homes.

CANADA

- City of Toronto "Prudent Avoidance Policy" for Cell Towers.

BULGARIA

- Mezdra and Balchik have banned 5G.

GREECE

- The installation of cell towers at the premises of schools, kindergartens, hospitals or eldercare facilities is prohibited.

CYPRUS

- Cyprus National Committee on Environment and Child Health 5G Position Paper calls for 5G free zones.

AUSTRALIA

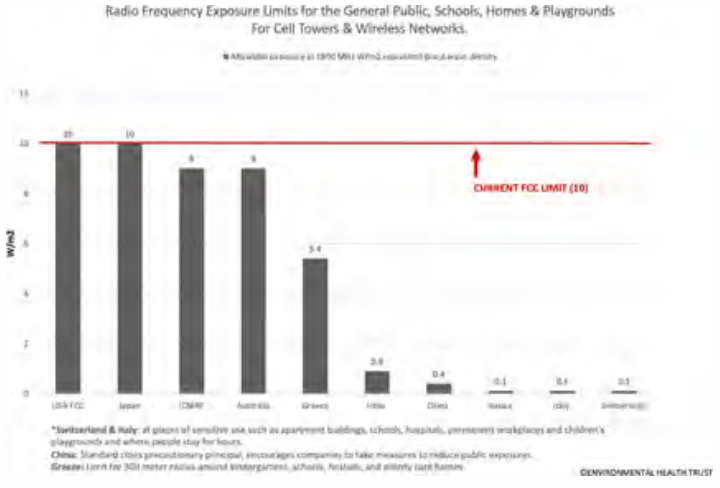
- New South Wales Dept. of Education policy objects to towers on/near schools.

LITHUANIA

- Cell antennas prohibited on kindergartens and hospitals.

INDIA

- RFR limit tightened to 1/10 of CNIRP limits after Inter-Ministerial Report on impacts to wildlife.
- Mumbai, Zilla Parishad & Karnataka: Cell towers prohibited/removed near schools, colleges, orphanages and old age homes.
- Brihanmumbai Municipal: Cell towers banned at parks and playgrounds.
- State of Rajasthan: Supreme Court of India upheld removal of “hazardous to life" cell towers from vicinity of schools, hospitals/playgrounds.



European Parliament

Health impact of 5G

STUDY

Panel for the Future of Science and Technology

EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)

PE 690.012 – July 2021

Health impact of 5G

Current state of knowledge of 5G-related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies

The upcoming deployment of 5G mobile networks will allow for significantly faster mobile broadband speeds and increasingly extensive mobile data usage. Technical innovations include a different transmission system (MIMO: use of multiple-input and multiple-output antennas), directional signal transmission or reception (beamforming), and the use of other frequency ranges. At the same time, a change is expected in the exposure to electromagnetic fields (EMF) of humans and the environment. In addition to those used to date, the 5G pioneer bands identified at EU level have frequencies of 700 MHz, 3.6 GHz (3.4 to 3.8 GHz) and 26 GHz (24.25 to 27.5 GHz). The first two frequencies (FR1) are similar to those used for 2G to 4G technologies and have been investigated in both epidemiological and experimental studies for different end points (including carcinogenicity and reproductive/developmental effects), while 26 GHz (FR2) and higher frequencies have not been adequately studied for the same end points.

The International Agency for Research on Cancer (IARC) classified radiofrequency (RF) EMF as 'possibly carcinogenic to humans' (Group 2B) and recently recommended RF exposure for re-evaluation 'with high priority' (IARC, 2019). Since 2011 a great number of studies have been performed, both epidemiological and experimental. The present review addresses the current knowledge regarding both carcinogenic and reproductive/developmental hazards of RF as exploited by 5G. There are various *in vivo* experimental and epidemiological studies on RF at a lower frequency range (450 to 6000 MHz), which also includes the frequencies used in previous generations' broadband cellular networks, but very few (and inadequate) on the higher frequency range (24 to 100 GHz, centimetre/MMW).

The review shows: 1) 5G lower frequencies (700 and 3 600 MHz): a) limited evidence of carcinogenicity in epidemiological studies; b) sufficient evidence of carcinogenicity in experimental bioassays; c) sufficient evidence of reproductive/developmental adverse effects in humans; d) sufficient evidence of reproductive/developmental adverse effects in experimental animals; 2) 5G higher frequencies (24.25-27.5 GHz): the systematic review found no adequate studies either in humans or in experimental animals.

Conclusions: 1) cancer: FR1 (450 to 6 000 MHz): EMF are probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas; FR2 (24 to 100 GHz): no adequate studies were performed on the higher frequencies; 2) reproductive developmental effects: FR1 (450 to 6 000 MHz): these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, foetuses and newborns; FR2 (24 to 100 GHz): no adequate studies were performed on non-thermal effects of the higher frequencies.

SCIENTIFIC RESEARCH STUDIES





European Parliament requested a research report "**Health Impact of 5G**" which was released in July 2021 and concluded that commonly used RFR frequencies (450 to 6000 MHz) are probably carcinogenic for humans and clearly affect male fertility with possible adverse effects on the development of embryos, fetuses and newborns.

A review entitled "**Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer**" reviewed the existing scientific literature and found radiofrequency sickness, cancer and changes in biochemical parameters (**Balmori 2022**).

A **study** published in Electromagnetic Biology and Medicine found changes in blood considered biomarkers predictive of cancer in people living closer to cell antenna arrays (**Zothansiama 2017**).

A **study** published in the International Journal of Environmental Research and Public Health found higher exposure to cell network arrays linked to higher mortality from all cancer and specifically lung and breast cancer (**Rodrigues 2021**).

A 10-year **study** published in Science of the Total Environment on cell phone network antennas by the local Municipal Health Department and several universities in Brazil found a clearly elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell phone towers (**Dode 2011**).

A **study** commissioned by the Government of Styria, Austria found a significant cancer incidence in the area around the RF transmitter as well as significant exposure-effect relationships between radiofrequency radiation exposure and the incidence of breast cancers and brain tumors (**Oberfeld 2008**).

A **review** published in Experimental Oncology found "alarming epidemiological and experimental data on possible carcinogenic effects of long term exposure to low intensity microwave (MW) radiation." A year of operation of a powerful base transmitting station for mobile communication reportedly resulted in a dramatic increase of cancer incidence among the population living nearby (**Yakymenko 2011**).

PUBLISHED RESEARCH STUDIES

OUTDOOR LEVELS OF RF ARE INCREASING DUE TO THE DENSIFICATION OF WIRELESS NETWORKS

An **article** published in *The Lancet Planetary Health* documents how RF exposures are increasing and so is the scientific research linking exposure to adverse biological effects. "It is plausibly the most rapidly increasing anthropogenic environmental exposure since the mid-20th century..."

A **2021 report** by the French government on 5G analyzed more than 3,000 measurements and found that while RF levels had *not yet* significantly increased, this was due to the lack of 5G traffic. Additional study specific to 5G in the 3500 MHz band with artificially generated traffic concluded that, "initial results suggest an eventual increase of about 20% in overall exposure."

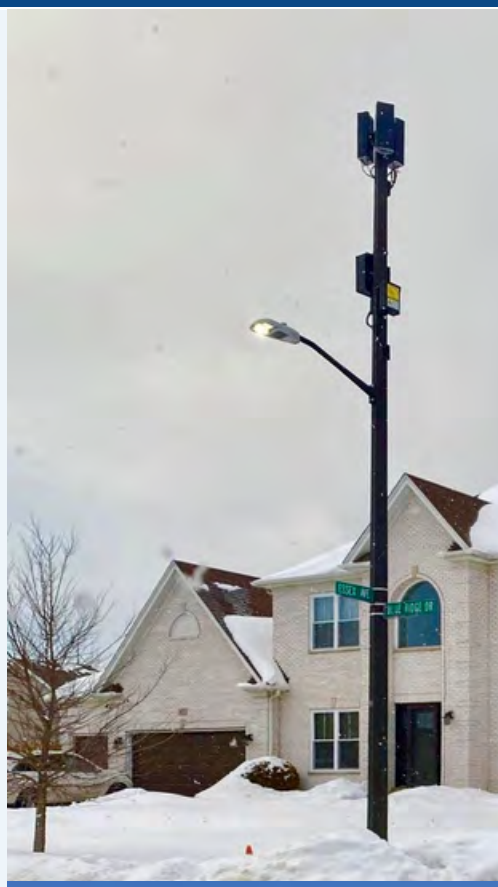
A **2018 multi-country study** published in *Environment International* measured RF in several countries and found cell tower/base station radiation to be the dominant contributor to RF exposure in most outdoor areas. Urban areas had higher RF.

A **study** measuring RF exposure in the European cities of Basel, Ghent and Brussels found the total RF exposure levels in outdoor locations had increased up to 57.1% in one year (April 2011 to March 2012) and most notably due to mobile phone base stations.

A **2018 study** published in *Oncology Letters* documented "unnecessarily high" RF levels in several locations in Sweden and concludes that "using high-power levels causes an excess health risk to many people."

A **2017 Swedish** study of Royal Castle, Supreme Court, three major squares and the Swedish Parliament found that despite the architecturally camouflaged RF-emitting antennas, the passive exposure was higher than RF levels associated with non-thermal biological effects. The researchers noted that the heaviest RF load falls on people working or living near hotspots.

A **2016 study** at Stockholm Central Railway Station in Sweden documented higher RF levels in areas where base station antennas were located closest to people. Importantly, the RF from the downlink of UMTS, LTE, GSM base station antennas contributed to most of the radiation levels.





Bold blue on this PDF are hyperlinked.

NEW HAMPSHIRE STATE COMMISSION

2020 REPORT: 5G HEALTH AND ENVIRONMENT

In 2020, the New Hampshire State Commission issued a Final Report with 15 recommendations to "to protect people, wildlife, and the environment from harmful levels of radiation" after a year-long investigation with numerous meetings and expert testimony.


State of New Hampshire

MEMORANDUM

"A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured."

Recommendations To Update RF Exposure Regulations With New Science

- A resolution to U.S. Congress to require the FCC to commission an independent health study and review of safety limits.
- New measurement protocols needed to evaluate high data rate, signal characteristics associated with biological effects and summative effects of multiple radiation sources.

Recommendations To Address Impacts to Wildlife And Environment

- Engage agencies with ecological knowledge to develop RF-radiation safety limits that will protect the trees, plants, birds, insects and pollinators.
- Under the National Environmental Policy Act, FCC should do an environmental impact statement as to the effect on New Hampshire and the country as a whole from 5G and the expansion of RF wireless technologies.

Recommendations To Reduce Public Exposure

- Require setbacks of 1,640 feet for new wireless antennas from residences, businesses and schools.
- Cell phones and wireless devices should be equipped with updated software that stops cell phones from radiating when positioned against the body.
- Establish RF radiation-free zones in commercial and public buildings.
- New Hampshire health agencies should educate the public on minimizing RF exposure with public service announcements on radio, television, print.

Recommendations To Utilize Safer Alternatives

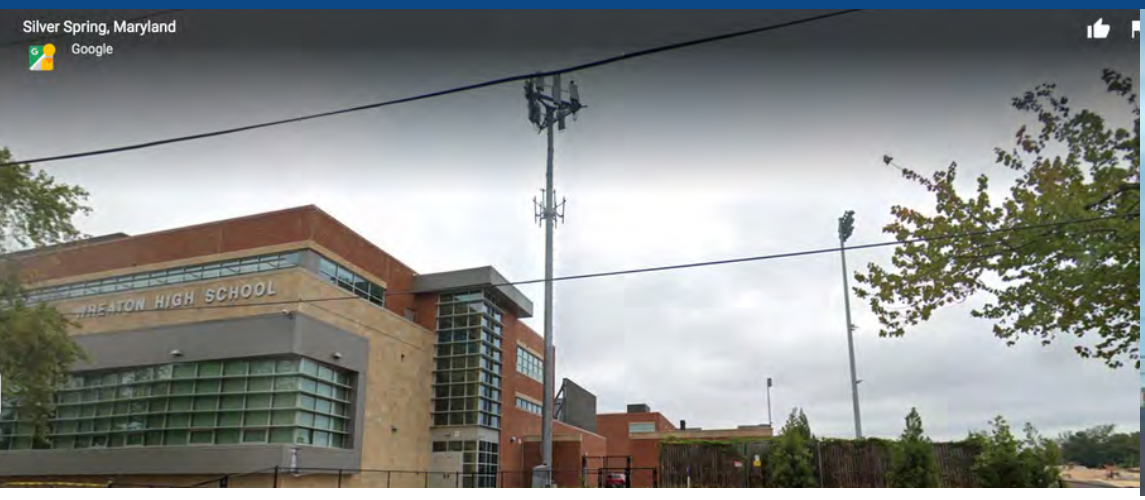
- New Hampshire schools and libraries should replace Wi-Fi with hardwired connections.
- Support statewide deployment of fiber optic cable connectivity with wired connections inside homes.

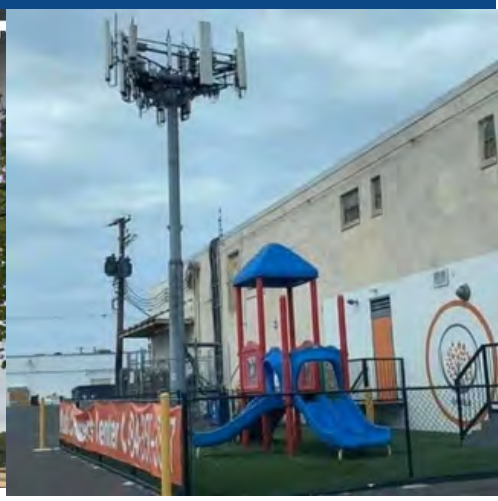
Recommendations To Increase Transparency

- State should measure RFR and post maps with RF measurements..
- Require 5G structures to be labeled for RFR at eye level and readable from nine feet away.
- RFR signal strength measurements for cell sites should be done by independent contractors.
- NH professional licensure to offer RF measurement education for home inspectors.
- Warning signs posted in commercial and public buildings.

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS





CONEJO PTA WANTS CELL TOWER MOVED
Op-ed in Thousand Oaks Acorn Journal

The California PTA advocates on behalf of children and families. They advocate against electromagnetic field radiation your schools.

The Conejo PTA urges the use of the precautionary principle in making decisions regarding public health this means if something cannot be proven to be safe it is best to avoid exposure. Most people don't realize that the 1996 FCC state standards for safe levels of omission was actually based on a level set by the American national standards institute in 1982. Well this standard has not been changed in 30 years it has usurped all local authority."

"For this reason, Conejo Council PTA made up of 9000 parents and teachers has decided to take action. We're calling on our local leaders to put in place policies that would ensure parents are notified when cell towers are propose near schools and then encourage a buffer zone around schools."

-Kim Huber, legislative chair of the Conejo Council PTA.

NEW YORK STATE PTA
-Adopted TWO Resolutions 2014

"CELLULAR PHONE TOWERS – 2014 (R-'07, R-'00); Resolved that the New York State Congress of Parents and Teachers, Inc. support legislation that would encourage local communities, including parents and school officials, to regulate the placement of cell towers and cell tower antennas particularly in schools and areas where children congregate,

and be it further Resolved that the New York State PTA support continued research into the long-term effects of radio frequency and microwave frequencies on humans especially as they apply to children, and be it further Resolved that the New York State PTA seek to educate parents and school officials as to the current debate over the placement of cell towers and antennas."

NEELSVILLE MIDDLE SCHOOL PTA (MD)

- Voted to oppose proposed cell tower.
- Hosted parent information session with both the cell tower company and Environmental Health Trust.

HILLSMERE ELEMENTARY SCHOOL PTA (MD)

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

BRIARLAKE ELEMENTARY (GA)

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

PACIFIC GROVE (CA) PTAs

- Forest Grove Elementary Pacific Grove Middle School and Pacific Grove High School PTAs sent a letter to City Council opposing a high school cell tower.

PARENT TEACHER ASSOCIATIONS

OPPOSE CELL TOWERS

Exhibit A

August 6, 2018

Pacific Grove City Council
City Hall
300 Forest Ave.
Pacific Grove, CA 93950

Dear members of Pacific Grove City Council,

I am writing you on behalf of Pacific Grove High School PTA in regard to the Pacific Grove Planning Commission's vote on July 26, 2018, which approved a request by Verizon Wireless to install and maintain a cell tower adjacent to Pacific Grove High School (PGHS). For the reasons described below, the Pacific Grove High School PTA **is strongly opposed** to the location of the Verizon cell tower and is requesting that the City Council consider and support the appeal that is being filed by a group of concerned parents who live in Pacific Grove and send their children to PG schools.

The installment of a cell tower adjacent to PGHS poses significant potential health dangers to both students and staff at PGHS. While some argue that radiation emitted from a cell tower is not a health danger, data from many studies indicate the opposite. Research shows that children and pregnant women are the most vulnerable – two demographics most likely to be on PGHS school grounds on a regular basis. The actual placement of the cell tower– near the back of PGHS and very close to Forest Grove Elementary School- only increases the concerns of the frequency in exposure.

Cell towers also pose a risk to students due to fire hazard. Many cell towers throughout the United States have caught fire and collapsed, posing a significant safety concern, especially in an area with young students walking to and from school every day.

The mission of all PTAs nationwide is to make every child's potential a reality by engaging and empowering families and communities to advocate for all children. Our local PTA is very active in expressing our support for or opposition to issues dealing with the health, safety, education, or general well-being of children and youth in our community.

The members of the Pacific Grove High School PTA strongly urge you to please reconsider the Pacific Grove Planning Commission's previous vote and rescind approval for the Verizon cell tower at Pacific Grove High School.

Sincerely,

Julie Kavanaugh
President, Pacific Grove High School PTA

Example of an EMF Exclusion in an Insurance Plan

THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ELECTROMAGNETIC RADIATION EXCLUSION

This endorsement modifies insurance provided under the following:

GENERAL LIABILITY COVERAGE PART
PUBLIC RISK GENERAL LIABILITY RETAINED LIMIT COVERAGE FORM
LAW ENFORCEMENT COVERAGE PART
LAW ENFORCEMENT LIABILITY RETAINED LIMIT COVERAGE FORM
PUBLIC OFFICIALS COVERAGE PART
PUBLIC OFFICIALS LIABILITY RETAINED LIMIT COVERAGE FORM
EMPLOYMENT PRACTICES LIABILITY COVERAGE PART
EMPLOYMENT PRACTICES LIABILITY RETAINED LIMIT COVERAGE FORM

The following **Exclusion** is added:

This policy does not apply to and we will not provide a defense for:

a. "Bodily injury," "property damage", "personal and advertising injury", "employee benefits wrongful acts", "personal injury", "law enforcement wrongful acts", "public officiels wrongful acts", "educator's legel wrongful acts", or "employment practices wrongful acts" arising out of, or which result in, the actual, alleged, threatened, perceived, latent, sudden and accidental or incidental exposure to or contact with electromegnetic radiation in any form, from any source.

b. The costs of abatement or mitigation of:

(1) Electromagnetic radiation; or

(2) Exposure to electromagnetic rediation.

c. Any supervision, instruction, recommendation, waming or advice given or which should have been given in connection with **a.** or **b.** above.

Electromagnetic radiation includes but is not limited to, magnetic energy, waves, fields or forces generated, produced, transmitted or maintained by the charges, currents, frequencies, energy or forces of electricity that is generated, flowing or otherwise transmitted through or via the medium, methods and equipment designed to generate, produce, distribute, trensport or transmit the electrical charges, currents, frequencies, energy or forces.



Verizon Total Mobile Protection Plan

16. Pollution

The discharge, dispersal, seepage, migration or escape of pollutants. Pollutants means any solid, liquid, gaseous, or thermal irritant or contaminant including smoke, vapor, soot, fumes, acid, alkalis, chemicals, artificially produced electric fields, magnetic field, electromagnetic field, sound waves, microwaves, and all artificially produced ionizing or non-ionizing radiation and/or waste. Waste includes materials to be recycled, reconditioned or reclaimed.

THE NEED FOR ACCOUNTABILITY ON WIRELESS SAFETY

EXPERT VOICES





"The National Toxicology Program studies clearly showed that non-ionizing cell phone radiofrequency radiation radiation can cause cancers and other adverse health effects. An important lesson that should be learned is that we cannot assume any current or future wireless technology such as 5G is safe without adequate testing."
— Ronald Melnick PhD 28 year scientist at National Institutes of Health

"I recommend public health organizations raise awareness and educate the public on why and how to reduce our daily exposure to wireless radio frequency radiation. Protective public health policy is needed now. It is time for regulatory bodies to fully evaluate the research and develop science based exposure limits that truly protect the public and the environment."
— Linda S. Birnbaum, PhD, Former Director, National Institute of Environmental Health Sciences and National Toxicology Program of the National Institutes of Health.

"Now we have 5G rolling out in massive quantities, without due diligence to determine are these sources of radiation safe not only for humans but for wildlife. And the answer is, no, they are not."
— Albert M. Manville II, Ph.D. Adjunct Professor, Johns Hopkins University, Wildlife Biologist (17 years), retired from Division of Migratory Bird Management, U.S. Fish & Wildlife Service

"Given the human, animal and experimental evidence, I assert that, to a reasonable degree of scientific certainty, the probability that RF exposure causes gliomas and neuromas is high."
— Christopher Portier PhD former Director of the United States National Center for Environmental Health at the CDC, former Director of the U.S. Agency for Toxic Substances and Disease Registry.

"We should not wait to protect children's brains. The science is now clear and compelling indicating that wireless technology is harmful to health, especially to for children. Wireless radiation is repeating the history of lead, tobacco and DDT."
— Devra Davis PhD, MPH, President of Environmental Health Trust, founding director of the Board on Environmental Studies and Toxicology of the U.S. National Research Council, National Academy of Sciences, and a member of the team of the Intergovernmental Panel on Climate Change scientists who were awarded the Nobel Peace Prize in 2007

CITIES AND TOWNS WITH STRONG ORDINANCES

SETBACKS FOR CELL ANTENNAS





Many communities have setbacks for cell towers and small cells.

Shelburne, MA: 3,000 feet for schools and 1,500 feet for homes; no new wireless antennas in residential zones
Copake, NY: 1,500 feet from homes, schools, churches or other buildings containing dwelling units
Sallisaw, OK: No commercial wireless telecommunications towers within 1,500 of homes.
Calabasas, CA: No "Tier 2" wireless telecommunications facilities within 1,000 feet of homes and schools
Bedford, NH: 750 feet from residentially-zoned property
Scarsdale, NY: No wireless facilities within 500 feet from homes, schools, parks, and houses of worship
Walnut City, California: 1,500 feet
Stockbridge, Massachusetts: 1,000 feet
San Diego County California: 1,000 feet (small cells)
Bar Harbor Maine: 1500 setback for schools

School Boards
Palo Alto, California: School Board supports the City of Palo Alto immediately establishing local municipal zoning setback rules of 1,500 feet or more from an operating wireless transmitter and a school site.
West Linn-Wilsonville Oregon School Board prohibits cell towers on school property.
Los Angeles California School District: Resolutions opposing cell towers on school property and a cautionary level for radiofrequency radiation 10,000 times lower than FCC limits.

Bold blue on this PDF are hyperlinked. For more setbacks go to ehtrust.org

ENVIRONMENTAL HEALTH TRUST

The 2022 study "**Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, South Carolina, USA**" published in World Academy of Sciences Journal authored by Tarmo Koppel and Lennart Hardell, MD of the Environment and Cancer Research Foundation found the highest RF exposure readings were registered close to cell phone base station antennas mounted on top of utility poles, street lamps or traffic lights.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 7. Gervais Street: Cell phone base station antenna placed close to street level and causing high exposure to pedestrians and nearby café visitors (exposure scenario illustration). The antenna appears camouflaged and seemingly part of a utility pole. The measurer only discovered the antenna due to the high radiofrequency levels in the vicinity.



WORLD ACADEMY OF SCIENCES JOURNAL 4: 23, 2022

Measurements of radiofrequency electromagnetic fields, including 5G, in the city of Columbia, SC, USA

TARMO KOPPEL[1,3] and LENNART HARDELL[2]

Figure 8. Gervais Street: Another cell phone base station antenna close to street level and causing high exposure to pedestrians (exposure scenario illustration). Note the antenna appears undistinguishable from the utility pole an unnoticeable between the trees.

5G, Small Cells & Cell Towers Can Drop Property Values

Would you buy a home with cell antennas outside the bedroom window?



Legal filings by cities and municipalities to the FCC highlight how small cell deployment could impact aesthetics and property values.

"many deployments of small cells could affect property values, with significant potential effect…"

— Reply Comments of Smart Communities Siting Coalition (local governments and associations representing 1,854 communities) 4/7/2017,Docket No. 16-421, April 7, 2017

"Considering that the Smart Communities' prior filings show that the addition of facilities of this size diminish property values, it is strange for the Commission to assume that approval can be granted in the regulatory blink of an eye…."

"…allowing poles to go up in areas where poles have been taken down has significant impacts on aesthetics (not to mention property values)."

— *Ex Parte* Submission of Smart Communities Letter to Ms. Marlene H. Dortch, Secretary, Federal Communications Commission, September 19, 2018

5G, CELL TOWERS AND WIRELESS

DECREASED PROPERTY VALUE



"An overwhelming 94 percent of home buyers and renters surveyed by the National Institute for Science, Law & Public Policy (NISLAPP) say they are less interested and would pay less for a property located near a cell tower or antenna."

"of the 1,000 survey respondents, 79 % said that under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas, and almost 90% said they were concerned about the increasing number of cell towers and antennas in their residential neighborhood."

"Cell Towers, Antennas Problematic for Buyers" — Realtor Magazine

"...cell towers are concerning to many people and drop property values."

"While most states do not require disclosure of neighborhood nuisances, such as cell towers or noisy neighbors, a few states do, and more are likely to in the future."
— Real Estate Attorney, South Florida Sun Sentinel, 2021

The California Association of Realtors' Property Sellers Questionnaire specifically lists "cell towers" on the disclosure form for sellers of real estate.
— Click to go to the California Association of Realtors' Property Sellers Questionnaire
(p. 3-4 under K. Neighborhood)

"While the magnitude of the impact varies, the studies uniformly indicate that there is a significant impact on residential property values from installation of cell phone towers..."
— David E. Burgoyne, ASA, SR/WA Certified General Real Estate Appraiser

"In some areas with new towers, property values have decreased by up to 20%."

"Your new neighbor, a cell tower, may impact the value of your home" National Business Post, 2022.

PDF is hyperlinked. More on property values at ehtrust.org

ENVIRONMENTAL HEALTH TRUST

THE URGENT NEED FOR SAFER TECHNOLOGY

EXPERT VOICES

"I am calling on my industry to bring safer technology to market. The current implementation of technology is not safe. Take a good look at the science. This is about our children's future. Do not be lulled into believing that 25-year-old standards can protect the youngest and most vulnerable. They simply cannot."
— Frank Clegg, Former President of Microsoft Canada, CEO of Canadians for Safe Technology

"A moratorium is urgently needed on the implementation of 5G for wireless communication."
— Lennart Hardell, MD, PhD , advisory to World Health Organization international Agency for Research on Cancer, Department of Oncology, University Hospital, Örebro, Sweden (retired) , leads the Environment and Cancer Research Foundation

"The evidence indicating wireless is carcinogenic has increased and can no longer be ignored. If the World Health Organization International Agency for Research on Cancer were to meet to review all of the evidence, we believe the weight of evidence supports a new determination- that wireless radiofrequency radiation is a human carcinogen."
— Anthony B. Miller MD, Professor Emeritus, Dalla Lana School of Public Health of the University of Toronto. Former Senior Epidemiologist for the International Agency for Research on Cancer and former Director of the Epidemiology Unit of the National Cancer Institute of Canada

"Most parents believe that cellphones were safety-tested before they came on the market. We assume that our federal health and environmental agencies regularly review the latest research and ensure that these incredible devices are safe. They do not. Children are not little adults. As we sadly learned with early childhood lead exposures leaving long-lasting impairments, the developing brain is particularly susceptible."
— Jerome Paulson, MD , Professor Emeritus, George Washington University, Milliken School of Public Health, former Chair of American Academy of Pediatrics Committee on Environmental Health

"The exposure levels of the Federal Communications Commission are totally outdated and do not protect the health of the public, especially of children. I urge you to take strong and active steps to reduce exposure of children and staff to excessive levels of radiofrequency EMFS within your schools."
— David O. Carpenter, M.D. Director, Institute for Health and the Environment University at Albany





FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION



FCC human exposure limits were adopted in 1996 after the EPA was defunded from creating safety limits. They have not properly reviewed these limits since 1996.

FCC's human exposure limits for the RF microwaves emitted by 5G, 4G, cell towers, cell phones, Wi-Fi, Bluetooth, smart devices and wireless networks are based on outdated science and faulty assumptions.

The limits are irrelevant to modern-day technologies and do not reflect the way people are exposed to RF and actually use technology in the 21st century.

Reasons Why FCC's 1996 Limits Do Not Protect:

Heating-Based Only

FCC limits are heat-based "thermal" limits. This means they primarily protect against the overheating of tissue from RF. FCC's limits are not based on protecting against non-heating biological effects such as cancer, oxidative stress, headaches, behavioral problems, memory damage, disrupting bee behavior, tree damage etc.

Short-Term Impacts Only

FCC limits are based on protecting against acute effects. No federal report or research review exists regarding safety from chronic, long-term RF exposures from cell towers, Wi-Fi and wireless networks in the home, school and workplace. The FDA nominated the National Toxicology Program (NTP) to perform animal studies designed to mimic a lifetime of human cell phone exposure. Cancer and DNA damage was found. Another large-scale animal study used cell tower level exposures and found the same tumors as the NTP. However, the FDA rejected these findings.

Children Are Not Protected

FCC limits are misleadingly presented as being "designed to protect children. When safety thresholds were developed decades ago, the science investigating RF impacts to children's developing brains did not exist. Current research concludes the limits should be hundreds of times more protective for children because they are more vulnerable.

FCC EXPOSURE LIMITS DO NOT PROTECT

OUTDATED FCC REGULATIONS FOR RF RADIATION

No Risk Analysis or Review of Totality of Science
No agency has reviewed all of the latest science. Usually the EPA and FDA use risk assessment to characterize the nature and magnitude of risks to human health for various populations such as children and pregnant women. The EPA also estimates ecological risks, including plants, birds, other wildlife and aquatic life. When groundbreaking studies are published, a quantitative risk analysis of the data is performed. This has never been done for RF.

"The FCC and FDA have failed in their obligation to prescribe safe RFR guidelines produced from wireless communication devices to protect the public health and safety. Devices are becoming more sophisticated, and their usage is as common to daily life as brushing your teeth."
— Pittsburgh Law Review "The FCC Keeps Letting Me Be: Why Radiofrequency Radiation Standards Have Failed to Keep Up With Technology" by Hala Mouzaffar

"The wireless industry reaction features stonewalling public relations and hyper aggressive legal action. It can also involve undermining the credibility and cutting off the funding for researchers who do not endorse cellular safety. It is these hardball tactics that look a lot like 20th century Big Tobacco tactics. It is these hardball tactics—along with consistently supportive FCC policies—that heighten suspicion the wireless industry does indeed have something to hide."

— Norm Alster in the Harvard Press Book "Captured Agency: How the Federal Communications Commission is Dominated by the Industries it Presumably Regulates"





ENVIRONMENTAL HEALTH TRUST

A REGULATORY GAP
No Federal Agency Ensuring Cell Tower Wireless Safety

There is no U.S. government agency with oversight for cell tower radiation health effects: no research reviews, no reports, no environmental monitoring, no risk mitigation and no post market health surveillance for the daily, full body radio-frequency (RF) radiation exposure from cell towers.

"The FDA does not regulate cell towers or cell tower radiation. Therefore, the FDA has no studies or information on cell towers to provide in response to your questions."
— Ellen Flannery, Director, FDA Policy Center for Devices and Radiological Health to a California mother with a cell tower on her street who asked the FDA about safety, July 11, 2022

"As a Federal research agency, the NCI is not involved in the regulation of radio frequency telecommunications infrastructure and devices, nor do we make recommendations for policies related to this technology"
— National Cancer Institute letter to Denise Ricciardi, member of the New Hampshire State Commission on 5G, July 30, 2020

The ACS does "not have any official position or statement on whether or not radiofrequency radiation from cell phones, cell phones towers, or other sources is a cause of cancer."
— American Cancer Society Website

"EPA's last review was in the 1984 document Biological Effects of Radiofrequency Radiation. The EPA does not currently have a funded mandate for radiofrequency matters."
— Lee Ann B. Veal Director, EPA Radiation Protection Division Office of Radiation and Indoor Air, July 8, 2020 Letter to Theodora Scarato

Fact: There are no scientific reports by the CDC on cell tower radiation safety, nor does the agency have staff with expertise monitoring the science and evaluating risk. Public information requests found that **several CDC website pages on radio frequency were found to be drafted with a wireless industry consultant.**

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today." **— U.S. Department of Interior Letter to FCC, 2014**

Fact: The World Health Organization (WHO) EMF Project has not reviewed the science since 1993. The WHO webpages on cell phones and cell towers are not based on a published scientific review. The WHO EMF Project webpages were written by a scientist who **used wireless industry money** to start the WHO EMF Project and who is now a consultant to industry. **In contrast, the WHO International Agency for Research on Cancer (a separate WHO entity vetted for conflicts of interest) determined RF radiation to be a Class 2 B "possible" carcinogen in 2011.** Many scientists now state **the evidence showing cancer has increased.**

Blue text *is hyperlinked to source.*

FACTSHEET: ENVIRONMENTAL HEALTH TRUST ET AL. V. FCC

COURT RULING ON FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS EXPOSURE LIMITS

LANDMARK FEDERAL COURT RULING AGAINST THE FCC

On August 13, 2021 the U.S. Court of Appeals for the D.C. Circuit ruled the Federal Communications Commission (FCC) ignored scientific evidence and failed to provide a reasoned explanation for its determination that its 1996 regulations adequately protect the public against all the harmful effects of wireless radiation.

FCC'S REFUSAL TO UPDATE 1996 LIMITS

The legal case challenged the FCC's 2019 decision not to update its 1996 regulations regarding allowable radiofrequency radiation (RF) exposures from wireless technologies - including 5G, cell phones, cell towers, Wi-Fi, and wireless networks.

EVIDENCE OF HARMFUL EFFECTS BELOW FCC LIMITS

FCC limits are based on the belief that heating is the only proven harm from RF. Over 11,000 pages of evidence - 447 exhibits in 27 Volumes - was submitted to the Court documenting biological effects and illness from wireless radiation exposure below heating levels. Research has found brain damage, headaches, memory problems, reproduction damage, synergistic effects, nervous system impacts, brain cancer, genetic damage, as well as harm to trees, birds, bees, and wildlife.

THE COURT FINDINGS

The ruling stated that the FCC's "arbitrary and capricious" decision to maintain their 25 year old exposure limits did not address evidence indicating "non-cancer" harm such as:

- impacts to children
- testimony of persons injured by wireless radiation
- impacts to the developing brain
- impacts to the reproductive system
- impacts to wildlife and the environment

THE COURT ORDER

The Court ordered the FCC to provide a reasoned determination as to whether the evidence warrants a change to 1996 RF limits especially in regards to:

- children's vulnerability
- long-term exposure
- environmental impacts
- new technological developments and the ubiquity of wireless
- how FCC's cell phone tests only measure heat and allow a space between the phone and body

TIMELINE

1980s: EPA had robust research program and was tasked to develop RF safety limits by U.S. Science Advisory Board.

1995: EPA presents to FCC on the EPA timeline for its development of human exposure RF limits which would include both thermal effects and non thermal effects.

1996: EPA is fully defunded by Congress amid heavy lobbying for Telecom Act and halts all research on RF.

1996: The FCC adopts RF limits developed by industry-tied groups - based on short term heating - thermal- effects from high power exposures (based on studies of small animals exposed to high RF levels for under an hour).

1999: FDA requests the National Toxicology Program (NTP) study RF because of the lack of safety data on long-term exposure.

2008/2009 Congressional Hearings

2011: Wireless RF classified as a "possible" Class 2B Carcinogen by International Agency for Research on Cancer.

2012: GAO Report recommends rules be reassessed to reflect current use patterns and recent science.

2013-2019: FCC opens record on RF limits - gets over 1000 submissions.

2018: NTP/NIH releases $30M animal study concluding "clear evidence" of cancer. FDA rejects the findings.

2019: FCC closes record, decides not to update its 1996 wireless RF limits.

2020: Cases filed against FCC.

2021: U.S. Court of Appeals, D.C Circuit ruled that the FCC decision not to change human exposure limits and regulations was "arbitrary and capricious." FCC ordered to respond.

2021: No FCC response to Court, so EHT and others filed request to refresh record.

Timeline is hyperlinked to sources.

FCC'S LACK OF ADEQUATE REVIEW FOR WIRELESS RADIATION EXPOSURE LIMITS

FCC Compliance Does Not Ensure Safety

Most of the public assumes that current FCC safety limits for cell phones, cell towers, Wi-Fi, 5G, and wireless networks are based upon an up to date robust review of all relevant research. This assumption of safety is now clearly documented to be erroneous.

Lack of Oversight by Health and Environmental Agencies

The ruling reveals a lack of accountability with our federal health agencies regarding wireless radiation. The EPA, CDC, NIOSH, and NCI did not submit any reports to the Court, revealing that none of these agencies has reviewed the science on health effects to ensure safety for the public. The U.S. has no pre- market safety testing for health effects, no post-market surveillance, no environmental monitoring, and no meaningful interagency coordination.

FDA's Dismissal of Harm Deemed Insufficient

The Court states the FCC improperly relied on the FDA's conclusions that RF limits did not need an update. The FDA's submissions were described by the Court as "cursory" and "insufficient." Although the FDA later released a literature review, it was only focused on cell phones, not cell towers, Wi-Fi nor 5G technology. It also was only focused on cancer, further confirming the fact that U.S. agencies have failed to evaluate the myriad of effects documented in scientific studies, such as brain, immune, fertility and endocrine impacts. A U.S. government review of *the full body of recent science* has simply never been done.

"the Commission's failure to provide a reasoned or even relevant explanation of its position that RF radiation below the current limits does not cause health problems unrelated to cancer renders its explanation as to the effect of RF radiation on children arbitrary and capricious. "

— 2021 EHT et al. v. FCC

The Court Did Not Agree That "Cell Phones Do Not Cause Cancer"

Contrary to the wireless industry's recent claims, the Court *did not make a scientific determination regarding cancer*. The ruling simply stated that in regards to cancer- the FCC passed the minimum legal requirement for adequate review because it (at least) referenced why the FCC dismissed cancer evidence. The FCC cited the rejections of NIH studies by the FDA and of ICNIRP (a small group with no oversight and whose members have a long history of industry ties).

Children's Vulnerability and Effects of Long Term Exposure Ignored by the FCC

The Court states the FCC "dismissed" the American Academy of Pediatrics recommendations to strengthen regs and ensure children and pregnant women are protected. The Court found the FCC failed to explain why it ignored research indicating children's developing brains are more sensitive. Children will have a lifetime of exposure, yet the FCC was found to ignore the issue of impacts *from long term exposure*.

Wildlife Remains Unprotected

FCC's limits were designed in 1996 to protect only humans, not flora or fauna. The Court found that the FCC had "completely failed" to address the "substantive evidence of potential environmental harms" on the record, which included science showing serious impacts to birds, bees, trees, and plants.

PETITIONERS: Environmental Health Trust, Consumers for Safe Cell Phones, Elizabeth Barris, Theodora Scarato, Children's Health Defense, Michelle Hertz, Petra Brokken, Dr. David Carpenter, Dr. Toril Jelter, Dr. Paul Dart, Dr. Ann Lee, Virginia Farver, Jennifer Baran, Paul Stanley M.Ed.

KEY RESOURCES: Court Ruling 8/13/2021, Evidence (11,000 pages), EHT Press Conference

Amicus Briefs

- Amicus of NRDC: Natural Resources Defense Council
- Amicus of Attorney Joe Sandri including declaration of Dr. Linda Birnbaum, former Director of the National Institute of Environmental Health Sciences
- Amicus of Catherine Kleiber
- Amicus of the Building Biology Institute

EHTrust.org for more.

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American Academy of Pediatrics Webpage Excerpts

Electromagnetic Fields: A Hazard to Your Health?

In recent years, concern has increased about exposure to radio frequency electromagnetic radiation emitted from cell phones and phone station antennae. An Egyptian study confirmed concerns that living nearby mobile phone base stations increased the risk for developing:

- Headaches
- Memory problems
- Dizziness
- Depression
- Sleep problems

Short-term exposure to these fields in experimental studies have not always shown negative effects, but this does not rule out cumulative damage from these fields, so larger studies over longer periods are needed to help understand who is at risk. In large studies, an association has been observed between symptoms and exposure to these fields in the everyday environment.

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Environmental Pollution

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Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective☆

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ABSTRACT

Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the World Health Organization. There is strong evidence that excessive exposure to mobile phone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. *In vivo* and *in vitro* studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. There is increasing evidence the exposures can result in neurobehavioral decrements and that some individuals develop a syndrome of "electro-hypersensitivity" or "microwave illness", which is one of several syndromes commonly categorized as "idiopathic environmental intolerance". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that excludes the symptoms as being only psychosomatic. Unfortunately standards set by most national and international bodies are not protective of human health. This is a particular concern in children, given the rapid expansion of use of wireless technologies, the greater susceptibility of the developing nervous system, the hyperconductivity of their brain tissue, the greater penetration of radiofrequency radiation relative to head size and their potential for a longer lifetime exposure.

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Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Non-ionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.



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Case Report

How does long term exposure to base stations and mobile phones affect human hormone profiles?

Emad F. Eskander ✉, Selim F. Estefan, Ahmed A. Abd-Rabou

Objectives

This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations v human's hormone profiles.

Results

This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels.

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Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads

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Fig. 3. Street view on the Skeppsbron street with some of the mobile phone base station antennas pointed out with a circle; note the low placement of the antennas, where microwaves irradiate the pedestrian at close range.

A B S T R A C T

In urban environment there is a constant increase of public exposure to radiofrequency electromagnetic fields from mobile phone base stations. With the placement of mobile phone base station antennas radiofrequency hotspots emerge. This study investigates an area at Skeppsbron street in Stockholm, Sweden with an aggregation of base station antennas placed at low level close to pedestrians' heads. Detailed spatial distribution measurements were performed with 1) a radiofrequency broadband analyzer and 2) a portable exposimeter. The results display a greatly uneven distribution of the radiofrequency field with hotspots. The highest spatial average across all quadrat cells was 12.1 V m^{-1} (388 mW m^{-2}), whereas the maximum recorded reading from the entire area was 31.6 V m^{-1} (2648 mW m^{-2}). Exposimeter measurements show that the majority of exposure is due to mobile phone downlink bands. Most dominant are 2600 and 2100 MHz bands used by 4G and 3G mobile phone services, respectively. The average radiofrequency radiation values from the earlier studies show that the level of ambient RF radiation exposure in Stockholm is increasing. This study concluded that mobile phone base station antennas at Skeppsbron, Stockholm are examples of poor radiofrequency infrastructure design which brings upon highly elevated exposure levels to popular seaside promenade and a busy traffic street.

Studies from recent decades have shown elevated health risk under long term exposure to such highly elevated radiofrequency fields.

A review by Khurana et al. (2010) found in 80% of the available studies neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations (Khurana et al., 2010). In another review exposure from base stations and other antenna arrays showed changes in immunological and reproductive systems as well as DNA double strand breaks, influence on calcium movement in the heart and increased proliferation rates in human astrocytoma cancer cells (Levitt and Lai, 2010).

When a GSM 900 MHz base station was installed in the village Rimbach in Germany it had an influence on the neurotransmitters adrenaline, noradrenaline, dopamine and phenyletylamine (Buchner and Eger, 2011). Influence on cortisol and thyroid hormones in people living near base stations was shown in other studies (Augner et al., 2010; Eskander et al., 2012).

Dode et al. (2011 compared base station (BS) clusters and cases of deaths by neoplasia in the Belo Horizonte municipality, Minas Gerais state, Brazil, from 1996 to 2006. In their study largest electric field was 12.4 V m^{-1} and the smallest was 0.4 V m^{-1}. They found cancer-related death rates be higher close to base stations. This finding confirmed earlier findings by Eger (Eger et al., 2004).

In a study from India, genetic damage using the single cell gel electrophoresis (comet) assay was assessed in peripheral blood leukocytes of individuals residing in the vicinity of a mobile phone base station and comparing it to that in healthy controls. Genetic damage parameters of DNA migration length, damage frequency, and damage index were significantly ($p < 0.001$) elevated in the sample group compared to respective values in healthy controls (Gandhi et al., 2014).

The effect of RF radiation among 20 subjects living close to mobile phone base station compared with 20 subjects living with a distance of about 1 km was studied (Singh et al., 2016). The authors concluded that: "*It was unveiled that a majority of the subjects who were residing near the mobile base station complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties, and hypertension. A majority of the study subjects had significantly lesser stimulated salivary secretion ($p < 0.01$) as compared to the control subjects.*"

Zothansiama et al. (2017) in India inspected DNA damage a antioxidant status in cultured human peripheral blood lymphocy (HPBLs) of individuals residing in the vicinity of mobile phone b stations and compared it with healthy controls living further away. analyses of data from the exposed group (n = 40), residing withi perimeter of 80 m of mobile base stations, showed statistically sign cantly ($p < 0.0001$) higher frequency of micronuclei when compare the control group, residing 300 m away from the mobile base statio

The Ramazzini Institute findings (Falcioni et al., 2018) are suppor by the results in the USNTP study on rats and mice exposed to RF diation (National Toxicology Program, 2018a, 2018b). A clear evide of increased incidence of heart Schwannoma and some evidence glioma and tumours in the adreanal medulla in male rats was fo according to the expert panel, for further discussion see Hardell Carlberg (2019).

The study concluded that Skeppsbron street mobile phone base station antennas are examples of a poor radiofrequency infrastructure design with mobile phone base station antennas positioned into close range to the general public which brings upon high exposure levels. Given the low placement of the antennas (height from the street floor), the highest exposure was often registered at pedestrian head level. Given that head is one of most vulnerable parts of the body, these placements by mobile telephony service providers put pedestrians into unnecessary risk. Position of these antennas, can pose a health risk to people at close range. This is especially critical for people at particular risk, including persons with medical implants, pregnant women or chronically ill persons.

Based on the latest scientific literature regarding RF exposure and adverse health effects, this study recommends repositioning such base station antennas to areas away from the nearby inhabitants, workers and the general public. Alternatively, very low power antennas may also be considered to reduce the exposure. Occupational exposure of people

April 21, 2022

The Honorable Jessica Rosenworcel, Chairwoman
Federal Communications Commission
45 L Street NE
Washington, DC 20554

RE: August 13, 2021 judgment by the U.S. Court of Appeals for the District of Columbia Circuit, in Environmental Health Trust et al. v. the FCC

Dear Chairwoman Rosenworcel,

In response to the judgment by the U.S. Court of Appeals in the Environmental Health Trust case, I am requesting that appropriate actions be taken immediately to wireless radiofrequency radiation levels. I request that the FCC ensure an up to date examination of its wireless radiofrequency radiation regulations by reopening Docket 13-84 ("Reassessment of FCC Radiofrequency Exposure Limits and Policies") to refresh the record before issuing its final response to the judgment.

The current scientific research must be immediately reviewed and acted upon in a timely manner so that the health and safety of our citizens is prioritized. Consumers must have accurate information related to the benefits and risks of the products and services available to them. Policies should be reflective of current scientific research performed in accordance with utilization. It is impossible for consumers to make educated decisions without accurate information; therefore, I am requesting that you take immediate action as directed by the courts to review the research and update any policies as necessary for the health and wellbeing of all citizens, including the most vulnerable, our children.

Sincerely,

Mark Gordon
Governor of Wyoming

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International Appeal: Scientists call for protection from non-ionizing electromagnetic field exposure

An introduction to the International EMF Scientist Appeal

The current issue of the European Journal of Oncology contains a document the "International EMF Scientist Appeal" (EMFscientist.org) that addresses the concerns of 215 scientists from 40 nations about the adverse health effects on the human population exposed to non-ionizing electromagnetic fields (EMF) from extremely-low frequency to radiofrequency. The Appeal has been submitted to the United Nations, to two of its sub-agencies, the World Health Organization (WHO) and the United Nations Environmental Programme (UNEP), and to all UN Member Nations.

We note that the overall weight of evidence reported in peer-reviewed, scientific studies strongly supports greater precautionary measures be taken to reduce or eliminate EMF exposure.

Coordinating and Advisory Committee for the "International EMF Scientist Appeal" (Martin Blank, Magda Havas, Elizabeth Kelley, Henry Lai, and Joel Moskowitz). We can be reached through Elizabeth Kelley at info@EMFscientist.org.

To: His Excellency Ban Ki-moon, Secretary-General of the United Nations;
Honorable Dr. Margaret Chan, Director-General of the World Health Organization; Honorable Achim Steiner, Executive Director of the U.N. Environmental Programme; U.N. Member Nations

Summary. We are scientists engaged in the study of biological and health effects of non-ionizing electromagnetic fields (EMF). Based upon peer-reviewed, published research, we have serious concerns regarding the ubiquitous and increasing exposure to EMF generated by electric and wireless devices. These include–but are not limited to–radiofrequency radiation (RFR) emitting devices, such as cellular and cordless phones and their base stations, Wi-Fi, broadcast antennas, smart meters, and baby monitors as well as electric devices and infra-structures used in the delivery of electricity that generate extremely-low frequency electromagnetic field (ELF EMF).

Scientific basis for our common concerns

Numerous recent scientific publications have shown that EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being

in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life.

These findings justify our appeal to the United Nations (UN) and, all member States in the world, to encourage the World Health Organization (WHO) to exert strong leadership in fostering the development of more protective EMF guidelines, encouraging precautionary measures, and educating the public about health risks, particularly risk to children and fetal development. By not taking action, the WHO is failing to fulfill its role as the preeminent international public health agency.

Inadequate non-ionizing EMF international guidelines

The various agencies setting safety standards have failed to impose sufficient guidelines to protect the general public, particularly children who are more vulnerable to the effects of EMF.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) established in 1998 the "Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)" (1). These guidelines are accepted by the WHO and numerous countries around the world. The WHO is calling for all nations to adopt the ICNIRP guidelines to encourage international harmonization of standards. In 2009, the ICNIRP released a statement saying that it was reaffirming its 1998 guidelines, as in their opinion, the scientific literature published since that time "has provided no evidence of any adverse effects below the basic restrictions and does not necessitate an immediate revision of its guidance on limiting exposure to high frequency electromagnetic fields (2). ICNIRP continues to the present day to make these assertions, in spite of growing scientific evidence to the contrary. It is our opinion that, because the ICNIRP guidelines do not cover long-term exposure and low-intensity effects, they are insufficient to protect public health.

The WHO adopted the International Agency for Research on Cancer (IARC) classification of extremely low frequency electromagnetic field (ELF EMF) in 2002 (3) and radiofrequency radiation (RFR) in 2011 (4). This classification states that EMF is a *possible human carcinogen (Group 2B)*. Despite both IARC findings, the WHO continues to maintain that there is insufficient evidence to justify lowering these quantitative exposure limits.

Since there is controversy about a rationale for setting standards to avoid adverse health effects, we recommend that the United Nations Environmental Programme (UNEP) convene and fund an independent multidisciplinary committee to explore the pros and cons of alternatives to current practices that could substantially lower human exposures to RF and ELF fields. The deliberations of this group should be conducted in a transparent and impartial way. Although it is essential that industry be involved and cooperate in this process, industry should not be allowed to bias its processes or conclusions. This group should provide their analysis to the UN and the WHO to guide precautionary action.

Collectively we also request that:

1. children and pregnant women be protected;
2. guidelines and regulatory standards be strengthened;
3. manufacturers be encouraged to develop safer technology;
4. utilities responsible for the generation, transmission, distribution, and monitoring of electricity maintain adequate power quality and ensure proper electrical wiring to minimize harmful ground current;
5. the public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies;
6. medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity;
7. governments fund training and research on electromagnetic fields and health that is independent of industry and mandate industry cooperation with researchers;

8. media disclose experts' financial relationships with industry when citing their opinions regarding health and safety aspects of EMF-emitting technologies; and
9. white-zones (radiation-free areas) be established.

The list of signatories and their affiliations is available at EMFscientist.org

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Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer

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ABSTRACT

The objective of this work was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base station antennas on humans. Studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Overall results of this review show three types of effects by base station antennas on the health of people: radiofrequency sickness (RS), cancer (C) and changes in biochemical parameters (CBP). Considering all the studies reviewed globally (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters. Furthermore, studies that did not meet the strict conditions to be included in this review provided important supplementary evidence. The existence of similar effects from studies by different sources (but with RF of similar characteristics), such as radar, radio and television antennas, wireless smart meters and laboratory studies, reinforce the conclusions of this review. Of special importance are the studies performed on animals or trees near base station antennas that cannot be aware of their proximity and to which psychosomatic effects can never be attributed.

1. Introduction

During the last few decades, hundreds of thousands of mobile phone base stations and other types of wireless communications antennas have been installed around the world, in cities and in nature, including protected natural areas, in addition to pre-existing antennas (television, radio broadcasting, radar, etc.). Only the aesthetic aspects or urban regulations have been generally considered in this deployment, while the biological, environmental and health impacts of the associated non-ionizing electromagnetic radiation emissions have not been assessed so far. Therefore, the effects on humans living around these anthropogenic electromagnetic field sources (antennas) have not been considered.

In France, there is a significant contribution of mobile phone base stations in the exposure to radiofrequency electromagnetic fields (RF-EMF) of urban citizens living nearby (De Giudici et al., 2021). Some studies from India indicate that more than 15% of people have levels of EMF strength above 12 V/m due to their proximity to antennas (Premlal and Eldhose, 2017). Exposure estimates have shown that RF-EMF from mobile telephone systems is stronger in urban than in rural areas. For instance, in Sweden the levels of RF radiation have increased considerably in recent years, both outdoor and indoor, due to new telecommunication technologies, and the median power density measured for RF fields between 30 MHz and 3 GHz was 16 $\mu W/m^2$ in rural areas, 270 $\mu W/m^2$ in urban areas and 2400 $\mu W/m^2$ in city areas (Hardell et al., 2018). Total exposure varies not only between urban and rural areas but also, depending on residential characteristics, between different floors of a building, with a tendency for building exposure to increase at higher floors (Breckenkamp et al., 2012).

Over the past five decades, and more intensively since the beginning of this century, many studies and several reviews have been published on the effects of anthropogenic electromagnetic radiation on humans living around the antennas. The first studies were carried out with radio and television antennas, investigating increases in cancer and leukaemia (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; Michelozzi et al., 1998; Altpeter et al., 2000), as well as around radars (Kolodynski and Kolodynska, 1996; Goldsmith, 1997).

Regarding base station antennas, there are scientific discrepancies in their effects: some studies concluded that there are no health-related effects (e.g. Augner and Hacker, 2009; Blettner et al., 2009; Röösli et al., 2010; Baliatsas et al., 2016) whereas others found increases in cancer and other health problems in humans living around antennas (e.g. Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004;

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Eger et al., 2004; Wolf and Wolf, 2004; Abdel-Rassoul et al., 2007; Khurana et al., 2010; Dode et al., 2011; Shinjyo and Shinjyo, 2014; Gandhi et al., 2015; López et al., 2021; Rodrigues et al., 2021). There is a specific symptomatology linked to radar and RF exposure at low levels, characterized by functional disturbances of the central nervous system (headache, sleep disturbance, discomfort, irritability, depression, memory loss, dizziness, fatigue, nausea, appetite loss, difficulty in concentration, dizziness, etc.), that has been termed 'RF sickness' (Lilienfeld et al., 1978; Johnson Lyakouris, 1998; Navarro et al., 2003).

The objective of this study was to perform a complete review of the existing scientific literature to update the knowledge on the effects of base stations on humans living around the antennas.

2. Methods

A search was performed in the EMF portal, Google Scholar and PubMed databases with the words: "mobile phone base station and health" or "cell tower and health".

Only studies performed in real urban conditions, with mobile phone base stations situated close to apartments, were selected. Studies conducted in larger regions with numerous antennas, based on surveys and geographic data, were also included.

On the contrary, studies were excluded that considered different sources of electromagnetic radiation, such as mobile phone base stations together with broadcast transmitters (TV and radio), radar, mobile phones, cordless phones, Wi-Fi or wireless smart meters. Also excluded were those that included antennas and powerlines jointly. Studies that only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with health effects, were excluded, as were surveys on risk perception and the nocebo effect, modelled radiofrequency electromagnetic field exposure from mobile-phone base stations or perceived exposure. All experimental laboratory studies, experiments in an exposure chamber or adapted room were also excluded. Finally, the comments or criticism of previously published studies were also excluded. However, due to their importance the conclusions of some of the excluded studies will be discussed in the corresponding section.

3. Results

The studies that met the selected criteria are presented in chronological order in Table 1, catalogued as Y/N depending on whether or not they found effects. The selected studies cover three types of effects: radiofrequency sickness (RS) (according to Lilienfeld et al., 1978; Johnson Lyakouris, 1998), cancer (C) and changes in biochemical parameters (CBP). Table 1 also includes the authors, year and country, antenna type, study design, diseases and symptoms found/not found and the main conclusions of each study.

Considering all the selected studies (n = 38), 73.6% (28/38) showed effects: 73.9% (17/23) for radiofrequency sickness, 76.9% (10/13) for cancer and 75.0% (6/8) for changes in biochemical parameters (Fig. 1). Therefore, most of the studies carried by research groups from twenty different countries reach the same conclusions.

For the reasons previously explained, the following studies (n = 85) were not considered in this review, even though the conclusions of some of these studies will be discussed later due to their importance regarding the similarities of the electromagnetic radiation types involved and the health effects found in many cases. Several studies only performed measurements or modelling of radiation levels in the environment of the antennas or in the body, but did not deal with the effects on health (e.g. Aniołczyk, 1999; Henderson and Bangay, 2006; Keow and Radiman, 2006; Neitzke et al., 2007; Bürgi et al., 2008; Augner et al., 2009; Chen and Chuang, 2009; Schmiedel et al., 2009; Viel et al., 2009; Hansson et al., 2011; Alhekail et al., 2012; Breckenkamp et al., 2012; Beekhuizen et al., 2013; Bürgi et al., 2014; Lyare et al., 2019; Urbinello et al., 2014; Lemaire et al., 2016; Admawi, 2021; De Giudici et al., 2021; Kazaure et al., 2021; Yetiş and Kayili, 2021). Some were surveys on risk perception and the nocebo effect, modelled RF-EMF exposure from mobile-phone base stations or perceived exposure (Wiedemann et al., 2006; Dohle et al., 2012; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Martens et al., 2017; Koh et al., 2020). Others jointly considered various sources of electromagnetic fields such as telephone antennas, mobile phones, cordless phones, Wi-Fi, powerlines or wireless smart meters (Seitz et al., 2005; Baliatsas et al., 2011; Atzmon et al., 2012; Eskander et al., 2012; Frei et al., 2012; Lamech, 2014; Singh and Pati, 2016; Boehmert et al., 2020; Akkam et al., 2020). Some studied the effects of radio or television antennas (Milham, 1988; Maskarinec et al., 1994; Hocking et al., 1996; Dolk et al., 1997a, 1997b; McKenzie et al., 1998; Michelozzi et al., 1998; Altpeter et al., 2000; Hocking and Gordon, 2000; Boscolo et al., 2001; Cooper et al., 2001; Michelozzi et al., 2002; Hallberg and Johansson, 2002; Elwood, 2003; Ha et al., 2003; Park et al., 2004; Abelin et al., 2005; Altpeter et al., 2006; Ha et al., 2007; Satta et al., 2018). Others were radar studies (Kolodynski and Kolodynska, 1996; Goldsmith, 1997; Szmigielski et al., 2001; Yakymenko et al., 2011; Schoeni et al., 2016; Martens et al., 2018). Some studies performed experiments in a laboratory, exposure chamber or adapted room, with simulated or real electromagnetic radiation from base station antennas (e.g. Zwamborn et al., 2003; Hinrichs et al., 2005; Regel et al., 2006, 2007; Eltiti et al., 2007; Leitgeb et al., 2008; Riddervold et al., 2008; Augner et al., 2009; Augner et al., 2010; Wallace et al., 2010; Danker-Hopfe et al., 2010; Falcioni et al., 2018; Azimzadeh and Jelodar, 2019; Smith-Roe et al., 2020). Some reports were comments or criticisms of previously published studies (e.g. Coggon, 2006; Röösli and Huss, 2008; Bithell, 2010; Dode and Leão, 2012; Foster and Trottier, 2012; Mortazavi, 2014, 2017).

4. Discussion

The results of this review show three types of effects by base station antennas on the health of humans: radiofrequency sickness, cancer and changes in biochemical parameters (Fig. 1). From among all these studies, most of them found effects (73.6%). Thus, despite some limitations and differences in study design, statistical measures, risk estimates and exposure categories (Khurana et al., 2010), together they provide a consistent view of the effects on the health of people living in the vicinity of base station antennas.

Studies conducted in large regions with numerous antennas, based on surveys and geographic data (e.g. Augner and Hacker, 2009; Dode et al., 2011; Baliatsas et al., 2016; Martens et al., 2017; Dode et al. al., 2021), have the limitation that there may be many factors other than the base station antennas affecting the health of the population (environmental and occupational determinants of diseases and symptoms, individual characteristics such as food and life habits, activity level, smoking, self-medication, individual pathologies or genetic factors) that can act as confounding factors. It is important to mention here that the meters used for power density measurements in research papers should have more high quality equipment and better measurement methods.

On the other hand, some studies did not meet the strict conditions to be considered in this review, but due to their importance regarding the similarities of the electromagnetic radiation types involved and the effects found in many cases, they provide important supplementary evidence, as we will see in the next paragraphs.

For example, mobile phone users had an increased risk of headache (one of the typical symptoms for RF sickness near base station antennas) compared with non-users, and the risk of headache was also increased in those who had a longer daily call duration and higher daily call frequency (Wang et al., 2017). The same was also seen with cancer (Hardell et al., 2007). On the other hand, the symptoms caused by wireless smart meters were similar to those reported by people exposed to RF fields emitted by mobile phones (Lamech, 2014).

Table 1
Studies that met the selected criteria.

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
1 Y RS	Santini et al. (2002), 2003a and 2003b France	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 530 people	Effects found on: -tiredness -headache -sleep disturbance -discomfort -irritability -depression -memory loss -dizziness -libido decrease -visual perturbations	Effects occur up to a distance of 300 m from the antenna. Older subjects are more sensitive. Also, hat the facing location is the worst position for some symptoms s tudied, especially for distances till 100 m from base stations. The frequency of reported complaints is significantly higher for women in comparison with men
2 Y RS	Gómez-Perretta et al., 2013 Spain	Base station antennas GSM 900 and 1800 MHz	Questionnaire survey in 101 people and electric field measurements	Effects found on: -fatigue -irritability -headache -nausea -appetite loss -discomfort -sleep disturbance -depression -difficulty in concentration -dizziness	Significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure. The incidence of most of the symptoms was related to exposure levels, independently of the demographic variables and some possible risk factors. Health changes related with GSM exposure seem to occur in a manner unrelated with those fears
3 Y RS	Bortkiewicz et al. (2004) Poland	Base station antennas	Review of previous publications	Effects found on: -circulatory system -sleep disturbances -irritability depression -blurred vision -concentration -difficulties nausea -lack of appetite -headache -vertigo	Relationship between the incidence of individual symptoms, the level of exposure, and the distance. This association was observed in both groups of persons, those who linked their complaints with the presence of the base station and those who did not notice such a relation.
4 Y C	Eger et al. (2004) Germany	2 Base station antennas	Number of cancer cases in the selected population (1045 resident) in Naila to compare results an inner area (within a distance of 400 m from the base station antennas) and outer area (beyond 400 m).	The number of newly developed cancer cases in the inner area is more than the expected number taken from the cáncer register, which represents the total population being irradiated. The group who had lived during the past five years within a distance of 400 m from the Base station antennas have a two times higher risk of developing cancer than that of the average population. The relative risk of getting cancer in the inner área compared with the Saarland cancer register is 1.7.	The risk of newly developing cancer was three times higher among those patients who had lived during past ten years (1994–2004), within a distance of 400 m From the cellular transmitter, in comparison to those who had lived further away.
5 Y C	Wolf and Wolf (2004) Israel	1 Base station antenna	A cancer incidence study to investigate the incidence of cancer cases of individuals (the cohort included 622 people) exposed to a Base station antenna, in comparison to those of a nearby clinic out of that area, to the national incidence rates of the whole country and to the incidence rates in the whole town of Netanya	There were 4.15 times more cases of cáncer in area A (breast carcinoma, ovary carcinoma, lung carcinoma, Hodgkin's disease, osteoid osteoma, and hypernephroma) than in the entire population.	The study indicates an association between an increased incidence of cancer and living in proximity to a Base station antenna.
6 Y RS	Hutter et al. (2006) Austria	10 Base station antennas in the 900 MHz band	Questionnaire survey in 365 subjects and exposure measurements	Effects found on: -headache -difficulties to concéntrate -Cold hands or feet No effects found on: -vertigo -palpitations -tremor -hot flushes -sweating -loss of apetite -loss of energy, -exhaustion -tiredness	Self-reported symptoms like headache and difficulties in concentrating show an association with microwave exposure from base stations, not attributable to subjects' fear of health effects from these sources. Other symptoms, like sleeping problems, seem to be more due to fear of adverse health effects than actual exposure.

(*continued on next page*)

Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-feeling strained -sleep	
7 Y RS	Abdel-Rassoul et al. (2007) Egypt	Base station antennas (GSM)	Questionnaire survey on 85 exposed persons and 80 controls	Effects found on: -headache -memory changes -dizziness -tremors -depressive symptoms -sleep disturbance No effects found on: -Blurred visión -Irritability -Lack of concentration	The prevalence of neuropsychiatric complaints were significantly higher among exposed inhabitants than controls. Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition.
8 N CBP	Augner and Hacker (2009) Austria	Base station antennas	Questionnaire survey on fifty-seven participants and saliva samples	Self-declared base station neighbors (≤100 m) had significantly higher concentrations of alpha-amylase in their saliva, higher rates in symptoms, somatization, obsessive-compulsive, anxiety, phobic anxiety. There were no differences in EMF-related health concern scales.	Self-declared base station neighbors are more strained than others. EMF-related health concerns cannot explain these findings.
9 N RS	Blettner et al. (2009) Berg-Beckhoff et al. (2009) Germany	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Questionnaire survey on 30,047 participants and geo-coding information on the residence distance (less or more than 500 m) to the nearest mobile phone base station. In a second phase RF measurements were conducted for a sub-sample in the households of 1500 persons	The mailed questionnaire included a list of 38 symptoms that have been reported in previous studies to be possibly associated with RF-EMF exposure	Participants who were concerned about or attributed adverse health effects to mobile phone base stations and those living in the vicinity of a mobile phone base station (500 m), reported slightly more health complaints tan others. The observed slightly higher prevalence of health complaints near base stations cannot be explained by attributions or concerns alone. The worries and health complaints of people living close to mobile phone base stations need to be taken seriously. Measured RF-EMFs emitted from mobile phone base stations were not associated with health disturbances. However, the study shows that sleep disturbances and health complaints are related to the attribution of adverse health effects to mobile phone base stations.
10 Y RS C	Kundi and Hutter (2009) Austria	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	There are indications from epidemiology that such exposures affect wellbeing and health weakly supported by human provocation studies and an inconclusive body of evidence from animal and in vitro studies. Cross-sectional investigations of subjective health as a function of distance or measured field strength, despite differences in methods and robustness of study design, found indications for an effect of exposure that is likely independent of concerns and attributions. Two ecological studies of cancer in the vicinity of base stations report both a strong increase of incidence within a radius of 350 and 400 m respectively. Due to the limitations inherent in this design no firm conclusions can be drawn, but the results underline the urgent need for a comprehensive investigation of this issue
11 Y C	Eger and Jahn (2010) Germany	Base station antennas	Questionnaire survey on 255 persons	Effects found on: -sleep problems -depression -headaches -cerebral affections -concentration difficulties -joint problems -infections -skin problems	A significant relationship between mean exposure levels of the study participants and reported health symptoms. Within the 400-m radius around the transmitter, a higher symptom rate could be documented for 14 out of 19 symptom groups in the highest exposure groups compared to groups

(*continued on next page*)

Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
				-dizziness -cardiovascular problems -disturbance of equilibrium -visual problems -nosebleed -gastrointestinal problems No effects found on: -toothaches -hormonal imbalances -weight gain -weight loss	further away from the transmitter and the difference is statistically significant. Decreasing symptom scores in relation to decreasing mean exposure levels caused by cell phone transmitter emissions
12 N C	Elliott et al. (2010) Great Britain	Base station antennas	Data on all registered cases of cancer in children aged 0–4 in Great Britain and data on mobile phone base stations to investigate the risk of early childhood cancer associated with the mother's exposure to radiofrequency from and proximity to mobile phone base stations during pregnancy.	Of the 1397 cases, there were 251 brain and central nervous system cancers and 527 cases of leukaemia and non-Hodgkin's lymphoma. The study found no association between mobile phone base stations and risk of cáncer.	In this systematic national investigation the authors found no association between risk of cancer in young children and estimated exposures to radiofrequency from mobile phone base stations during pregnancy. However there is a research paper limitation on page 5: "our models did not include information on other sources of radiofrequency exposure, such as from microcells or picocells" and the city centers (especially) are full of these kind of antennas.
13 Y RS C	Khurana et al. (2010) international	Base station antennas	Review of previous publications	Effects found on: Adverse neurobehavioral symptoms or cancer	The authors identified a total of 10 epidemiological studies that assessed for putative health effects of mobile pone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. The authors found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances <500 m from base stations.
14 N RS	Röösli et al. (2010) Switzerland	Base station antennas (GMS 900 and 1800 and UMTS 2170)	Systematic review	There are no adverse effects	Not indication of an association between any health outcome and RF-EMF exposure from mobile phone base stations at levels typically found in our everyday environment. There is also no evidence that EHS individuals are more susceptible to base station radiation than the rest of the population. The evidence for the absence of long-term effects is limited.
15 N CBP C	Yildirim et al. (2010) Turkey	Base station antennas	Blood samples to analise the micronucleus (MN) frequency and chromosomal aberrations on blood in people living around mobile phone base stations and healthy controls.	There was not a significant difference of MN frequency and chromosomal aberrations between the two study groups.	Mobile phones and their base stations do not produce important carcinogenic changes.
16 Y RS	Alazawi, 2011 Iran	8 Base station antennas	Questionnaire survey on 375 subjects. Not measurements	Effects found on: -headaches -sleep disturbances -irritability -depressive -tendencies -feeling of discomfort, -difficulties in concentration -memory loss -lowering of libido	This study shows that inhabitants living nearby mobile phone base stations are at risk for developing non specific health symptoms, the facing position appears to be the worst one for distances from cellular phone base stations <100 m. It is advisable that cellular phone base stations should not be sited closer than 300 m to populations, as a precautionary measure, sitting of base stations should be such as to minimize exposure of neighbors.
17 Y C	Dode et al. (2011) Brazil	Base station antennas	This research was conducted in a broad environmental context, aiming to verify if there is a spatial correlation between the Base station antennas and the cases of death by neoplasia during the period between 1996 and 2006 in Belo Horizonte municipality (Brazil).	The mortality rates and the relative risk were higher for the residents inside a radius of 500 m from the Base station antennas, compared to the average mortality rate of the entire city, and a decreased dose– response gradient was observed for residents who lived farther away from these base stations.	The research showed the existence of a spatial correlation between cases of death by neoplasia and the locations of the Base station antennas, in the Belo Horizonte municipality from 1996 to 2006.

(*continued on next page*)

Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
18 Y C	Li et al. (2012) Taiwan	Base station antennas	Population-based case–control study in Taiwan considerering incident cases aged 15 years or less and admitted in 2003–2007 for all neoplasm (n = 3481 children). Exposure of each study subject to radio frequency (RF) was indicated by the averaged annual power density within 5 years prior to the neoplasm diagnosis. Controls were randomly selected.	Taiwanese children with higher-than median exposure of RF potentially emitted from Base station antennas were at significantly increased risk of all neoplasms combined. Although there were also positive associations between RF power density and risks of brain neoplasm and leukaemia in children, such associations did not reach statistical significance.	This study noted a significantly increased risk of all neoplasms in children with higher-than-median RF exposure to Base station antennas. The slightly elevated risk was seen for leukaemia and brain neoplasm, but was not statistically significant.
19 N C	Stewart et al. (2012) Great Britain	1 Base station antennas (GMS 1800)	Data on cancer incidence and mortality accessing the medical information of near residents	The study cannot conclude that the base station is responsible for the incidence of cancer in the local residents	Although the age range for local residents with cancer in the suspected cluster was younger than might be generally expected, there was no evidence that their cancer incidence is associated with the mobile phone base station. 10 cancers were registered after installation of the base station. However, the collection of cancers does not fulfil the criteria for a cancer cluster; the cases are a mixed variety of relatively common cancers. No single type of cancer was dominant, all but one were common types of cancer and none were seen in a group not usually affected by that cancer. Data from primary and secondary care also provide evidence that lifestyle and family history factors could have contributed to some individual cases.
20 N RS	Islam and Mohammed (2014) Bangladesh	Base station antennas	Questionnaire survey on 220 adults living near a Base station antenna for at least one year in two selected areas	Half of the respondents experienced problems in sleeping patterns, recent episodes of headache or dizziness and mood change, anxiety, or depression. 11 respondents experienced some generalized burning sensation and 4 reported episodes of shaking or fits. 48 respondents mentioned one or more other health effects, such as mood changes/problem, buzzing in the head, hopelessness, palpitation, tachycardia, heaviness of chest, anorexia, diarrhoea, and skin diseases.	From the results of the study cannot conclude that the health effects are direct results of the base station antennas. However, the complaints were similar to those of other studies, which shows the importance of conducting further research to determine the effects of electromagnetic radiarion from base station antennas on human health and should be considered as a public health concern.
21 Y RS	Pachuau and Pachuau (2014) India	Base station antennas (GSM 900)	Questionnaire survey conducted on 64 adults (31 female, 33 male) and electric field measurements. Health symptoms of RF exposure faced by the inhabitants within 50 m and outside 50 m from the tower were analysed and compared.	Effects found on: -Muscle pain -Fatigue -Sleep disorder -Nausea -Skin problema -Dizziness -Feeling of discomfort -Difficulty in concentration -Memory loss -Visual disruption	Inhabitants living within 50 m had more health complaints than those living outside 50 m. It was also found that females had more complaints than males
22 Y RS	Shinjyo and Shinjyo (2014) Japan	2 base station antennas (CDMA 800 MHz and 2 GHz)	Medical examinations and health questionnaires comparing the health of 107 residents during the base station's operation and after its removal. Measurement of the power density	Effects found on: -fatigue -eye problems -sleep disturbances -dizziness -headache -tinnitus -nasal bleeding No effects found on: -tachycardia -tumours -skin problems -rhinitis -angina pectoris -hearing loss	A total of 34 residents suffered from health problems after installation of the 800 MHz antennas. Three months after their removal this number decreased to 13. There were 41 residents who had health problems after installation of the 2 GHz antennas, and this number decreased to 15 after removal of the 2 GHz antennas. In total 49 residents suffered from health problems during operation of both the 800 MHz and the 2 GHz antennas. However, this number decreased to 25 after removal of both sets of antennas.The residents had no prior knowledge about possible adverse health effects of RF-EMFs. Health problems of the residents were associated with the operation of the

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
					mobile phone base station and these problems improved after its removal.
23 Y CBP	Gandhi et al. (2015) India	Base station antennas	Questionnaire survey and blood simples from 91 individuals, with 70% (63) residing in a populated area with a mobile phone base station (the sample group) and 30% (28) in a sparsely-populated zone without any nearby base stations (the control group). Radiofrequency field measurements	Effects found on: Genetic damage parameters of DNA migration length, damage frequency (DF) and damage index	Genetic damage was significantly increased in the sample group compared to that in the controls. The 2.5–4.5-fold increase in DNA damage in peripheral blood lymphocytes of persons staying near a mobile phone base station is of acute concern given that all neoplasia initiate via unrepaired DNA damage. In the light of the above observations and the statistically significant genetic damage observed in those residing within 300 m of a mobile phone base station in this study, it implies that the effects of radiations from mobile phone base stations cannot be overlooked, as unrepaired DNA damage can lead to cancer, precocious ageing and age-related effects.
24 Y CBP	Meo et al. (2015) Saudi Arabia	2 Base station antennas (925 MHz) near two schools	RF-EMF measurements and blood sample collection	Effects found on: -chronic hyperglycemia -increased HbA1c -diabetes mellitus	Students who were exposed to high EMFR generated by MPBS had significantly higher HbA1c and prevalence of pre diabetes mellitus compared to the students who exposed to low EMFR. EMFR appears to be another risk factor contributing to high levels of HbA1c and risk of type 2 diabetes mellitus.
25 Y RS	Pachuau et al. (2015) India	Base station antennas (GSM 900)	Questionnaire survey from 50 exposed and 50 control individuals. Power density measurements	Effects found on: -fatigue -sleep disruption -headache -dizziness -muscle pain -cramp No effects found on: -nausea -discomfort -difficulty in concentration -memory los -skin problems -visual disruption -hearing problem	Inhabitants living near mobile tower are having more health complaints than those inhabitants living in the area where there is no mobile tower
26 Y CBP	Al-Quzwini et al. (2016) Iraq	Base station antennas	Questionnaire survey. Two hundred couples (one hundred subfertile couples as a study group, and one hundred fertile couples as a control group. Semen analysis	Twenty-nine percentage of subfertile couples had exposure to environmental hazards (communication's tower beside their house-within 50 m), and 71% non-hazard. The duration of the exposure to the environmental factor ranged from 2 to 7 years.	The exposure to environmental hazards shows significant difference between the subfertile and the fertile men; as higher percentage of exposure to mobile phone tower among subfertile group, 29% versus 12% for the fertile group,
27 N RS	Baliatsas et al. (2016) The Netherlands	Base station antennas (GSM and UMTS)	Health records from 1069 adult participants, All participants were living within 500 m from the nearest bases station. A propagation model combined with a questionnaire was used to assess indoor exposure to RF-EMF from MPBS at T1. Estimation of exposure at T0 was based on number of antennas at T0 relative to T1.	Compared to the baseline period, there was a higher prevalence of symptoms theoretically relevant to EMF at T1. A significant increase was observed in the prevalence of ear symptoms and a two-fold (but not significant) increase in the prevalence of skin symptoms. Overall, the total prevalence was slightly lower at T1. A consistent association between UMTS exposure and different clusters of GP-registered symptoms, for the self-declared mobile phone base stations-sensitive group.	This before-after study found no evidence that RF-EMF exposure from mobile phone base stations is associated with the development of non-specific symptoms in the general population, corroborating recent observational studies. Subgroup analyses among people with self-reported sensitivity to base stations showed a higher prevalence for most symptoms at T1 compared to baseline and there was some indication for a higher risk of non-specific symptoms for the mobile phone base stations-sensitive group, in relation to exposure.
28 N RS	Klaps et al. (2016) Austria	Base station antennas	Meta-analysis based on the results of 17 studies	The effects of mobile phone base stations seem to be rather unlikely. However, nocebo effects occur.	It is unclear whether electromagnetic fields emitted by mobile phone base stations affect well-being in adults. The existing studies on this topic are highly inconsistent.
29 Y	Singh et al. (2016) India	4 Base station antennas		Effects found: -sleep disturbances	A majority of the subjects who were residing near the mobile base station

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
RS CBP			Questionnaire survey and salivary analysis in 20 individuals (case group) and 20 (control group)	-headache -dizziness -irritability -concentration difficulties -hypertension	had various complaints. A majority of the study subjects had significantly lesser stimulated salivary secretion as compared to the control subjects. The effects of prolonged exposure to EMRs from mobile phone base stations on the health and well-being of the general population cannot be ruled out.
30 Y RS	Premlal and Eldhose, 2017 India	14 Base station antennas	Questionnaire survey (229 persons) and power density measurements	Joint pain, sleep disorders, migraine related headaches and digestive problems	For 32 different diseases, only 4 were found to have obvious relation to the cell tower radiation. Females are more prone to the bad effects of cell tower radiation. The current Indian standard for cell tower exposure is inadequate for the safe living.
31 Y CBP	Taheri et al. (2017) Iran	Base station antennas	45 healthy individuals with their home near BTS antenna (exposed group) and 45 healthy subjects who were away from the antenna	In the exposed group, the whole number of white blood cells, the level of hematocrit, percent of monocytes, eosinophils and basophils were significantly lower than the control group. The number of red blood cells, their average volume and the mean concentration of hemoglobin were notably higher than the controls. There was not observed a significant difference between the two groups in hemoglobin, its mean concentration, platelet count, percent of lymphocytes and neutrophils as well as serum levels of cytokines IL-4, IL-10 and interferon γ.	The radiation of base station antennas influenced the blood and immune systems.
32 Y RS C	Vijay and Choudhary (2017) India	40 Base station antennas (900–1800 MHz)	Questionnaire survey	Effects found: - headache - depression - sleep disturbance - nausea - fatigue - asthma - cancer - Alzheimer's disease - multiple sclerosis - brain tumor.	The questionnaires show that people have some kind of physical or mental illness after the installation of mobile towers.
33 Y CBP	Zothansiama et al. (2017) India	6 Base station antennas (900–1800 MHz)	Questionnaire survey. Blood sample collection and lymphocyte culture. Power density measurement. Exposed group (n = 40) Control group (n = 40) The study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.	Effects found: -higher frequency of micronuclei -decreased antioxidants	The analyses of data from the exposed group residing within a perimeter of 80 m of mobile base stations, showed significantly higher frequency of micronuclei when compared to the control group, residing 300 m away from themobile base station. The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione concentration, activities of catalase and superoxide dismutase and rise in lipid peroxidation when compared to controls. Multiple linear regression analyses revealed a significant association among decreased antioxidants and elevated miconuclei frequency with increasing RF power density. The persistence of DNA unrepaired damage leads to genomic instability which may lead to several health disorders including the induction of cancer.
34 Y RS	Meo et al. (2019) Saudi Arabia	Two different schools both situated nearby base station antennas (925 MHz)	Cognitive function, motor screening task and spatial working memory were tested, and also RF measurements were made.	There was a statistically significant impairment in the motor screening task and spatial working memory among students who were exposed to high RF generated by base station antennas (School 2: 10.021 μW/cm^2) compared to students who were exposed to lower levels of RF (School 1: 2.010 μW/cm^2).	High exposure to RF-EMF produced by base station antennas is associated with a decrease in fine and gross motor skills and spatial working memory and attention in school adolescents compared to students who had been exposed to low RF-EMF.

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Table 1 (*continued*)

N°	Reference and country	Antenna type	Study design	Diseases and symptoms found/not found	Main conclusions
35 Y RS	Ali et al. (2021) Iraq	Base station antennas (900–1800 MHz)	Questionnaire survey comparing two groups. The first group (n = 79) was located in a town with three cell phone towers with less than a hundred meters apart. The second study group (n = 79) was limited to the area almost empty from cell phone towers. Electric field measurements were made.	There was a significant association between health problems (skin problem, hair loss issues, sleeping difficulties, and fertility issues) and distance to towers (less distance, more problems: P-value < 0.05). In regards to health problems (abnormalities, blood pressure issues, tumours cases, and memory and concentration difficulties), the obtained results were not statistically significant.	The results showed an increase in both short- and long-term health problems near base stations antennas in general.
36 Y RS C	López et al., 2021 Spain	9 Base station antennas	Questionnaire survey on 268 persons, 174 in exposed área and 94 in control área, and EMF measurements	Effects found on -headache -dizziness -instability -tachycardias -nightmares No effects found on: -fainting	People who are exposed to higher radiation values present more severe headaches, dizziness and nightmares. 5.6% cancer cases in the study population, a percentage 10 times higher tan that of the total Spanish population.
37 N RS	Martin et al. (2021) France	Base station antennas	Questionnaire survey in 354 residents from buildings located at a distance of 250 m or less from the base station antennas in the main transmit beam of the antennas and home exposure measurements	No significant association between RF-EMF exposure and the overall symptoms score, nor between RF-EMF exposure from MPBSs and insomnia-like symptoms. There was a significant association between RF-EMF exposure and insomnia-like symptoms only for participants who attributed their symptoms to radiofrequencies.	The findings of the study do not support the hypothesis of an association between RF-EMF exposure and health outcomes, such as self-reported non-specific or insomnia-like symptoms in the general population. However, they may suggest a possible association between such exposure and insomnia-like symptoms among people reporting environmental concerns.
38 Y C	Rodrigues et al. (2021) Brazil	Base station antennas	This is an ecological study using capitals as the unit of analysis. The authors collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime and investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers).	For all cancers and for the specific types investigated (breast, cervix, lung, and esophagus cancers), the higher the exposure to RBS radiofrequency, the higher the median of mortality rate.	The results indicates that the exposure to radiofrequency electromagnetic fields from an RBS increases the rate of mortality by all cancers and specifically by breast, cervix, lung, and esophageal cancers. These conclusions are based on the fact that the findings of the study indicate that, the higher the RBS radiofrequency exposure, the higher the cancer mortality rate, especially for cervix cancer. The spatial analysis showed that the highest radiofrequency exposure was observed in a city located in the southern region of Brazil, which also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancers.

4.1. Investigations with radar and radio/television antennas

In studies carried out in the last century, occupational exposure of people to microwave radiation (RF) related to military, industrial and radio uses, as well as radio waves, showed several types of effects: an increase in spontaneous abortions, changes in red and white blood cell counts and an increase in childhood, testicular and other cancers. These findings suggest that RF exposures are potentially carcinogenic and have other health effects; the author recommends precautionary measures to avoid unnecessary exposure (Goldsmith, 1997). An analysis of particular locations of diagnosed neoplasms indicates significantly higher morbidity rates in the military exposed to RF for alimentary tract cancers, skin tumours, neoplasms and cerebral and haematological/lymphatic malignancies. For haematological/lymphatic malignancies, the difference in morbidity between exposed and unexposed military was the largest. This may suggest that spontaneous neoplasms develop faster in the exposed group, with a shorter latency period than in those not exposed. In fact, in exposed subjects, the disease occurs 5–10 years earlier (Szmigielski et al., 2001). On the other hand, children exposed to radar electromagnetic radiation had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased (Kolodynski and Kolodynska, 1996).

In several studies performed around radio and television antennas, there was a significant decrease in the risk of cancer and leukaemia with increasing distance to the antennas (Maskarinec et al., 1994; Dolk et al., 1997a, 1997b; Hocking and Gordon, 2000; Michelozzi et al., 2002; Park et al., 2004). People exposed to a radio antenna shortwave broadcasting station in Schwarzenburg (Switzerland) had sleep disturbances, which were more frequent in exposed than in unexposed subjects (Altpeter et al., 2000).

Thus, the coincidences of similar effects from studies with different sources of electromagnetic radiation (but with similar pulsed, polarized and modulated radiation), such as radar or radio/television antennas, reinforce the conclusions of this review. Non-ionizing EMF are among the fastest growing forms of environmental pollution, its increase around the world in recent years has been exponential (Bandara and Carpenter, 2018) and symptoms reported today may be classic microwave/RF sickness (Levitt and Lai, 2010).

4.2. RF exposure incidents among diplomats (Havanna syndrome)

From late 2016 through August 2017, US government personnel on a diplomatic mission in Havana, Cuba, reported neurological symptoms, including cognitive, balance, visual and hearing disturbances, sleep

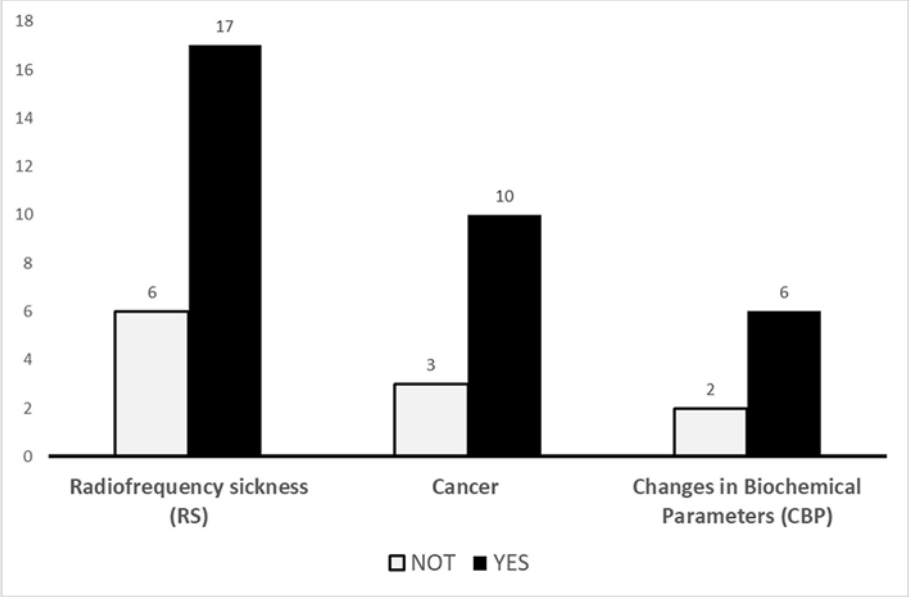


Fig. 1. Results on effects according to the study type considered.

disturbances and headaches. These individuals appeared to have sustained injuries to generalized brain networks with no associated history of head trauma (Swanson et al., 2018). They complained of cognitive decline, fatigue and headache, especially after cognitive exertion, and in some cases tinnitus, nausea and balance problems (Dyer, 2018). This mysterious disease that affected US and Canadian diplomats in Cuba (and later also in China) has confused the FBI, the State Department and US intelligence agencies.

The reported facts seem consistent with pulsed RF/microwave as the source of injuries to the affected diplomats (Golomb, 2018). The same conclusion was later reached by the National Academy of National Academies of Sciences (2020), who reported that many of the chronic or non-specific symptoms were consistent with known effects of RF, such as dizziness, headache, fatigue, nausea, anxiety, cognitive deficits and memory loss. In general, directed pulsed RF energy appears to be the most plausible mechanism to explain these cases. Such symptoms had already been described much earlier at the Moscow embassy (Lilienfeld et al., 1978; Johnson Lyakouris, 1998).

There are objective pathophysiological changes and health effects induced by EMF exposure that can biologically damage the organism and are noxious agents in healthy people (Belpomme and Irigaray, 2022).

4.3. Important laboratory studies

The United States National Toxicology Program (NTP) tested the two main modulation types used for mobile phones worldwide for GSM (2G) and UMTS (3G/4G), in a two-year rodent cancer bioassay under near-field exposure conditions; the experiments included additional assays for genotoxicity endpoints (Smith-Roe et al., 2020). They found clear evidence of carcinogenic activity, and more specifically malignant schwannomas of the heart, malignant gliomas of the brain and benign, malignant or complex pheochromocytomas (combined) of the adrenal medulla. They also found increased DNA damage (measured by the comet assay) in the frontal cortex of male mice, in the leukocytes of female mice and in the hippocampus of male rats, indicating that mobile phone EMF could cause DNA damage and consequent carcinogenesis. In a similar large carcinogenicity study by the Ramazzini Institute, Falcioni et al. (2018) examined far-field exposure to GSM 1800 MHz EMF and reported very similar results to the NTP study. Specifically, they also found increased incidence of tumours of the brain and heart in the mobile phone EMF-exposed Sprague-Dawley rats. Furthermore, these tumours are of the same histotype as those observed in some epidemiological studies on mobile phone users (Hardell et al., 2007).

Kostoff et al. (2020) emphasizes that most of the laboratory experiments conducted to date were not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate, as many experiments do not include pulsing and modulation of the carrier signal and the majority do not account for synergistic adverse effects of other toxic stimuli.

4.4. Importance of studies with biological parameters and those performed on animals and plants

Despite the scientific evidence shown in the studies carried out in many countries by different teams of researchers that we have reviewed, several studies conclude that no effects are found and blame it on risk perception and the nocebo effect (Wiedemann et al., 2006; Kowall et al., 2012; Freudenstein et al., 2015; Dieudonné, 2016; Klaps et al., 2016; Koh et al., 2020). However, the nocebo effect is not supported by objective data (Belpomme and Irigaray, 2022), by the results of cancer studies (Eger et al., 2004; Wolf and Wolf, 2004; Dode et al., 2011; Li et al., 2012; Rodrigues et al., 2021), by studies on changes in haematological parameters (Gandhi et al., 2015; Meo et al., 2015; Taheri et al., 2017; Zothansiama et al., 2017), by hormonal changes after long-term exposure (Eskander et al., 2012), by salivary secretion (Singh et al., 2016) and by effects on fertility (Al-Quzwini et al., 2016). Many reviews on the health effects of mobile phones have reached the same conclusions regarding their effects on male infertility (El-Hamd and Aboeldahab, 2018). Unfortunately, the studies that allude to the nocebo effect seem to be the ones taken into account by the World Health Organization (World Health Organization, 2015).

On the other hand, studies performed on animals or trees near base station antennas are especially important, because animals and plants cannot be aware of their proximity and therefore nocebo or psychosomatic effects cannot be attributed (Balmori, 2005, 2010; Balmori and Hallberg, 2007; Hässig et al., 2012; Lázaro et al., 2016; Waldmann-Selsam et al., 2016; Levitt et al., 2021). In fact, a similar result of this study for humans was found in a review on the significant ecological effects of RF EMF in 65% of the studies on vertebrates, birds and plants (Cucurachi et al., 2013).

Moreover, for these effects, perfectly plausible mechanisms of action

have already been proposed. Plasma membrane calcium channels and other voltage-gated ion channels are irregularly activated/inactivated by man-made EMF in both animals and plants, increasing intracellular [Ca^{2+}] and altering intracellular ion concentrations (Panagopoulos et al., 2002, 2021; Pall, 2016).

Under the influence of non-thermal intensities of microwave radiation, often there are important signals of some hazardous changes in cell metabolism. A significant increase of reactive oxygen species and nitrogen oxide generation in cells under non-thermal intensities has been detected both in vivo and in vitro (Yakymenko et al., 2011; Belpomme and Irigaray, 2022). Thus, the different findings clearly argue for a causal role of EMF in inducing free radical species, including overproduction of reactive oxygen and nitrogen species or suppression of antioxidant defence in cells (Belpomme and Irigaray, 2022). Furthermore, this exposure can result in DNA damage through oxidative stress with reactive oxygen species/free radical overproduction (Yakymenko et al., 2011; Kıvrak et al., 2017; Panagopoulos et al., 2021).

5. The Precautionary Principle

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is a private organization that issues exposure guidelines that are then adopted by governments, but it has been accused of having conflicts of interest (Hardell and Carlberg, 2020; Hardell et al., 2021). The ICNIRP (2010, 2020) limits are thousands of times above the levels where effects are recorded for both extremely low frequency and RF man-made EMF and account only for thermal effects, whereas the vast majority of recorded effects are non-thermal. These existing guidelines for public health protection only consider the effects of acute intense (thermal) exposures and do not protect from lower level long-term exposures (Israel et al., 2011; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016; Belpomme and Irigaray, 2022). The exposure duration is crucial to assess the induced effects.

The Precautionary Principle is one of the fundamental principles of the European Union, governing policies related to the environment, health and food safety (Harremoes et al., 2013). This principle enables decision-makers to adopt precautionary measures when the scientific evidence regarding an environmental or human health factor is not certain regarding its safety. Therefore, despite the existing ample and rapidly increasing scientific evidence, no significant progress has been made over all these years, at least at the level of guidelines issued by the responsible authorities and official regulatory bodies. Some authors have pointed out that the source of funding correlates with study findings, and many systematic reviews and meta-analyses in this field have failed to correct for this source of funding bias, which has likely underestimated the evidence for causation (Carpenter, 2019). A growing number of scientists have been calling internationally on governments to raise their safety standards for RF-EMF (Blank et al., 2015; Hardell and Nyberg, 2020; Frank, 2021). Thus, there is an urgent need to adopt the Precautionary Principle and impose more restrictive levels (Zinelis, 2010; Yakymenko et al., 2011; Blank et al., 2015; Starkey, 2016).

6. Conclusion

In the current circumstances, it seems that the scientific experts in the field are very clear about the serious problems we are facing and have expressed this through important appeals (Blank et al., 2015; Hardell and Nyberg, 2020). However, the media, the responsible organizations (World Health Organization, 2015) and the governments are not transmitting this crucial information to the population, who remain uninformed. For these reasons, the current situation will probably end in a crisis not only for health but also for this technology itself, as it is unsustainable and harmful to the environment and the people.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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A Small Sampling of the *Numerous* Scientific Research Studies Published After December 4, 2019- The Day the FCC Closed Their Inquiry on Human Exposure to Radiofrequency Radiation (RFR).

The Environmental Working Group published a study in *Environmental Health* analyzing the findings of tumor and heart damage from the National Toxicology Program study and concluded that FCC limits should be strengthened by 200 to 400 times to protect children according to current risk assessment guidelines (Uche 2021).

European Parliament requested a research report "Health Impact of 5G" released in July 2021 concluding 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 landmark three part **2021 research review** on effects to wildlife published in R*eviews on Environmental Health* by U.S experts including former U.S. Fish and Wildlife senior biologist Albert Manville states current science should trigger urgent regulatory action citing more than 1,200 scientific references which found adverse biological effects to wildlife from even very low intensities of non ionizing radiation with findings of impacts to orientation and migration, reproduction, mating, nest, den building and survivorship (Levitt et al., 2021a, Levitt et al., 2021b, Levitt et al., 2021c).

- **February 2020-** Scientists of the National Institute of Environmental Health Sciences National Toxicology Program published a study finding "significant increases in DNA damage" in groups of male mice, female mice and male rats after just 14 to 19 weeks of exposure to RFR (Smith-Roe et al., 2020).
- **March 2020**- Yale researchers published a study supported by the American Cancer Society linking thyroid cancer to cell phone use in people with a type of common genetic variation (Luo et al., 2020).
- **May 2020-** A meta analysis of 300 peer-reviewed scientific publications (1990-2015) describing 1127 experimental observations in cell-based in vitro models on RFR published in *Environmental Research* found less differentiated cells such as epithelium and spermatozoa are more sensitive to RF (Halgamuge et al., 2020).
- **May 2020**- A review on real world exposure to 5G published in *Toxicology Letters* found that 5 G will have systemic effects as well as adverse effects to the skin and eyes (Kostoff et al., 2020).
- **November 2020-** A systematic review and meta-analysis of case-control studies found evidence that linked cellular phone use to increased tumor risk (Choi et al., 2020).
- **February 2021**- A 4G study found kidney inflammation and damage to the testes in mice (Hasan et al., 2021).
- **March 2021**- The Switzerland Institute of the Environment expert published review found increased oxidative stress in the majority of animal studies and cell studies with exposures within regulatory limits (Schuermann et al., 2021).
- **July 2021-** International consensus report calls for the acknowledgement of electrohypersensitivity as a distinct neuropathological disorder and for inclusion in WHO Int. Classification of Diseases (Belpomme et al. 2021).
- **July/August 2021**- Two systematic reviews find harm to sperm (Sungjoon et al. 2021, Yu et al., 2021).
- **August 2021**- A review on impacts to the thyroid found RFR might be associated alterations in thyroid hormone levels, with a possible disruption in the hypothalamic-pituitary-thyroid axis (Alkayyali et al., 2021)
- **August 2021-** 2400 MHz affects the structural integrity of the hippocampus in mice (Hasan et al., 2021).
- **August 2021-** A review summarizes the effects of EMR on the neurotransmitters in the brain (Hu et al., 2021).
- **August 2021-** Review on RFR and the brain published in the International Journal of Radiation Biology found the threshold for an effect in EEG is far lower than the level deemed safe by the U.S. FCC (Hinrikus et al. 2021).
- **September 2021**- A systematic review on the effects of RFR to male reproductive hormones found that wireless can decrease testosterone (Maluin et al, 2021).
- **September 2021-** A review on the genetic effects of non-ionizing electromagnetic fields found DNA strand breaks, micronucleus formation, and chromosomal structural changes (Lai 2021).
- **September 2021**- A systematic review published in the Annals of the New York Academy of Sciences found that neuronal ion channels are particularly affected (Bertagna et al 2021).
- **October 2021**- A review in the International Journal of Oncology describes how EMFs lead to dysfunction of ion channels which lead to reactive oxygen species/free radical overproduction providing " a complete picture" of how exposure may indeed lead to DNA damage and related pathologies, including cancer," (Panagopoulos et al. 2021).

- **October 2021-** Scientific modeling study finds RF absorption in a mosquito is 16x higher at 60 GHz than at 6 GHz indicating 5G future technologies "can cause dielectric heating and have an impact on behaviour, development and possibly spread of the insect" substantiating calls to ensure pollinators are protected before 5G deployment.

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Current Alzheimer Research, 2022, *19*, 119-132

MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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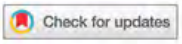


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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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The roles of intensity, exposure duration, and modulation on the biological effects of radiofrequency radiation and exposure guidelines

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ABSTRACT

In this paper, we review the literature on three important exposure metrics that are inadequately represented in most major radiofrequency radiation (RFR) exposure guidelines today: intensity, exposure duration, and signal modulation. Exposure intensity produces unpredictable effects as demonstrated by nonlinear effects. This is most likely caused by the biological system's ability to adjust and compensate but could lead to eventual biomic breakdown after prolonged exposure. A review of 112 low-intensity studies reveals that biological effects of RFR could occur at a median specific absorption rate of 0.0165 W/kg. Intensity and exposure duration interact since the dose of energy absorbed is the product of intensity and time. The result is that RFR behaves like a biological "stressor" capable of affecting numerous living systems. In addition to intensity and duration, man-made RFR is generally modulated to allow information to be encrypted. The effects of modulation on biological functions are not well understood. Four types of modulation outcomes are discussed. In addition, it is invalid to make direct comparisons between thermal energy and radiofrequency electromagnetic energy. Research data indicate that electromagnetic energy is more biologically potent in causing effects than thermal changes. The two likely functionthrough different mechanisms. As such, any current RFR exposure guidelines based on acute continuous-wave exposure are inadequate for health protection.

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MINI-REVIEW ARTICLE



Low Intensity Electromagnetic Fields Act *via* Voltage-Gated Calcium Channel (VGCC) Activation to Cause Very Early Onset Alzheimer's Disease: 18 Distinct Types of Evidence



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Abstract: Electronically generated electromagnetic fields (EMFs), including those used in wireless communication such as cell phones, Wi-Fi and smart meters, are coherent, producing very high electric and magnetic forces, which act on the voltage sensor of voltage-gated calcium channels to produce increases in intracellular calcium $[Ca^{2+}]i$. The calcium hypothesis of Alzheimer's disease (AD) has shown that each of the important AD-specific and nonspecific causal elements is produced by excessive $[Ca^{2+}]i$. $[Ca^{2+}]i$ acts in AD *via* excessive calcium signaling and the peroxynitrite/oxidative stress/inflammation pathway, which are each elevated by EMFs.An apparent vicious cycle in AD involves amyloid-beta protein (Aβ) and $[Ca^{2+}]i$. Three types of epidemiology suggest EMF causation of AD, including early onset AD. Extensive animal model studies show that low intensity EMFs cause neurodegeneration, including AD, with AD animals having elevated levels of Aβ, amyloid precursor protein and BACE1. Rats exposed to pulsed EMFs every day are reported to develop universal or near universal very early onset neurodegeneration, including AD; these findings are superficially similar to humans with digital dementia. EMFs producing modest increases in $[Ca^{2+}]i$ can also produce protective, therapeutic effects. The therapeutic pathway and peroxynitrite pathway inhibit each other. A summary of 18 different findings is provided, which collectively provide powerful evidence for EMF causation of AD. The author is concerned that smarter, more highly pulsed "smart" wireless communication may cause widespread very, very early onset AD in human populations.

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REVIEW

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Genetic effects of non-ionizing electromagnetic fields

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ABSTRACT

This is a review of the research on the genetic effects of non-ionizing electromagnetic field (EMF), mainly on radiofrequency radiation (RFR) and static and extremely low frequency EMF (ELF-EMF). The majority of the studies are on genotoxicity (e.g., DNA damage, chromatin conformation changes, etc.) and gene expression. Genetic effects of EMF depend on various factors, including field parameters and characteristics (frequency, intensity, wave-shape), cell type, and exposure duration. The types of gene expression affected (e.g., genes involved in cell cycle arrest, apoptosis and stress responses, heat-shock proteins) are consistent with the findings that EMF causes genetic damages. Many studies reported effects in cells and animals after exposure to EMF at intensities similar to those in the public and occupational environments. The mechanisms by which effects are induced by EMF are basically unknown. Involvement of free radicals is a likely possibility. EMF also interacts synergistically with different entities on genetic functions. Interactions, particularly with chemotherapeutic compounds, raise the possibility of using EMF as an adjuvant for cancer treatment to increase the efficacy and decrease side effects of traditional chemotherapeutic drugs. Other data, such as adaptive effects and mitotic spindle aberrations after EMF exposure, further support the notion that EMF causes genetic effects in living organisms.

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Article

The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil

Nádia Cristina Pinheiro Rodrigues [1,2,*], Adilza Condessa Dode [3], Mônica Kramer de Noronha Andrade [1], Gisele O'Dwyer [1], Denise Leite Maia Monteiro [4], Inês Nascimento Carvalho Reis [1], Roberto Pinheiro Rodrigues [5,6], Vera Cecília Frossard [1] and Valéria Teresa Saraiva Lino [1]

Abstract: Background: this study aims to estimate the rate of death by cancer as a result of Radio Base Station (RBS) radiofrequency exposure, especially for breast, cervix, lung, and esophagus cancers. Methods: we collected information on the number of deaths by cancer, gender, age group, gross domestic product per capita, death year, and the amount of exposure over a lifetime. We investigated all cancer types and some specific types (breast, cervix, lung, and esophagus cancers). Results: in capitals where RBS radiofrequency exposure was higher than 2000/antennas-year, the average mortality rate was 112/100,000 for all cancers. The adjusted analysis showed that, the higher the exposure to RBS radiofrequency, the higher cancer mortality was. The highest adjusted risk was observed for cervix cancer (rate ratio = 2.18). The spatial analysis showed that the highest RBS radiofrequency exposure was observed in a city in southern Brazil that also showed the highest mortality rate for all types of cancer and specifically for lung and breast cancer. Conclusion: the balance of our results indicates that exposure to radiofrequency electromagnetic fields from RBS increases the rate of death for all types of cancer.

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ELSEVIER

Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission

A B S T R A C T

Background: In 2011, IARC classified radiofrequency radiation (RFR) as possible human carcinogen (Group 2B). According to IARC, animals studies, as well as epidemiological ones, showed limited evidence of carcinogenicity. In 2016, the NTP published the first results of its long-term bioassays on near field RFR, reporting increased incidence of malignant glial tumors of the brain and heart Schwannoma in rats exposed to GSM – and CDMA – modulated cell phone RFR. The tumors observed in the NTP study are of the type similar to the ones observed in some epidemiological studies of cell phone users.

Objectives: The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2448 animals. In this article, we reported the final results regarding brain and heart tumors.

Methods: Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day.

Results: A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of heart Schwann cells hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), although this was not statistically significant. An increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant.

Conclusions: The RI findings on far field exposure to RFR are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the re-evaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.

WILDLIFE AND WIRELESS: POLICY IS NEEDED TO PROTECT FLORA AND FAUNA

Escalating levels of wireless RF* radiation from the proliferation of 4G and 5G telecommunication antennas pose serious risks to wildlife and the natural world. Accumulating research studies have found numerous adverse effects at levels much lower than the Federal Communication Commission (FCC) legal limits for cell tower emissions.

No Safety Standards

The FCC's federal exposure limits were designed for humans, not wildlife. "Safe" levels of RF exposure for wildlife and plants have never been developed by any scientific or government entity.

Serious Regulatory Gaps

There is no federal agency measuring or monitoring the current levels of RF in the environment, monitoring the scientific research or gathering data on wildlife impacts from wireless infrastructure.

No Environmental Review

There has been no review of the environmental impact of the 5G infrastructure buildout which the FCC states will require 800,000 new wireless "small" cells.

Higher Exposures

Birds, insects and other airborne species fly, nest and perch close to transmitting antennas. "Small" cells and cell towers emit plumes of RF radiation which can greatly exceed FCC limits, even at 10 to more than 40 feet away from the antennas. Yet these emissions are "legal" because telecom compliance tests *for RF only consider areas inhabited by people.*

Pollinators at Risk

5G networks will include higher frequencies — submillimeter and millimeter waves — which studies have found uniquely absorb at higher intensities into the bodies of bees and insects. Studies on bees have long linked cell tower frequencies to increased stress, decreased honey production and altered pupal development.

Damage to Tree Canopy

Trees are being cut down, aggressively trimmed and their roots disturbed to build "small" cell infrastructure. A ten-year field study found damage to trees after years of RF exposure from cell antennas.

The need for regulatory action is urgent. Immediate steps must be taken to reduce environmental levels of RF and develop safety standards to ensure wildlife and their habitat are protected now and in the future.





"In addition to its impact on humans, radiofrequency radiation poses harmful effects to flora and fauna."

— Natural Resources Defense Council Amicus Brief in EHT et al. v the FCC

*RF = radiofrequency

SCIENCE ON FLORA, FAUNA, WIRELESS AND NON-IONIZING RADIATION

Adequate Science To Trigger Regulatory Action To Protect Wildlife

A landmark research review by U.S experts of over 1,200 studies on the effects of non-ionizing radiation to wildlife entitled "Effects of non-ionizing electromagnetic fields on flora and fauna" published in *Reviews on Environmental Health* found adverse effects at very low intensities, including impacts to orientation and migration, reproduction, mating, nest, den building and survivorship. (Levitt et al., 2021)

"A review of the ecological effects of RF-EMF" published in *Environment International* found RF had a significant effect on birds, insects, other vertebrates, other organisms and plants in 70% of the studies. Development and reproduction in birds and insects were strongly affected. (Cucurachi et al., 2013)

The research review "Electromagnetic radiation as an emerging driver factor for the decline of insects" published in *Science of the Total Environment* found "sufficient evidence" of effects to insects, including impacts to flight, foraging, feeding, short-term memory and mortality. (Balmori, 2021)

A 2022 Oregon State University study investigated the long-term behavioral effects to zebrafish from short-term exposures to 5G's midband 3.5 GHz. The researchers found "subtle but significant abnormal responses…that suggest potential long-term behavioral effects," and they concluded, "Overall, our study suggests the impacts of RFRs on the developing brain, behavior, and the metabolome should be further explored." (Dasgupta et al., 2022)

U.S. RF Exposure Limits Unchanged Since 1996

The U.S. has the most lenient rules regarding allowable emissions from cell towers. Many countries, such as Italy, Switzerland, Israel, China, Russia and India, have environmental RF limits 10 to 100 times lower (more stringent).

India dropped its RF limits to 1/10th of U.S. limits after an Inter-Ministerial Committee set up by the Ministry of Environment and Forests reviewed the research on birds, bees, plants and animals and found the majority of studies *showed impacts*.

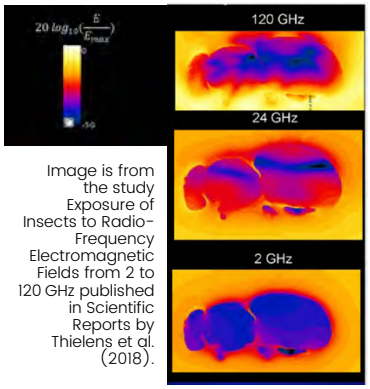


Image is from the study Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz published in Scientific Reports by Thielens et al. (2018).

This is an image of the normalized electric field strength (dB) into a Western Honey Bee at various wireless frequencies. It shows that as the wavelengths are higher (as will be used in 5G) the absorption in the bodies of insects also increases, even when the power is the same.

Norway Maple Tree, Damaged by Cell Antennas



Image: Tree Observation Guide by Helmut Breunig 2017 .

"The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today."

— U.S. Department of the Interior letter that details studies showing impacts to birds from cell tower radiation.

"The Federal Communications Commission also completely failed even to acknowledge, let alone respond to, comments concerning the impact of RF radiation on the environment."

— U.S. Court of Appeals for the D.C. Circuit Ruling in EHT et al. v. FCC

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Scientific and Policy Developments in Radiofrequency Radiation

December 2019 through November 29, 2021

Selected Research Publications Showing Adverse Effects Since the FCC Issued its Determination December 2019 Not to Update its 1996 Standards for Evaluating Wireless Radiation from Cell Phones, Electronic Devices and Networks

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New Scientific and Policy Developments in Radiofrequency Radiation

to not update its 1996 limits for radio frequency radiationA Sampling of Research Publications Showing Adverse Effects Since the FCC Issued its Determination Not to Update its 1996 Standards for Evaluating Wireless Radiation from Cell Phones, Electronic Devices and Networks

More than 75 new important scientific developments, expert reports and recommendations have been published since the FCC issued its determination to not initiate a rulemaking proceeding to update its regulatory limits for human exposure to wireless radiofrequency radiation (RFR) in December 2019.

This report showcases a small sampling of the last two years of scientific publications that have documented adverse effects of RFR exposure. Studies include impacts to wildlife and the environment, the unique vulnerability of children and the fetus, DNA damage, oxidative stress, nervous and reproductive system impacts and brain development. New experimental and epidemiological evidence for cancer tied to RFR has been published as well as papers detailing how cancers can arise from non-ionizing radiation.

Further, recent publications have documented significant health and environmental implications arising from 5G network related millimeter wave frequencies and all current and new wireless air interfaces' use of modulation, pulsation and other waveform manipulation. Wireless telecommunications signals are complex and FCC regulations do not address the biological impact of different modulations nor consider the numerous unique characteristics of real world telecommunication signals. We highlight how new landmark papers document the science indicating the urgent need to consider modulation and pulsation, rather than simply power density.

The evidence is now clear that RF emissions within the Commission's guidelines have significant negative adverse biological effects.

WILDLIFE/ENVIRONMENT

The FCC's current FCC radiofrequency radiation (RFR) emissions limits apply to human exposures.They do not address wildlife, plants or trees. Birds perch and nest on cell towers. Bats and bees and other airborne species occupy air space in close proximity to transmitting cell antennas. Wireless network densification increases RFR levels (El-Hajj & Naous, 2020) and with over 800,000 new cell sites projected[1] for the 5G buildout, environmental effects need to be properly examined because ambient RFR is increasing in wildlife habitat.

A landmark three-part research review on effects to wildlife was published in R*eviews on Environmental Health in 2021* by U.S experts, including former U.S. Fish and Wildlife senior biologist Albert Manville. The authors reviewed and cited more than 1,200 scientific references. These experts concluded that the evidence was adequate to trigger urgent regulatory action.

[1] Remarks of FCC Chairman Ajit Pai White House 5G Summit Washington DC, September 28, 2018

The review found adverse biological effects to wildlife from even very low intensity non-ionizing radiation emissions at multiple orders of magnitude below current FCC-allowed levels (Levitt et al., 2021a, Levitt et al., 2021b, Levitt et al., 2021c).

Comprehensive documentation of the biological effects of non-ionizing electromagnetic radiation to flora and fauna has never before been undertaken to this degree in any previous publication. These three experts divide their science and findings with urgent warnings into three parts: **Part 1** identifies ambient EMF adverse effects on wildlife, and notes a particular urgency regarding millimeter wave emissions and the pulsation/modulation used in 5G technologies. **Part 2** explores natural and man-made fields, animal magnetoreception mechanisms, and pertinent studies to all wildlife kingdoms. **Part 3** examines current exposure standards, applicable laws, and future directions. Their conclusions after this expansive review of the science are neither equivocal nor speculative. This environmental research review is a clarion call to develop regulations that ensure wildlife and its habitat are protected. The abstract summarizes the findings:

> "Numerous studies across all frequencies and *taxa* indicate that low-level EMF exposures have numerous adverse effects, including on orientation, migration, food finding, reproduction, mating, nest and den building, territorial maintenance, defense, vitality, longevity, and survivorship. Cyto-toxic and geno-toxic effects have long been observed. It is time to recognize ambient EMF as a novel form of pollution and develop rules at regulatory agencies that designate air as 'habitat' so EMF can be regulated like other pollutants. Wildlife loss is often unseen and undocumented until tipping points are reached. A robust dialog regarding technology's high-impact role in the nascent field of electroecology needs to commence. Long-term chronic low-level EMF exposure standards should be set accordingly for wildlife, including, but not limited to, the redesign of wireless devices, as well as infrastructure, in order to reduce the rising ambient levels."

Numerous individual studies on impacts to flora and fauna have been published over the last two years, notably several on pollinators and insects.

Two studies used scientific simulations to quantify the amount of power absorbed into the bodies of various insects for different RFR frequencies. In January 2020 researchers published "Radio-frequency electromagnetic field exposure of Western Honey Bees" in *Scientific Reports* on the absorption of RFR into honey bees at different developmental stages with phantoms simulating worker bees, a drone, a larva, and a queen (Thielens et al., 2020). The simulations were combined with measurements of environmental RF-EMF exposure near beehives in Belgium in order to estimate realistic exposures. They found absorbed RF-EMF power increases by factors of up to 16 to 121 when the frequency is increased from 0.6 GHz to 6 GHz for a fixed incident electric field strength. The implications of the impacts to such an ecologically and economically important insect species bees would be widespread and consequential.

In October 2021 a second simulation study with far-reaching implications "Radio-frequency exposure of the yellow fever mosquito (*A. aegypti*) from 2 to 240 GHz"

published in *PLOS Computational Biology* simulated the far field exposure of a mosquito between 2 and 240 GHz and found power absorption is 16 times higher at 60 GHz than at 6 GHz at the same incident field strength. This increase is even larger (by a factor of 21.8) for 120 GHz when compared to 6 GHz. The authors conclude "higher absorption of EMF by yellow fever mosquitoes, which can cause dielectric heating and have an impact on behaviour, development and possibly spread of the insect."

In 2020, a report by Alain Hill of the biological effects of non-ionizing radiation on insects found that mobile communications were a critical factor in weakening the insect world along with pesticides and habitat loss. (Khan et al., 2021) found the Apis Cerana bee becomes very passive at a certain level of frequencies and power.

In May 2021, biologistb Alfonso Balmori published "Electromagnetic radiation as an emerging driver factor for the decline of insects" in *Science of The Total Environment. concluding* that electromagnetic radiation threatens insect biodiversity worldwide. He documents sufficient evidence of non-thermal, effects of non-ionizing radiation on insects at levels well below the limits allowed by FCC guidelines, and warns that action must be taken now before significant deployment of new technologies (like with 5G) is undertaken. He cautions that the loss of insect diversity and abundance will likely provoke cascading effects on food webs and ecosystem services.

A November 2021 review of the effects of millimeter waves, ultraviolet, and gamma rays on plants found many non-thermal effects specifically from millimeter waves (Zhong et al. 2021). (The paper examined the millimeter range 30 to 300 GHz which overlaps with FCC's limits 300 kHz to 100 GHz.) Millimeter-wave irradiation stimulated cell division, enzyme synthesis, growth rate, and biomass. The review highlights how different doses and durations provoked dynamic morphophysiological effects in plants. Seed pretreatment with weak microwaves or millimeter wave irradiation altered root physiology. Different effects were observed in different plants and the authors state that, "the discordance of proteomic changes in different plants is reasonable, since different plants have a distinct tolerance to stress. Moreover, the cell tissues from soybeans and chickpeas used for proteomic analysis were different, which implies that tissue-specific or organ-specific responses of plants under millimeter-wave irradiation might exist and require further investigation." This review adds to the published analysis confirming non thermal effects from RFR. While these frequencies may have beneficial uses in agriculture, the adverse impact to trees and plants in close vicinity to transmitting antennas must be addressed.

CHILDREN

Children are proportionally more exposed to RF-EMF than adults because their brain tissue is more conductive, their skulls are thinner, and their bodies are smaller. Children are known to be at greater risk than adults when exposed to any carcinogen because of their rapidly dividing cells. Because the average latency time between first exposure and diagnosis of a tumor can be decades, tumors induced in children from RFR may not be diagnosed until adulthood. Even more importantly, children and the developing fetus are more vulnerable to

RFR because their brains and organs are still developing and more sensitive. Research over the last two years has added critical new science on children's vulnerability to health impacts from RFR and supports the acute need to reduce exposures..

To start, the Environmental Working Group published a landmark study in *Environmental Health* analyzing the findings of increased tumors and heart damage from the National Toxicology Program study and concluded that FCC limits should be strengthened by 200 to 400 times to protect children according to current risk assessment guidelines (Uche, 2021). "The analysis presented here supports a whole-body SAR limit of 2 to 4 mW/kg for adults, an exposure level that is 20- to 40-fold lower than the legally permissible limit of 0.08 W/kg for whole-body SAR under the current U.S. regulations. A ten-fold lower level of 0.2–0.4 mW/kg whole-body SAR may be appropriate for young children. Both technology changes and behavior changes may be necessary to achieve these lower exposure levels. Simple actions, such as keeping the wireless devices farther away from the body, offer an immediate way to decrease RFR exposure for the user."

(Cabré-Riera et al., 2020) investigated RFR doses in preadolescents at 9 – 12 years old. In "Estimated whole-brain and lobe-specific radiofrequency electromagnetic fields doses and brain volumes in preadolescents" published in *Environment International* the authors reveal their findings that although whole-brain and lobe-specific RF-EMF doses from all RF-EMF sources together, from mobile and DECT phone calls and far-field sources were not associated with global, cortical, or subcortical brain volumes, a higher whole-brain RF-EMF dose from mobile phone use for internet browsing, e-mailing, text messaging, tablet use, and laptop use while wirelessly connected to the internet was indeed associated with a smaller caudate volume. The caudate nucleus plays an important role in procedural learning, associative learning and inhibitory control of action and it is also one of the brain structures comprising the reward system. Analysis of cognitive impacts in another analysis (Cabré-Riera et al., 2020) found higher overall whole-brain RF-EMF doses from all RF-EMF sources together and from phone calls were associated with lower non-verbal intelligence score in Dutch and Spanish preadolescents.

Yet another publication by the same group (Cabré-Riera et al., 2021) investigated the association of estimated all-day and evening whole-brain radiofrequency electromagnetic field (RF-EMF) doses with sleep disturbances and objective sleep measures in preadolescents. The researchers, publishing their findings in *Environmental Research*, found preadolescents with high evening whole-brain RF-EMF dose from phone calls had a shorter total sleep time compared to preadolescents with zero evening whole-brain RF-EMF dose from phone calls.

A 2020 research review from the Department of Pediatrics, Hanyang University School of Medicine, Seoul, Korea (Moon, 2020) recommends precaution and minimizing EMF exposure to children, cautioning that the nervous systems of children are more vulnerable to the effects of electromagnetic waves than those of adults.

PREGNANCY

Using a mobile phone for calls for more than 30 minutes per day during pregnancy was associated with a negative impact on fetal growth (Boileau et al., 2020). Mobile phone use during pregnancy was associated with night-wake of infants (Weng et al., 2020). (Bektas et al., 2020) concluded that mobile phone exposure during pregnancy could cause oxidative stress and DNA damage in cord blood and placenta. Finally, the combined effects of Wi-Fi plus mobile phone exposure could have a higher potential to cause synergistic effects.

Recent animal research includes a study that found Wi-Fi signals increase lipid peroxidation, SOD activity (oxidative stress), apoptosis and CDKN1A and GADD45a overexpression in mice placenta tissue (Vafaei et al., 2020). A study on pregnant rats found damage to cells in the cerebellum. The authors conclude that prenatal mobile phone radiation might lead to the damage of axon, the nerve fiber, and myelin, the sheath that forms around nerves, with activity of astrocytes in cerebellum of male rat offspring (Yang et al., 2020).

CHARACTERIZING RFR EXPOSURES DURING CHILDHOOD AND PREGNANCY

Current FCC exposure levels were set in 1996 without a complete understanding of how RFR is absorbed into the fetus, pregnant women or children. Research published in 2020 and 2021 adds critical new data regarding these exposures. For example, (Foroutan et al., 2020) studied the absorption of WiFi and LTE frequencies into a 43-year-old pregnant woman model carrying a 24-week baby to allow scientists to better understand health impacts due to the interaction between electromagnetic fields and human tissue. (Psenakova et al., 2020) states "numerical results have shown that the obtained maximal SAR values in AustiWoman model is higher than are maximum values determined according to maximum SAR in European standards limit."

In "Electromagnetic Field in Vicinity of Electronic Baby Monitor" published by IEEE, (Gombarska et al., 2020) found exposures from a baby monitor to be regulation-compliant but the authors warn, "Some caution should be exercised when using such devices, in particular regarding keeping a safe distance from the little children." These and other new studies confirm the urgent need to reduce exposures, especially for children and pregnant women.

FERTILITY

Environmental Research published "A meta-analysis of in vitro exposures to weak radiofrequency radiation exposure from mobile phones (1990–2015)" describing 1127 experimental observations in cell-based in vitro models on RFR. It found less differentiated cells such as epithelium and spermatozoa are more sensitive to RF (Halgamuge et al., 2020). This study also confirms observations from the REFLEX project, Belyaev and others that cellular response varies with signal properties.

Several reviews on RFR impacts to sperm and reproduction were published over the last two years analyzing the body of evidence. A systematic review and meta-analysis (Sungjoon et al., 2021) evaluated 18 studies and found exposure to mobile phones is associated with reduced sperm motility, viability and concentration. (Yu et al., 2021) found mobile phone RFR exposure could decrease the motility and viability of mature human sperm *in vitro* and the pooled results of animal studies showed that mobile phone RF-EMR exposure could suppress sperm motility and viability. A systematic review on the effects of RFR to male reproductive hormones (Maluin et al., 2021) found that wireless can impact testosterone. The authors detail how testes are one of the most vulnerable organs to RF-EMR. Testicular tissues are more susceptible to oxidative stress due to a high rate of cell division and mitochondrial oxygen consumption.

(Okechukwu, 2020) reviewed human and animal studies published from 2003 to 2020 investigating RFR from cell phones and male fertility, publishing their findings "Does the Use of Mobile Phone Affect Male Fertility? A Mini-Review" in *Journal of Human Reproductive Sciences*. They found evidence in both animal and human spermatozoa of reduced motility, structural anomalies, and increased oxidative stress due to overproduction of reactive oxygen species after RFR exposure. The authors assert that scrotal hyperthermia and increased oxidative stress might be the key mechanisms through which EMR affects male fertility.

As an example of the experimental studies published over the last two years, an animal study on 4G found kidney inflammation and damage to the testes in mice (Hasan et al., 2021). The researchers concluded that fourth-generation cell phone radiation exposure may affect blood hemostasis and inflammation of mice's kidney and testis tissue and they warn that "based on these studies, it is important to increase public consciousness of potential adverse effects of mobile phone radiofrequency electromagnetic radiation exposure."

(Hassanzadeh-Taheri et al., 2021) assessed the effects of cell phone RFR on sperm parameters, DNA fragmentation, and apoptosis in normozoospermic and found higher apoptotic sperms and DNA fragmentation in the RFR exposed. The authors conclude: "it is recommended to keep the cell phone away from the pelvis as much as possible."

ELECTROSENSITIVITY

The International Journal of Molecular Sciences published "Electrohypersensitivity (EHS) as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It" (Belpomme & Irigaray, 2020). This paper documents the data and shows EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented. Utilizing a database of over 2000 electrohypersensitivity (EHS) and/or multiple chemical sensitivity (MCS) self-reported cases, they found EHS can be clinically characterized by a similar symptomatic picture to multiple chemical sensitivity by low-grade inflammation and an autoimmune response involving autoantibodies against O-myelin. According to the authors: "80% of the patients with EHS present with one, two, or three detectable oxidative stress

biomarkers in their peripheral blood, meaning that overall these patients present with a true objective somatic disorder."

"The Critical Importance of Molecular Biomarkers and Imaging in the Study of Electrohypersensitivity. A Scientific Consensus International Report" in the *International Journal of Molecular Sciences* is a scientific consensus international report authored by 32 scientists. They call for the acknowledgement of electrohypersensitivity as a distinct neuropathological disorder and for inclusion in the WHO International Classification of Diseases (*e.g.*, distinct from the current grouping within other ICD codes addressing exposure to non-ionizing radiation) (Belpomme et al., 2021). The paper presents the French teams' EHS/MCS physiopathological model based on low-grade neuroinflammation and oxidative/nitrosative stress-induced blood–brain barrier disruption, which attempts to account for the mechanisms through which pathophysiological effects could take place in the brain of EHS and/or MCS patients and how EHS and/or MCS pathogenesis may consequently occur. The paper also documents the methodological defects that make provocation tests unsuitable for sham versus EMF exposure analysis in EHS-bearing patients. The paper documents how EHS patients' RFR exposure has been found to increase plasma glucose levels, affect heart rate variability and in multiple sclerosis-bearing patients RFR exposure can worsen symptoms, meaning that RFR can induce objective, bioclinical alterations in humans.

BRAIN/NEUROLOGY

(Hasan et al., 2021) found long-term exposure to 2400 MHz 4G impacted the structural integrity of the hippocampus and increased anxiety-like behavior in mice. (Hu et al., 2021) published "Effects of Radiofrequency Electromagnetic Radiation on Neurotransmitters in the Brain" in *Frontiers in Public Health,* offering a review that summarizes the effects of EMR on the neurotransmitters in the brain. The nervous system is an important target organ system and is sensitive to EMF. They document research that suggests that long-term exposure to EMR may lead to abnormal norepinephrine and epinephrine contents in the brain, metabolic disorders of monoamine neurotransmitters in the brain and excitatory amino acid neurotransmitters in the hippocampus, "which may affect the excitatory-inhibitory balance of neurons, thus causing a decline in learning and memory ability." The authors also considered the underlying mechanism as "EMR exposure does increase the intracellular calcium and the formation of ROS, which would alter the cellular function eventually and lead to numerous biological effects including neurotransmitter imbalance." The authors call for more research to clarify effects.

A systematic review (Bertagna et al., 2021) published in *Annals of the New York Academy of Sciences* found that neuronal ion channels are particularly affected by EMF exposure. Changes in calcium homeostasis, attributable to the voltage-gated calcium channels, were the most commonly reported result of EMF exposure. EMF effects on the neuronal landscape appear to be diverse and greatly dependent on parameters like the field's frequency, exposure time, and intrinsic properties of the irradiated tissue, such as the expression of VGCs. The researchers systematically clarify how neuronal ion channels are particularly affected and differentially modulated by EMFs at multiple levels, such as gating dynamics, ion conductance,

concentration in the membrane, and gene and protein expression. Ion channels represent a major transducer for EMF-related effects on the CNS.

(Tan et al., 2021) evaluated the acute effects of 2.856 GHz and 1.5 GHz microwaves to male rats and found exposures induced a decline in spatial memory.

"Exposure of Radiofrequency Electromagnetic Radiation on Biochemical and Pathological Alterations" in *Neurology India* (Sharma et al., 2020) found 800 MHz frequency at a SAR of 0.433 W/kg in male Wistar rats led to neurochemical and pathophysiological damage by initiating the inflammatory process in various brain regions, especially in hippocampus and cerebral cortex. The authors conclude that since the hippocampus involves storing and retaining information during the learning process, RFR exposure negatively affects the memory and learning process and "could be a huge risk of induction of brain damage."

(Hinrikus et al., 2021) review "Threshold of radiofrequency electromagnetic field effect on human brain" in the *International Journal of Radiation Biology* found the threshold for EEG effects is far lower than the level deemed safe by the U.S. FCC. The lowest level of RF EMF at which the effect in EEG was detected is 2.45 V/m (SAR = 0.003 W/kg). The authors state the changes in EEG caused by RF EMF appeared similar in the majority of analyzed studies and similar to those found in depression. They conclude that the "possible causal relationship between RF EMF effect and depression among young people is [a] highly important problem."

(Luo et al., 2021) in their paper "Electromagnetic field exposure-induced depression features could be alleviated by heat acclimation based on remodeling the gut microbiota" published in *Ecotoxicology and Environmental Safety* share their findings that pulsed electromagnetic fields (2450 MHz) caused gut microbiota and metabolites disturbance similar to depression model. "In our study, EMF induced disturbance in the metabolite profiles of serum samples. Significantly different metabolites included cholesterol, D-fructose and fumaric acid and these were associated with depression (Xiong et al., 2020). Based on KEGG classification, the metabolites involved in neurotransmitters and steroids were altered significantly."

They concluded that "our study demonstrated that EMF exposure could not only lead to neurobehavioral disorders such as depression, but also cause gut microbiota imbalance." The researchers also referenced how "growing evidence indicates that the gut microbiota affects not only gastrointestinal function but also central nervous system (CNS) physiology and behavior by regulating the microbiota-gut-brain axis."

OXIDATIVE STRESS

More recently published studies demonstrate consistency for the induction of oxidative stress. Oxidative DNA damage can lead to mutations, chromosomal translocations, and genomic instability, which are cellular events that can result in cancer development. Induction of oxidative stress, which is a key characteristic of many human carcinogens including ionizing radiation and asbestos, may also lead to the genotoxicity and carcinogenicity of non-ionizing

RFR. Oxidative stress caused by EMFs is thought to be due to the altering of recombination rates of short-lived radical pairs leading to increases in free radical concentrations. Thus, even without causing direct DNA damage, RFR may induce oxidative DNA damage and thereby initiate or promote tumor development.

(Schuermann & Mevissen, 2021) published a major review on oxidative stress, "Manmade Electromagnetic Fields and Oxidative Stress – Biological Effects and Consequences for Health" in *International Journal of Molecular Sciences*. The authors found increased oxidative stress in the majority of animal studies and cell studies, many with exposures compliant with FCC and ICNIRP regulatory limits. Increased oxidative stress caused by RF-EMF and ELF-EMF were reported in the majority of the animal studies and in more than half of the cell studies. Investigations in Wistar and Sprague-Dawley rats provided consistent evidence for oxidative stress occurring after RF-EMF exposure in the brain and testes and some indication of oxidative stress in the heart. Observations in Sprague-Dawley rats also seem to provide consistent evidence for oxidative stress in the liver and kidneys. "A trend is emerging, which becomes clear even when taking these methodological weaknesses into account, i.e., that EMF exposure, even in the low dose range, may well lead to changes in cellular oxidative balance." The authors explain that pre-existing conditions like diabetes and neurodegenerative diseases compromise the body's defense mechanisms, including antioxidant protection processes, and individuals with pre-existing conditions are more likely to experience health effects. Further, very young or old individuals can react less efficiently to oxidative stress. This puts them at greater risk of health impacts.

"Effects of different mobile phone UMTS signals on DNA, apoptosis and oxidative stress in human lymphocytes" (Gulati et al., 2020) published in *Environmental Pollution* comparatively analyzed genotoxic effects of UMTS signals at different frequency channels used by 3G mobile phones (1923, 1947.47, and 1977 MHz) and found a relatively small but statistically significant induction of DNA damage in dependence on UMTS frequency channel with maximal effect at 1977.0 MHz, supporting the notion that each specific signal used in mobile communication should be tested.

"Effects of pulse-modulated radiofrequency magnetic field (RF-EMF) exposure on apoptosis, autophagy, oxidative stress and electron chain transport function in human neuroblastoma and murine microglial cells" published by (Zielinski et al., 2020) in *Toxicology in Vitro* investigated the effects of ELF-modulated 935 MHz RF-EMF on apoptosis, autophagy, oxidative stress and electron exchange in human neuroblastoma and murine microglial cells. The authors found effects indicating that "short-time RF-EMF at SAR levels accepted by today's safety guidelines might cause autophagy and oxidative stress with the effect being dependent on cell type and exposure duration. Further studies are needed to evaluate possible underlying mechanisms involved in pulse-modulated RF-EMF exposure."

(Singh et al., 2020) exposed male Wistar rats to RFR for 16 weeks (2 h/day) and observed oxidative stress, an inflammatory response, and HPA axis deregulation. "Effect of mobile phone radiation on oxidative stress, inflammatory response, and contextual fear memory

in Wistar rat" was published in *Environmental Science and Pollution Research International.* The study shows that chronic exposure to MP-RF-EMF radiation emitted from mobile phones may induce oxidative stress, inflammatory response, and HPA axis deregulation.

(Hussien et al., 2020) found a significant decrease in plasma nesfatin-1 level and thyroid functions with an increase in oxidative stress and apoptosis. Further, there was a correlation between nesfatin-1 level and markers of thyroid function, oxidative stress and apoptosis. The researchers conclude that Nesfatin-1 plays a role in thyroid dysfunctions of rats exposed to mobile phone radiation. The authors' "Decreased level of plasma nesfatin-1 in rats exposed to cell phone radiation is correlated with thyroid dysfunction, oxidative stress, and apoptosis" published in *Archives of Physiology and Biochemistry* details these findings.

GENOTOXICITY/ DNA DAMAGE

Major studies using validated experimental protocols published in 2020 and 2021 associate non-ionizing RFR exposure with DNA damage.

In February 2020, U.S. government scientists published landmark findings of "significant increases in DNA damage" in groups of male mice, female mice and male rats after just 14 to 19 weeks of non-thermal cell phone RFR exposure as part of the large scale National Toxicology Program cell phone animal studies (Smith-Roe et al., 2020). "Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure" published in *Environmental and Molecular Mutagenesis* details the much-anticipated results of the comet assay showing significant increases in DNA damage in the frontal cortex of male mice (both modulations), leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). Increases in DNA damage judged to be equivocal were observed in several other tissues of rats and mice. "In conclusion, these results suggest that exposure to RFR is associated with an increase in DNA damage." In short, DNA damage was found at non-thermal RFR levels, levels the FCC regulatory limits presume are harmless.

The authors explain that the NTP studies were designed to evaluate non-thermal effects of cell phone RFR exposure, which meant that body temperature could not change more than 1° C and therefore the NTP scientists considered it unlikely that thermal effects were a confounding factor for these genetic toxicity tests. Thus, this data again adds to the large body of evidence confirming that the assumption that non-ionizing radiation does not cause any adverse health effects other than by heating is wrong. The study is a game changer because the NTP exposures were carefully controlled and NTP studies are considered the gold standard in animal testing.

In "Genetic effects of non-ionizing electromagnetic fields" published in *Electromagnetic Biology and Medicine,* (Lai, 2021) reviewed the research on the genetic effects of non-ionizing electromagnetic fields and found many studies reported effects in cells and animals after exposure to EMF at intensities similar to those in the public and occupational environments. Approximately 70% of reviewed studies showed effects including DNA strand breaks,

micronucleus formation, and chromosomal structural changes. Lai highlights how the effects are waveform and cell-type specific.

Dr. Lai's findings underscore the complexity of interactions between EMF and biological tissues, and may partially explain why effects were observed in some studies but not others. Lai states it is essential to understand why and how certain wave-characteristics of an EMF are more effective than other characteristics in causing biological effects, and why certain types of cells are more susceptible to EMF effects. Very significantly, Dr. Lai asserts that "there are different biological effects elicited by different EMF wave-characteristics" and this is a critical proof for the existence of non-thermal effects.

The review explains how genetic effects depend on various factors, including field parameters and characteristics (frequency, intensity, wave-shape), cell type, and exposure duration. Lai also found non-ionizing EMFs interact synergistically with different entities on genetic functions. These interactions, particularly with chemotherapeutic compounds, raise the possibility of using EMF as an adjuvant for cancer treatment to increase the efficacy and decrease side effects of traditional chemotherapeutic drugs.

Lai explains that since the energy level is not sufficient to cause direct breakage of chemical bonds within molecules, the effects are probably indirect and secondary to other induced chemical changes in the cell. He suspects that biological effects are caused by multiple inter-dependent biological mechanisms. He states that the mechanism remains to be uncovered, "but, knowing the mechanism is not necessary to accept that the data are valid. It is also a general criticism that most EMF studies cannot be replicated. I think it is a conceptual and factual misstatement. Replication is also not a necessary and sufficient condition to believe that certain data are true." Lai then states that, "to prove an effect, one should look for consistency in data. Genetic damage studies have shown similar effects with different set-up and in various biological systems. And, the gene expression results (Supplement 3) also support the studies on genetic damages. Expression of genes related to cell differentiation and growth, apoptosis, free radical activity, DNA repair, and heat-shock proteins have been reported. These changes could be consequences of EMF-induced genetic damages."

An October 2021 review "Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review)" in the *International Journal of Oncology* describes the cascade of effects from non-ionizing EMFs that lead to DNA damage. (Panagopoulos et al., 2021) documents the scientific research base indicating EMF exposures lead to ion channel dysfunction. According to the ion forced-oscillation mechanism for dysfunction of VGICs, human-made (polarized and coherent) ELF/ULF EMFs or the ELF/ULF modulation/pulsing/variability components of modern RF/WC EMFs can alter intracellular ionic concentrations by irregular gating of VGICs on cell membranes. This leads to immediate oxidative stress by ROS [oxidative stress that cause damage to lipids, proteins and DNA] (over)production in the cytosol and/or the mitochondria, which can damage DNA when cells are unable to reinstate electrochemical balance (normal

intracellular ionic concentrations). Consequently, DNA damage can lead to reproductive disabilities, neurodegenerative diseases, aging, genetic alterations and cancer.

Moreover, the review addresses how, in addition to polarization and coherence, ELFs are a common feature of almost all human-made EMFs. The authors suggest that the non-thermal biological effects attributed to RF EMFs are actually due to their ELF components. The researchers conclude that, "The long-existing experimental and epidemiological findings connecting exposure to human-made EMFs and DNA damage, infertility and cancer, are now explained by the presented complete mechanism. The present study should provide a basis for further research and encourage health authorities to take measures for the protection of life on Earth against unrestricted use of human-made EMFs."

NEW GOVERNMENT REPORTS AND RECOMMENDATIONS

The European Union

In July 2021, the European Parliament Panel for the Future of Science and Technology European Parliamentary Research Service Report "Health Impact of 5G" offered a review of the epidemiological and experimental evidence which has significantly increased since 2011 when the International Agency for Research on Cancer (IARC) classified radiofrequency (RF) EMF as "possibly carcinogenic to humans" (Group 2B). Due to the post-2011 published research, the IARC advisory group has now recommended RF exposure for re-evaluation "with high priority" (IARC, 2019). The report concludes that the body of evidence now indicates that the frequencies of 450 to 6,000 MHz are "probably carcinogenic for humans, in particular related to gliomas and acoustic neuromas."

For non-cancer effects the EU Report concludes that there was sufficient evidence of reproductive/developmental adverse effects in experimental animals and "these frequencies clearly affect male fertility and possibly female fertility too. They may have possible adverse effects on the development of embryos, foetuses and newborns." In regards to 5G's higher frequencies (24.25-27.5 GHz), and frequencies 24 to 100 GHz the systematic review found there was an inadequate base of studies either in humans or in experimental animals with which to even substantiate a conclusion one way or the other regarding a carcinogenic effect or any other non-thermal effect.

The report makes several policy recommendations, including:

- Adopting stricter RFR limits for mobile phone devices and reducing RFR exposure with devices that emit lower energy and "if possible only working when at a certain distance from the body".
- Revisiting RFR exposure limits for the public and the environment in order to reduce RF-EMF exposure from cell towers through more stringent limits such as those used in Italy, Switzerland, China, and Russia - all of which are significantly lower than those recommended by ICNIRP and the FCC.

- Adopting measures to incentivise the reduction of RF-EMF exposure which include using optic-fibre cables to connect schools, libraries, workplaces, houses, public buildings, and all new buildings etc. “Public gathering places could be 'no RF-EMF' areas (along the lines of no-smoking areas) so as to avoid the passive exposure of people not using a mobile phone or long-range transmission technology, thus protecting many vulnerable elderly or immune-compromised people, children, and those who are electro-sensitive.”
- Promoting a multidisciplinary scientific research effort to assess the long-term health effects of 5G millimeter waves (MMW) in order to rule out the risk that tumours and adverse effects on reproduction and development may occur upon exposure to 5G MMW, and to exclude the possibility of synergistic interactions between 5G MMW networks and other frequencies and networks that are already being used. Research is needed on the biological effects of 5G MMW at frequencies between 6 and 300 GHz not only for humans but also for the flora and fauna of the environment, e.g. non-human vertebrates, plants, fungi, and invertebrates.
- Promoting research to identify an adequate method of monitoring exposure to 5G because there is currently inadequate monitoring of the actual exposure of the population.
- Promoting a public educational awareness campaign on the potential harms of RFR at all levels, beginning with schools. This campaign should include the potential health risks, opportunities for digital development, safer infrastructure alternatives, and strategies to reduce exposure to wireless phones.

The report concludes that the gaps in knowledge in regards to 5G’s higher frequencies justify the call for a moratorium on 5G millimeter wave networks, pending completion of adequate research, “before exposing the whole world population and environment.” The report’s conclusion carries a very clear warning: “Implementing MMW 5G technology without further preventive studies would mean conducting an 'experiment' on the human population in complete uncertainty as to the consequences.”

In 2020, the European Parliament briefing Effects of 5G wireless communication on human health reviewed the various policies and reports in Europe including: 1) the 2011 Council of Europe Parliamentary Assembly Resolution 1815 that recommended reducing RFR exposure; the fact that the European Environment Agency (EEA) has long advocated precaution concerning EMF exposure; 2) the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) 2015 opinion and the organizations that suggest many members of SCENIHR could have conflict of interests, as they had professional relationships with or received funding from various telecom companies; 3) the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), replacing the former Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) evaluated the scale, urgency and interactions (with ecosystems and species) of possible hazard from 5G *as high as* “there could be biological consequences from a 5G environment.”

The briefing also highlighted the biological impacts from pulsations and modulations stating, “Studies show that pulsed EMF are in most cases more biologically active and therefore more dangerous than non-pulsed EMF. Every single wireless communication device

communicates at least partially via pulsations, and the smarter the device, the more pulsations. Consequently, even though 5G can be weak in terms of power, its constant abnormal pulse radiation can have an effect. Along with the mode and duration of exposures, characteristics of the 5G signal such as pulsing seem to increase the biologic and health impacts of exposure, including DNA damage, which is considered to be a cause of cancer. DNA damage is also linked to reproductive decline and neurodegenerative diseases."

A review of occupational EMF exposures (Stam, 2021) of the National Institute for Public Health and the Environment of the Netherlands pointed to the need for exposure guidelines and regulation to incorporate new technology developments, especially in regards to 5G applications. Although ICNIRP's thermally-based RFR limits were used as the action level in this article (and adverse biological effects have been found at non-thermal levels as documented in this report), this paper highlights the critical need to characterize occupational exposures and better assess health effects because of the new wireless networks found in the modern workplace.

In April 2020, the Swiss Parliament refused to weaken their RFR radiation limits. In September 2020, the Netherlands issued a 5G and Health Advisory Report that recommended measuring environmental levels of RFR (an action the FCC does not take) and importantly, the Report also recommended *against* using the 26 GHz frequency band for 5G "for as long as the potential health risks have not been investigated."

Starting in July 2020, new French government policy ensures that wireless companies label tablets, laptops, Wi-Fi routers, DECT phones and other wireless connected electronics with RFR SAR exposure levels at point of sale and in all advertising. Legislation in the country has long ensured labeling cell phones for SAR levels, but this did not apply to other wireless devices. Now all wireless devices used close to the head and body are potentially covered.The ANFR (The National Frequency Agency) SAR Regulation Guide lists the equipment qualified as radio equipment that required SAR testing. One category includes mobile phones, tablets equipped with a 3G or 4G/5G SIM card, connected watches that contain a mobile phone SIM card, 3G or 4G/5G pocket format routers, Maritime Portable VHF, laptops (3G or 4G/5G); and the second category includes DECT cordless phones, walkie-talkies or equivalent devices (PMR), tablets operating using Wi-Fi or bluetooth, wireless microphones, radio controls used for drones or model making, connected motorcycle helmets and Wi-Fi laptops. ANFR states that technological evolutions in connected objects may lead to the extension of this labeling to include radio frequency belts, connected glasses ("smart glasses"), wireless headphones or headsets, portable safety sensors (distance sensors) and virtual reality headsets.

Expert Recommendations to Minimize Exposure to Children

Since the COVID pandemic, there have been several new expert recommendations to reduce RFR exposure for children in virtual education on computers for 7 hours or more a day. For example, in April 2020 the Cyprus National Committee on Environment and Children's Health released recommendations for parents on how to set up wired internet. In March 2020,

the Scientific Research Institute of Hygiene and Children's Health of the Russian Ministry of Health and the Russian National Committee on Non-Ionizing Radiation Protection also released recommendations for distance learning including restricting cell phones, using wired connections rather than Wi-Fi, reading real books and writing in real notebooks to support learning objectives. In November 2020, the Switzerland Doctors for Environmental Protection (AefU) released "Consistently apply the precautionary principle in mobile communications" demanding a reduction in exposure for children and youth.

Expert Appeals

Expert recommendations to reduce public and environmental exposures have escalated over the last two years. The 2020 Consensus Statement of UK and International Medical and Scientific Experts and Practitioners on Health Effects of Non-Ionising Radiation (NIR) was signed by over 3500 medical doctors cautioning: "Hundreds of peer-reviewed scientific studies have demonstrated adverse biological effects occurring in response to a range of NIR [non-ionizing radiation] exposures below current safety guidelines; however emissions continue to escalate. Medical evidence of harm has now reached the critical mass necessary to inspire the medical community to step out of their usual roles, stand up and speak out regarding their concern."

Expert groups have continued to organize and call for urgent action in various countries. For example, in October 2020 a letter signed by 135 health professionals in Chile requested a moratorium on the deployment of 5G technology, and a 5G Appeal was launched in support of a new 5G petition: "Apoya con tu firma la carta de solicitud de moratoria al 5G en Chile enviada al Ministro Paris"; English Translation: "With your signature, support the letter requesting a moratorium on 5G in Chile sent to Minister Paris".

In France, a September 2020 petition addressed to the Prime Minister was signed by over 60 elected officials urging the government to assess environmental effects before deploying 5G. In Canada, the Urgent Appeal to the Government of Canada to Suspend the 5G Rollout and to Choose Safe and Reliable Fiber Connections was launched by Canadians for Safe Technology (C4ST) in May 2020. The Appeal calls for a systematic review of the scientific evidence of health effects of RFR as well as binding guidelines to protect wildlife and the environment from RFR. The CEO of C4ST calling for this review is Frank Clegg, the former Chairman of Microsoft Canada.

Medical Conference on EMF

In 2021, the EMF Medical Conference 2021 presented evidence based information on the prevention, diagnosis and treatment of EMF associated illness featuring leading EMF experts in science, medicine, health and assessment. These proceedings are available as online courses for continuing medical education credits for medical doctors and health professionals. See www.emfconference2021.com

Expert Recommendations in the USA

The New Hampshire State Commission released its 2020 Report on 5G Health and Environment with 15 recommendations that included reducing public exposure to RFR via wired (not Wi-FI) internet connections in schools and libraries; software changes to phones and wireless devices to minimize exposure; informing the public about RFR exposures via educational campaigns and public posting of RFR levels; government measuring of RFR exposures; developing updated safety standards to protect the public and environment; and ensuring independent scientific review of the research.

On June 17th, 2020, over U.S. 400 medical professionals wrote the FCC a letter calling for consideration of non-thermal biological impacts. The Alliance of Nurses for Healthy Environments (ANHE), a national organization of nurses, also sent a 2020 letter calling for the FCC to address the science on children's vulnerability.

Over the last two years, several U.S. cities have passed resolutions and policies to halt increased RFR exposure and to ensure adequate scientific review of the health effects of RFR radiation. For example, Hawai'i County (July 2020), Easton Connecticut (May 2020), Keene New Hampshire (March 2020) and Farragut Tennessee (May 2020) have passed resolutions to halt 5G. The Coconut Creek Florida Commission adopted a Resolution on 5G and radiofrequency radiation (November 2020) "imploring the US Congress to allocate funding and direct a cross discipline federal agency study of the effects caused by exposure to current and proposed electromagnetic spectrum and radiofrequency commissions on human health and the environment in light of the recent implementation of fifth generation technology and to use those findings to create science based laws or rules regarding limiting human and environmental exposure."

On April 2, 2021 Montgomery County Maryland Council President Hucker and County Executive Elrich sent a letter to U.S. Senator Chris Van Hollen that included two specific requests regarding RFR:

> *"Request responsibility for setting RF standards be transferred from the Federal Communications Commission (FCC) - a regulatory agency - to the National Institute of Standards and Technology (NIST) - a standards setting body. Direct NIST to complete a review of credible published papers on the health effects of RF emissions on humans, including women and children, and tests to measure biological impact on humans, and thermal and biological tests of RF at different frequencies within 6 months. Further direct NIST to create and update thermal and biological standards for smartphones, small cells, and household Internet-of-Things (IoT) devices, Wi-Fi, and Bluetooth devices within 2 years and review and update standards every 5 years thereafter.*

Environmental Groups

Internationally and in the USA, environmental groups have issued statements and positions calling for protections for the environment before allowing wireless network proliferation. For example, in 2021, a major environmental group in Spain, Ecologistas en Accion or Ecologists in Action issued a position on 5G calling for precaution. They propose information campaigns, reducing exposure, monitoring compliance and requiring transparency, impartiality and plurality in health risk assessments. They also recommend wireless networks are replaced with wired connections and the recognition of electrohypersensitivity syndrome as an environmental disease with protections that include the creation of EMF-free zones.

In February 2021, the Green Party of California issued a Statement on 5G Wireless Technology advocating for "robust and independent scientific environmental review of 4G/5G wireless exposure" and to reduce exposures per the As Low As Reasonably Achievable (ALARA) principle. It is notable that environmental organizations are also issuing statements regarding the increased energy consumption of 5G. For example, Greenpeace France's "What is Digital Pollution" addresses how 5G will increase "digital pollution." Several investigative articles have been published on the environmental impacts including "How Green is 5G?" published November 2021 in Envirotech Magazine; "What Will 5G Mean for the Environment?" published January 2020 by Clair Curran of the Henry M. Jackson School of International Studies; and "Is Wireless Technology an Environmental Health Risk?" published January 2021 by Katie Alvord in the journal of the Society of Environmental Journalists.

5G NETWORKS AND MILLIMETER WAVE FREQUENCIES

The review paper "Adverse health effects of 5G mobile networking technology under real-life conditions" (Kostoff et al., 2020) published in *Toxicology Letters* identified a wide range of adverse systemic effects from 5G network deployment when real life conditions are considered such as the information content of signals along with the carrier frequencies and other toxic stimuli that can act in combination with the exposure. Many experiments do not include the real-life pulsing and modulation of the carrier signal. The vast majority of experiments do not account for synergistic adverse effects of other toxic stimuli with wireless radiation. 5G mobile networking technology will affect the skin and eyes and has adverse systemic effects. "In aggregate, for the high frequency (radiofrequency-RF) part of the spectrum, these reviews show that RF radiation below the FCC guidelines can result in: carcinogenicity (brain tumors/glioma, breast cancer, acoustic neuromas, leukemia, parotid gland tumors), genotoxicity (DNA damage, DNA repair inhibition, chromatin structure), mutagenicity, teratogenicity, neurodegenerative diseases (Alzheimer's Disease, Amyotrophic Lateral Sclerosis), neurobehavioral problems, autism, reproductive problems, pregnancy outcomes, excessive reactive oxygen species/oxidative stress, in ammation, apoptosis, blood-brain barrier disruption, pineal gland/melatonin production, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, tinnitus, burning and flushed skin, digestive disturbance, tremor, cardiac irregularities, adverse impacts on the neural, circulatory, immune, endocrine, and skeletal systems." The authors conclude that "Superimposing 5G radiation on an already imbedded toxic wireless radiation environment will exacerbate the adverse health

effects shown to exist. Far more research and testing of potential 5G health effects under real-life conditions is required before further rollout can be justified."

In "Absorption of 5G Radiation in Brain Tissue as a Function of Frequency, Power and Time" published in *IEEE Access* (Gultekin & Siegal, 2020) examines the beam penetration, absorption and thermal diffusion at representative 4G and 5G frequencies and shows that RF heating increases rapidly with frequency due to decreasing RF source wavelength and increasing power density with the same incident power and exposure time.

(Trillo et al., 2021) in their paper "Effects of the signal modulation on the response of human fibroblasts to in vitro stimulation with subthermal RF currents" published in *Electromagnetic Biology and Medicine* found the modulated signal was more efficient in inducing Hsp27 and decorin overexpression and promoting cell proliferation. "These data indicate that the cellular response is dependent on the RF signal modulation…"

5G human exposure studies include (Kim & Nasim, 2020). In their paper "Human Electromagnetic Field Exposure in 5G at 28 GHz" published in *IEEE Consumer Electronics Magazine* the authors compared the human EMF exposure in a 5G system to previous-generations of cellular systems. They suggest a minimum separation distance between a transmitter and a human user in order to keep exposure compliant with regulatory limits.

In their paper "Human RF-EMF Exposure Assessment Due to Access Point in Incoming 5G Indoor Scenario" published in *IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology* (Bonato et al., 2021) simulated the exposure to an adult and child from an indoor 5G access points (3.7 GHz and at 14 GHz) to evaluate how beamforming and the higher frequency use could impact exposure levels and found the reciprocal position between the antenna and the model head and the frequency range and the distance are factors that could greatly influence the exposure levels.

"Physiological effects of millimeter-waves on skin and skin cells: an overview of the to-date published studies" published in *Reviews on Environmental Health* is an overview of the physiological effects of millimeter waves on skin and skin cells (Leszczynski, 2020) by Dr. Leszczynski, one of the IARC working group members who voted 29 to 1 in May 2011 to classify RF-EMF as a 2B or "possible human" carcinogen. The author explains how the skin and eyes are directly exposed to the millimeter-waves from 5G and yet the current body of research on millimeter-waves is insufficient to devise science-based exposure limits and policies. He recommends precautionary measures such as postponing or limiting 5G deployment in residential areas until adequate research studies scientifically establish safety thresholds.

In "Limiting liability with positioning to minimize negative health effects of cellular phone towers" published in *Environmental Research* (Pearce, 2020) summarizes the peer-reviewed literature on the effects of RFR from cellular phone base stations and concludes that, "to protect cell phone tower firms, companies should seek to minimize human RFR exposure" because there is "already enough medical-scientific evidence to warrant long-term liability concerns."

In "Millimeter (MM) wave and microwave frequency radiation produce deeply penetrating effects: the biology and the physics" published in *Reviews on Environmental Health*, (Pall, 2021)

highlights three very important findings “rarely recognized in the EMF scientific literature: coherence of electronically generated EMFs; the key role of time-varying magnetic fields in generating highly penetrating effects; the key role of both modulating and pure EMF pulses in greatly increasing very short term high level time-variation of magnetic and electric fields. It is probable that genuine safety guidelines must keep nanosecond timescale-variation of coherent electric and magnetic fields below some maximum level in order to produce genuine safety. These findings have important implications with regard to 5G radiation.”

STANDARDS

The Environmental Working Group modeled the health effects incidence data from the National Toxicology Program (NTP) cell phone radiation studies to estimate departure points for exposure guidelines in a landmark analysis published in *Environmental Health*. The NTP study reported an increased incidence of cardiomyopathy in female and male rats and increased incidences of various neoplasms in male rats. They concluded that FCC limits should be strengthened by 200 to 400 times to protect children according to current risk assessment guidelines concluding that ”the analysis presented here supports a whole-body SAR limit of 2 to 4 mW/kg for adults, an exposure level that is 20- to 40-fold lower than the legally permissible limit of 0.08 W/kg for whole-body SAR under the current U.S. regulations. A ten-fold lower level of 0.2–0.4 mW/kg whole-body SAR may be appropriate for young children.

Both technology changes and behavior changes may be necessary to achieve these lower exposure levels. In “Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach” published in *Environmental Health*, the authors suggest: “Simple actions such as keeping the wireless devices farther away from the body offer an immediate way to decrease RFR exposure for the user.” (Uche, 2021)

In April 2020, Barnes and Greenebaum published “Setting Guidelines Electromagnetic Exposures Research Needs”, in *Bio Electro Magnetics* about the fact that current limits for exposures to non-ionizing electromagnetic fields do not address long-term exposures but are instead based on relatively short-term exposures. “What is missing in the current guidelines or regulations are guidelines for long-term exposure to weak EMF.” The authors document the science substantiating their recommendations for next steps regarding research and approaches for more protective exposure guidelines. They conclude that the science is sufficient indicating biological impacts at low levels:

> *“However, over the last 20 years the evidence has become extremely strong that weaker EMF over the whole range for frequencies from static through millimeter waves can modify biological processes. There is now solid experimental evidence and supporting theory showing that weak fields, especially but not exclusively at low frequencies, can modify reactive free radical concentrations and that changes in radical concentration and that of other signaling molecules, such as hydrogen peroxide and calcium, can modify biological processes…”*

The authors posit with copious scientific documentation how non-ionizing EMFs can impact cancer cell growth rates, membrane potentials, concentrations of calcium, reactive oxygen species (ROS), superoxide (O2−), nitric oxide (NO), hydrogen peroxide (H2O2), and intercellular pH, specifically highlighting the issue of oxidative stress as long-term elevations ``are associated with cancer, aging, and Alzheimer's." They highlight how funding for research into the effects of EMF in the United States "is close to nonexistent" and make numerous recommendations for research studies. They also recommend, for example, that guidelines be set at three levels: the individual user, local company, and national or international level and posit that recommended limits could well be a function of frequency, amplitude, and modulation systems as well as be dependent on the condition of the person being exposed. Barnes and Greenebaum acknowledge, "There seem to be a smaller number of 'hypersensitive people' who have very real and serious problems" from exposure to weak RF fields.

The co-authors conclude: "We believe a carefully targeted program of federal research funds is called for, supplemented by communications system operators and corporations that manufacture equipment, under independent scientific management. Both governmental and private entities that emit RF signals would be well advised to fund research to elucidate and define threshold signal levels for the generation of long-term biological effects."

CANCER

The evidence that RFR is a human carcinogen has continued to increase with the publication of several new research studies and papers. Furthermore, cancer incidence is rising among children and young adults. The latest U.S. Annual Report to the Nation on the Status of Cancer (a collaborative effort among the American Cancer Society, the Centers for Disease Control and Prevention, the National Cancer Institute, part of the National Institutes of Health; and the North American Association of Central Cancer Registries) published in *Journal of the National Cancer Institute* found higher overall cancer incidence rates in children and young adults in almost all racial/ethnic groups, with increasing trends for the most common cancer types among children including leukemia, brain and other nervous system cancers, and lymphoma.

In November 2020 a systematic review and meta-analysis of case-control studies by (Choi et al., 2020), "Cellular Phone Use and Risk of Tumors: Systematic Review and Meta-Analysis", was published in *Environmental Research and Public Health.* The authors found evidence that linked cellular phone use to increased tumor risk. The meta-analysis established that 1,000 or more hours of cell phone use, or about 17 minutes per day over 10 years, was associated with a statistically significant 60% increase in brain tumor risk.

In their paper "Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut" published in *Environmental Research* (Luo et al., 2020), the Yale researchers with support from the American Cancer Society found cell phone use was significantly associated with thyroid cancer in people with a type of common genetic variation. The association increased as cell phone use

duration and frequency increased. The authors conclude that their findings “provide more evidence for RFR carcinogenic group classification.”

Regarding the impact of EMFs to the thyroid, a 2021 review by California Institute of Behavioral Neurosciences & Psychology researchers (Alkayyali et al., 2021) focused on thyroid hormones and thyroid gland histopathology documented studies indicating that RFR could be associated with alterations in hormone levels and impacts such as the hyperstimulation of thyroid gland follicles, causing oxidative stress and apoptosis of follicular cells. In “An Exploration of the Effects of Radiofrequency Radiation Emitted by Mobile Phones and Extremely Low Frequency Radiation on Thyroid Hormones and Thyroid Gland Histopathology” published in *Cureus*, the researchers found studies correlated thyroid impacts to the exposure duration, intensity, and SAR value of the RFR exposure. The authors state that “non-ionizing EMF radiation might be responsible for the recent increase in the incidence of thyroid insufficiency and cancer in the general population.”

In “The Effect of Continuous Low-Intensity Exposure to Electromagnetic Fields from Radio Base Stations to Cancer Mortality in Brazil” (Rodrigues et al. 2020) published their findings in the *International Journal of Environmental Research and Public Health* linking higher exposure to radio frequency radiation from cell antenna installations in Brazil to increased deaths from cancers. For all cancers and for the specific types investigated (breast, cervix, lung, and esophagus cancers), the higher the exposure, the higher the median of mortality rate.

The last two years of research has significantly increased the scientific evidence that RFR can increase oxidative stress, a hallmark of cancer, addressed earlier in this document. However, in addition, there are other endpoints associated with cancer that have been published in the last two years increasing the evidence related to the carcinogenicity of RFR. For example, (Ghandehari et al. 2021) found increased cell phone usage significantly correlated with a higher frequency of the micronucleus containing buccal mucosa cells and a higher frequency of micronucleus in each cell in the buccal mucosa. In “Micronucleus Assay in Cell Phone Users: Importance of Oral Mucosa Screening” published in *International Journal of Preventive Medicine*, the authors surmise, “Based on these results, it can be concluded that human buccal cells are likely to show increased micronucleus cells as a result of the genotoxic effects of cell phone waves which have been chronically exposed.”

Micronuclei are biomarkers of disease and they play an active role in tumor biology (Kwon et al. 2020). (Yao et al. 2021), in “The biological effects of electromagnetic exposure on immune cells and potential mechanisms” published in *Electromagnetic Biology and Medicine*, undertake a review of the biological effects of electromagnetic exposure on immune cells. The researchers found: “Accumulated data suggested that electromagnetic exposure could affect the number and function of immune cells to some extent, including cell proportion, cell cycle, apoptosis, killing activity, cytokines contents…”; and the authors conclude that, “knowledge of the biological effects on immune cells associated with electromagnetic fields is critical for proper health hazard evaluation, development of safety standards, and safe exploitation of new electromagnetic devices and applications.”

(Hardell & Carlberg, 2021) published “Lost opportunities for cancer prevention: historical evidence on early warnings with emphasis on radiofrequency radiation” in *Reviews in Environmental Health*. This eloquent review gives insight into missed opportunities for cancer prevention exemplified by asbestos, tobacco, certain pesticides and now RF radiation. The authors highlight how economic considerations were favored instead of cancer prevention. “A strategy to sow doubt on cancer risks was established decades ago and is now adopted and implemented in a more sophisticated way by the telecom industry regarding RF-EMF risks to human beings and the environment. Industry has the economic power, access to politicians and media whereas concerned people are unheard.” The examples clearly show that if the scientific evidence on cancer risks had been taken seriously, many lives could have been saved.

The 2020 study “Increased Generational Risk of Colon and Rectal Cancer in Recent Birth Cohorts under Age 40 - the Hypothetical Role of Radiofrequency Radiation from Cell Phones” published in *Annals of Gastroenterology and Digestive Disorders* by Davis et al. presented data from the U.S. Centers for Disease Control and Prevention, the U.S. Surveillance Epidemiology and End-Results Program and Iranian cancer registries on the staggering increases in colon and rectal cancer in those under age 50. Those born in the U.S. in the 1990s have a doubled risk of colon cancer and a fourfold increase in rectal cancer by the time they reach age 24 compared to those born six decades ago. The researchers document experimental studies indicating that cells from the colon and rectum of Sprague-Dawley rats are exquisitely sensitive to RFR and assert that these cancer increases could be due to the way people carry cell phones close to their bodies in front and back pockets. They reference how the French government frequency testing agency (ANFR) found that 9 out of 10 phones exceeded the safety guidelines when held against the body by factors of 1.6-3.7 times for the European standard or by factors as high as 11 if 1-g SAR values were to be measured as required by the U.S. FCC. “It appears prudent to promote policies to reduce exposures to radiofrequency radiation and encourage ALARA during pediatric CT procedures, while continuing to promote advances in software and hardware of phones and scanners that can lower exposures to non-ionizing radiation during normal operations. In addition, major public educational programs should be developed to promote awareness of the need to practice safer technology, especially for the young, who may well be at greater risk of developing cancer due to their immunological immaturity.”

In March 2021, Christopher Portier, Ph.D., formerly the Director of the United States National Center for Environmental Health at the Centers for Disease Control and Prevention (CDC) in Atlanta and the Director of the Agency for Toxic Substances and Disease Registry submitted a comprehensive review of the scientific research in a major cell phone/brain cancer lawsuit where he concludes: “The evidence on an association between cellular phone use and the risk of glioma in adults is quite strong.” Portier further states in his Expert Report: “In my opinion, RF exposure probably causes gliomas and neuromas and, 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.”

A important paper was published in *Health Physics* in 2020 by longtime NIH scientist Dr. Ronald Melnick entitled "ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields" addressing numerous criticisms of the NTP findings. Melnick documents one by one how these criticisms include false claims and "several incorrect statements that appear to be written to justify retaining exposure standards that were established more than 20 years ago." He presents the scientific documentation that each of these criticisms are unfounded stating "ICNIRP's misrepresentation of the methodology and interpretation of the NTP studies on cell phone RF radiation does not support their conclusion that "limitations preclude drawing conclusions about carcinogenicity in relation to RF EMFs."

Melnick explains that the utility of the NTP studies for assessing human health risks is undermined by the incorrect statements and misinformation in the ICNIRP critique. Melnick describes how the ICNIRP note failed to recognize that focal hyperplasias (proliferative lesions) of glial cells in the brain and of Schwann cells in the heart are putative preneoplastic lesions that may progress to malignant glioma or to cardiac schwannoma tumors, respectively.

Further, Melnick documents how the ICNIRP note focused on the carcinogenicity but ignored other adverse biological effects observed in the NTP studies, including reduced birth weights, DNA strand breaks in brain cells (which is supportive of the cancer findings), increased incidences of proliferative lesions (tumors and hyperplasia) in the prostate gland, and exposure-related increases in the incidence of cardiomyopathy (a type of tissue damage) of the right ventricle of the heart in male and female rats.

"After all, it was the US Food and Drug Administration that requested the NTP studies of cell phone radiation in experimental animals to provide the basis to assess the risk to human health. The NTP studies show that the assumption that RF radiation is incapable of causing cancer or other adverse health effects other than by tissue heating is wrong. If ICNIRP's goal is truly aimed at protecting the public from potential harm, then it would be appropriate for this group to quantify the health risks associated with exposure to RF-EMFs and then develop health-protective guidelines for chronic exposures, especially for children, who are likely to be more susceptible than adults to adverse effects of RF radiation."

These studies are a small sampling of the numerous studies that have documented adverse effects from RFR.

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