The information below is from the website of Children's Health Defense. It is presented to show you that scientific information about the health impacts of electromagnetic fields is ALREADY AVAILABLE. Please study the existing scientific literature. You don't need to re-invent the wheel.

Please, in the name of Love, do the right thing: protect human beings, animals, plants and eco-systems.

https://childrenshealthdefense.org/emr/emf-wireless-health-impacts/#ems

Health Impacts of Electromagnetic Fields (EMF)

EMF are physical regions of electromagnetic energy produced by electrically charged particles and electromagnetic radiation (EMR).

EMF Scientist – International Appeal (2022)
"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."

PowerWatch: 1,670 Peer-Reviewed Scientific Papers on Electromagnetic Fields and Biology or Health (2018)
"Powerwatch has been researching the links between EMF and health risks for more than 25 years. The organization, which is completely independent of government and industry, gathers information to help the lay person (sic) understand this issue."

Kivrak et al. (2017)
"The results of the recent studies not only clearly demonstrate that EMF exposure triggers oxidative stress in various tissues, but also that it causes significant changes in levels of blood antioxidant markers. Fatigue, headache, decreased learning ability, and cognitive impairment are among the symptoms caused by EMF."

Health Impacts of Radiofrequency (RF) Radiation

Frequencies ranging from 3 kilohertz to 300 gigahertz on the electromagnetic radiation (EMR) spectrum are defined as RF radiation.

Bioinitiative Report – Updated Research Summaries (2022)
"Clearly the trend continues that the great majority of studies report effects of low-intensity

exposures to both ELF-EMF and RFR, and a small percentage of published studies report that no effects are seen."

Hardell et al. (2021)
"These results give support to the increased cancer risk in humans and laboratory tested animals for RF radiation. In fact, RF-EMF may now be classified as a human carcinogen, Group 1. However, such classification can only be made by IARC."

Yadav et al. (2021)
"This review with the help of in vitro and in vivo studies shows that RF could change the morphology and physiology of germ cells with affected spermatogenesis, motility and reduced concentration of male gametes. RF also results in genetic and hormonal changes. In addition, the contribution of oxidative stress and protein kinase complex after RFR exposure is also summarized which could also be the possible mechanism for reduction in sperm parameters."

Smith-Roe et al. (2020)
"In conclusion, these results suggest that exposure to RFR is associated with an increase in DNA damage."

Boileau et al. (2020)
"Using a mobile phone for calls for more than 30 min per day during pregnancy may have a negative impact on fetal growth."

Stein et al. (2020)
"It is concluded that the mechanisms underlying the symptoms of EHS are biologically plausible and that many organic physiologic responses occur following EMF exposure. Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses."

Kim et al. (2019)
"It has been found that RF-EMF can induce changes in central nervous system nerve cells, including neuronal cell apoptosis, changes in the function of the nerve myelin and ion channels; furthermore, RF-EMF act as a stress source in living creatures."

Hardell et al. (2019)
"We conclude that there is clear evidence that RF radiation is a human carcinogen, causing glioma and vestibular schwannoma (acoustic neuroma). There is some evidence of an increased risk of developing thyroid cancer, and clear evidence that RF radiation is a multi-site carcinogen. Based on the Preamble to the IARC Monographs, RF radiation should be classified as carcinogenic to humans, Group 1."

National Toxicology Program – U.S. Department of Health and Human Services (2018)
"NTP conducted two-year toxicology studies in rats and mice to help clarify potential health hazards, including cancer risk, from exposure to RFR like that used in 2G and 3G cell phones which operate within a range of frequencies from about 700–2700 megahertz (MHz)."

The NTP studies found that high exposure to 900 MHz RF radiation used by cell phones was associated with:

- Clear evidence of an association with tumors (malignant schwannoma) in the hearts of male rats.
- Some evidence of an association with tumors (malignant glioma) in the brains of male rats.
- Some evidence of an association with tumors (benign, malignant, or complex combined pheochromocytoma) in the adrenal glands of male rats.
- Measurable DNA damage under certain exposure conditions.

Miller et al. (2018)
"The Epidemiological studies reported since the 2011 IARC Working Group meeting are adequate to consider RFR as a probable human carcinogen (Group 2 A). However, they must be supplemented with the recently reported animal data as performed at the Ramazzini Institute and the US National Toxicology Program as well as by mechanistic studies. These experimental findings together with the epidemiology reviewed here are sufficient in our opinion, to upgrade the IARC categorization of RFR to Group 1."

Obajuluwa et al. (2017)
"In conclusions (sic), these data showed that long term exposure to WiFi may lead to adverse effects such as neurodegenerative diseases as observed by a significant alteration on AChE gene expression and some neurobehavioral parameters associated with brain damage."

Eghlidospour et al. (2017)
"It is concluded that accumulating dose of GSM 900-MHz RF-EMF might have devastating effects on NSCs proliferation and neurogenesis requiring more causations in terms of using mobile devices."

Havas (2017)
"While IR directly damages DNA, NIR interferes with the oxidative repair mechanisms resulting in oxidative stress, damage to cellular components including DNA, and damage to cellular processes leading to cancer. Furthermore, free-radical damage explains the increased cancer risks associated with mobile phone use, occupational exposure to NIR (ELF EMF and RFR), and residential exposure to power lines and RF transmitters including mobile phones, cell phone base stations, broadcast antennas, and radar installations."

Houston et al. (2016)
"Among a total of 27 studies investigating the effects of RF-EMR on the male reproductive system, negative consequences of exposure were reported in 21. Within these 21 studies, 11 of the 15 that investigated sperm motility reported significant declines, 7 of 7 that measured the production of reactive oxygen species (ROS) documented elevated levels and 4 of 5 studies that probed for DNA damage highlighted increased damage due to RF-EMR exposure."

Lerchl et al. (2015)
"Numbers of tumors of the lungs and livers in exposed animals were significantly higher than in sham-exposed controls. In addition, lymphomas were also found to be significantly elevated by exposure. A clear dose-response effect is absent. We hypothesize that these tumor-promoting

effects may be caused by metabolic changes due to exposure. Since many of the tumor-promoting effects in our study were seen at low to moderate exposure levels (0.04 and 0.4 W/kg SAR), thus well below exposure limits for the users of mobile phones, further studies are warranted to investigate the underlying mechanisms."

Yakymenko et al. (2015)
"In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation."

Meo et al. (2015)
"Exposure to high RF-EMFR generated by MPBS is associated with elevated level of HbA1c and prevalence of pre diabetes mellitus among school aged adolescents. RF-EMFR appears to be another risk factor contributing to high levels of HbA1c and incidence of type 2 diabetes mellitus."

Cinar et al. (2013)
"Our findings suggest that acute exposure to EMW may facilitate epileptic seizures, which may be independent of EMW exposure time."

Volkow et al. (2012)
"In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna."

Bioinitiative Report (2012)
The Bioinitiative 2012 Report was prepared by an international group of experts collectively holding medical degrees, PhDs and master's degrees. They conclude, "Bioeffects are clearly established to occur with very low exposure levels (non-thermal levels) to electromagnetic fields and radiofrequency radiation exposures." They also clearly state, "The scientific evidence is… substantial enough to warrant preventative actions for RF."

Summary of the Science
Brain Tumors and Acoustic Neuromas

- "People who have used a cell phone for ten years or more have higher rates of malignant brain tumor and acoustic neuromas. It is worse if the cell phone has been used primarily on one side of the head."
- "People who have used a cordless phone for ten years or more have higher rates of malignant brain tumor and acoustic neuromas. It is worse if the cordless phone has been used primarily on one side of the head."
- "The current standard for exposure to the emissions of cell phones and cordless phones is not safe considering studies reporting long-term brain tumor and acoustic neuroma risks."

Changes in the Nervous System and Brain Function

- "There is little doubt that electromagnetic fields emitted by cell phones and cell phone use affect electrical activity of the brain."
- "Changes in the way in which the brain and nervous system react depend very much on the specific exposures. Most studies only look at short-term effects, so the long-term consequences of exposures are not known."
- "The consequence of prolonged exposures to children, whose nervous systems continue to develop until late adolescence, is unknown at this time. This could have serious implications to adult health and functioning in society if years of exposure of the young to both ELF and RF result in diminished capacity for thinking, judgment, memory, learning, and control over behavior."
- "The effects of long-term exposure to wireless technologies including emissions from cell phones and other personal devices, and from whole-body exposure to RF transmissions from cell towers and antennas is simply not known yet with certainty. However, the body of evidence at hand suggests that bioeffects and health impacts can and do occur at exquisitely low exposure levels: levels that can be thousands of times below public safety limits."

Effects on Genes (DNA)

- "Both ELF and RF exposures can be considered genotoxic (will damage DNA) under certain conditions of exposure, including exposure levels that are lower than existing safety limits."

Effects on Stress Proteins (Heat Shock Proteins)

- "Very low-level ELF and RF exposures can cause cells to produce stress proteins, meaning that the cell recognizes ELF and RF exposures as harmful. This is another important way in which scientists have documented that ELF and RF exposures can be harmful, and it happens at levels far below the existing public safety standards."

Effects on the Immune System

- "There is substantial evidence that ELF and RF can cause inflammatory reactions, allergy reactions and change normal immune function at levels allowed by current public safety standards."

Plausible Biological Mechanisms

- "Oxidative stress through the action of free radical damage to DNA is a plausible biological mechanism for cancer and diseases that involve damage from ELF to the central nervous system."

World Health Organization – International Agency for Research on Cancer (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, associated with wireless phone use." The IARC's conclusion was based on an increased risk (of glioma) identified in those who used cell phones for over 10 years for an average of 30 minutes per day. The radiation emitted by cell phones, cell towers, Wi-Fi, Bluetooth, laptop computers, routers and baby monitors is now in the same category that DDT, diesel fuel and lead resided before being boosted to the Group 2A: probably carcinogenic to humans classification.

Avendaño et al. (2011)
"Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility."

Han et al. (2010)
"Watching TV and using mobile telephone during the first term of pregnancy maybe (sic) increase the risk of embryo growth ceasing significantly, in particular the high-risk pregnant women with embryo growth ceasing history. Suggest pregnant women not use the appliances for a long time or do the safety protection when using the appliances, e.g., distance protection."

Bas et al. (2009)
"Histopathological evaluations were made on sections of the CA region of the hippocampus. Results showed that postnatal EMF exposure caused a significant decrease of the pyramil cell number in the CA of the EMF group ($P<0.05$). Additionally, cell loss can be seen in the CA region of EMF group even at qualitative observation. These results may encourage researchers to evaluate the chronic effects of 900 MHz EMF on teenagers' brains."

Baste et al. (2008)
"For self-reported exposure both to high-frequency aerials and communication equipment there were significant linear trends with lower ratio of boys to girls at birth when the father reported a higher degree of radiofrequency electromagnetic exposure."

Belyaev et al. (2005)
"In conclusion, 50 Hz magnetic field and 915 MHz microwaves under specified conditions of exposure induced comparable responses in lymphocytes from healthy and hypersensitive donors that were similar but not identical to stress response induced by heat shock."

Salford et al. (2003)
"In this study we investigated whether a pathologic leakage across the blood–brain barrier might be combined with damage to the neurons. Three groups each of eight rats were exposed for 2 hr to Global System for Mobile Communications (GSM) mobile phone electromagnetic fields of different strengths. We found highly significant ($p<0.002$) evidence for neuronal damage in the cortex, hippocampus, and basal ganglia in the brains of exposed rats."

Lai et al (1995)
"Furthermore, in rats exposed for 2 h to continuous-wave 2450 MHz microwaves (SAR 1.2 W/kg), increases in brain cell DNA single-strand breaks were observed immediately as well as at 4 h postexposure."

Naval Medical Research Institute – Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation (1972)
"More than 2000 references on the biological responses to radio frequency and microwave radiation, published up to June 1971, are included in the bibliography.* Particular attention has been paid to the effects on man of non-ionizing radiation at these frequencies. The citations are arranged alphabetically by author, and contain as much information as possible so as to assure

effective retrieval of the original documents. An outline of the effects which have been attributed to radio frequency and microwave radiation is also part of the report."

Health Impacts on Children

This section explores the health impacts of EMF on children.

Maryland Children's Environmental Health and Protection Advisory Council – Guidelines to Reduce Electromagnetic Field Radiation (2022)
"Children may be at greater risk than adults from exposure to RF energy. Their bodies and brains are still developing and are more vulnerable to exposures that could cause harm. Because their skulls are thinner and their heads are smaller than those of adults, children have a relatively greater risk of exposure to the RF energy of cell phones. Children also will accumulate many more years of cell phone and wireless exposure than adults. Animal research has also shown the potential for health effects of RF radiation to a developing fetus."

Seomun et al. (2021)
"Significant associations were observed between exposure to ELF-MFs and childhood leukemia. Furthermore, a possible dose-response effect was also observed."

Sage and Burgio (2018)
"Mobile phones and other wireless devices that produce electromagnetic fields (EMF) and pulsed radiofrequency radiation (RFR) are widely documented to cause potentially harmful health impacts that can be detrimental to young people. New epigenetic studies are profiled in this review to account for some neurodevelopmental and neurobehavioral changes due to exposure to wireless technologies. Symptoms of retarded memory, learning, cognition, attention, and behavioral problems have been reported in numerous studies and are similarly manifested in autism and attention deficit hyperactivity disorders, as a result of EMF and RFR exposures where both epigenetic drivers and genetic (DNA) damage are likely contributors."

American Academy of Pediatrics (2016)
"They're not toys. They have radiation that is emitted from them and the more we can keep it off the body and use (the phone) in other ways, it will be safer," said Jennifer A. Lowry, M.D., FAACT, FAAP, chair of the AAP Council on Environmental Health Executive Committee in the AAPs press release on the results of the NTP study.

Zhang et al. (2015)
"From the MWM [Morris water maze] test, we observed that male offspring demonstrated decreased learning and memory, while females were not affected in learning and memory, which suggested that microwaves had gender-dependent effects."

Morgan et al. (2014)

Conclusions:

1. "Children absorb greater amount of microwave radiation (MWR) than adults."

2. "MWR is a Class 2B (possible) carcinogen as is carbon black, carbon tetrachloride, chloroform, DDT, lead, nickel, phenobarbital, styrene, diesel fuel, and gasoline. It seems clear that we would not expose children to these other agents, so why would we expose children to microwave radiation?"
3. "Fetuses are even more vulnerable than children. Therefore pregnant women should avoid exposing their fetus to microwave radiation."
4. "Adolescent girls and women should not place cellphones in their bras or in hijabs."
5. "Cell Phone manual warnings make clear an overexposure problem exists."
6. "Wireless devices are radio transmitters, not toys. Selling toys that use them should be banned."
7. "Government warnings have been issued but most of the public are unaware of such warnings."
8. "Exposure limits are inadequate and should be revised such that they are adequate."

BioInitiative 2012 Report Issues New Warnings on Wireless and EMF (2013)
"While we aggressively investigate the links between autism disorders and wireless technologies, we should minimize wireless and EMF exposures for people with autism disorders, children of all ages, people planning a baby, and during pregnancy." – Martha Herbert, MD, PhD.

American Academy of Pediatrics (2012)
The American Academy of Pediatrics (AAP) President Robert W. Block urged the FCC to review their RF radiation exposure guidelines and to lower them to protect children. He wrote:

"Children … are not little adults and are disproportionately impacted by all environmental exposures, including cell phone radiation. In fact, according to IARC, when used by children, the average RF energy deposition is two times higher in the brain and 10 times higher in the bone marrow of the skull, compared with mobile phone use by adults."

BioInitiative Working Group (2012)
"The premise of this review is that although scant attention has been paid to possible links between electromagnetic fields and radiofrequency exposures (EMF/RFR) and Autism Spectrum Disorders (ASDs), such links probably exist. The rationale for this premise is that the physiological impacts of EMF/RFR and a host of increasingly well-documented pathophysiological phenomena in ASDs have remarkable similarities. Additional support may be found in the parallels between the rise in reported cases of ASDs and the remarkable increases in EMF/RFR exposures over the past few decades. Reviewing these similarities does not prove that these parallels imply causality – that kind of research has not been done."

Divan et al. (2010)
"The findings of the previous publication were replicated in this separate group of participants demonstrating that cell phone use was associated with behavioural problems at age 7 years in children, and this association was not limited to early users of the technology. Although weaker in the new dataset, even with further control for an extended set of potential confounders, the associations remained."

Divan et al. (2008)
"Exposure to cell phones prenatally—and, to a lesser degree, postnatally—was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school

entry. These associations may be noncausal and may be due to unmeasured confounding. If real, they would be of public health concern given the widespread use of this technology."

Kheifets et al. (2005)
"Concerns about the potential vulnerability of children to radio frequency (RF) fields have been raised because of the potentially greater susceptibility of their developing nervous systems; in addition, their brain tissue is more conductive, RF penetration is greater relative to head size, and they will have a longer lifetime of exposure than adults."

Health Impacts on Reproduction

This section explores the health impacts of EMF on reproduction including pregnancy, miscarriage and sperm.

Boileau et al. (2022)
"Using a mobile phone for calls for more than 30 min per day during pregnancy may have a negative impact on fetal growth."

Hassanzadeh-Taheri et al. (2022)
"Cell phone waves had a detrimental effect on human sperm's biological features. Therefore, it is recommended to keep the cell phone away from the pelvis as much as possible."

Zhao et al. (2021)
"Our study confirmed that exposure to some electrical appliances was associated with a higher risk of CHD [Congenital Heart Defects], and wearing a radiation protection suit was associated with a lower risk of CHD. Women should therefore reduce the usage of electrical appliances before and during pregnancy."

Negi and Singh (2020)
"Cell phone radiation harms male fertility by affecting the different parameters like sperm motility, sperm count, sperm morphology, semen concentration, morphometric abnormalities, increased oxidative stress along with some hormonal changes."

Kamali et al. (2017)
"Our study revealed a significant decrease in the quality of human semen after exposure to EMWs [Electromagnetic waves] emitted from 3G+wi-fi modems."

Levine et al. (2017)
"In this comprehensive meta-analysis, sperm counts…declined significantly among men from North America, Europe and Australia during 1973–2011, with a 50–60% decline among men unselected by fertility, with no evidence of a 'leveling off' in recent years. These findings strongly suggest a significant decline in male reproductive health, which has serious implications beyond fertility concerns. Research on causes and implications of this decline is urgently needed."

Li et al. (2017)
"In this study, we found an almost three-fold increased risk of miscarriage if a pregnant woman was exposed to higher MF levels compared to women with lower MF exposure."

Sepehrimanesh (2017)
"Our results indicate that exposure to RF-EMF produces increases in testicular proteins in adults that are related to carcinogenic risk and reproductive damage. In light of the widespread practice of men carrying phones in their pockets near their gonads, where exposures can exceed as-tested guidelines, further study of these effects should be a high priority."

Adams et al. (2014)
"We conclude that pooled results from in vitro and in vivo studies suggest that mobile phone exposure negatively affects sperm quality. Further study is required to determine the full clinical implications for both sub-fertile men and the general population."

Li et al. (2011)
"Our findings provide new epidemiological evidence that high maternal MF [magnetic fields] levels in pregnancy may increase the risk of asthma in offspring."

Shahin et al. (2014)
"Further, these adverse reproductive effects suggest that chronic exposure to nonionizing MW [microwave] radiation may lead to infertility via free radical species-mediated pathway."

Ghanbari et al. (2013)
"Exposure to cell phone waves can decrease sperm viability and motility in rats. These waves can also decrease sperm total antioxidant capacity in rats and result in oxidative stress."

Avendaño et al. (2012)
"To our knowledge, this is the first study to evaluate the direct impact of laptop use on human spermatozoa. Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility."

Desai et al. (2009)
"Hence, RF-EMW [Radiofrequency electromagnetic waves] from commercially available cell phones might affect the fertilizing potential of spermatozoa. Therefore, the SAR limit (maximum acceptable exposure limit) should be lowered for cellular phones."

De Iuliis et al. (2009)
"These findings have clear implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring."

Agarwal et al. (2008)
"Radiofrequency electromagnetic waves emitted from cell phones may lead to oxidative stress in

human semen. We speculate that keeping the cell phone in a trouser pocket in talk mode may negatively affect spermatozoa and impair male fertility."

Health Impacts of Electromagnetic Radiation Syndrome (EMR-S)

EMR-S is a condition whereby individuals suffer adverse health effects from electromagnetic field (EMF) exposure. Commonly, it is referred to as Electromagnetic Radiation Syndrome (EMR-S), Electrosensitivity, Electrohypersensitivity (EHS), microwave syndrome/illness or radiofrequency sickness. This section explores the health impacts of EMR-S.

Hardell and Nilsson (2024)
"Our seven case studies, comprising 16 persons, on health effects from real 5G RF radiation exposure, showed that the study persons developed the microwave syndrome after installation of 5G base stations in the neighborhood of their dwellings. Most prevalent were symptoms of the nervous system: sleeping problems, headache, fatigue, irritability, emotional symptoms and concentration/attention deficiency. Very high RF radiation levels, although much lower than limits recommended by ICNIRP and the FCC, were measured with the broad band meter. Some of the studied persons developed severe symptoms. Most persons could move to another settlement without 5G, whereby the microwave syndrome alleviated and disappeared within short."

U.S. Access Board – IEQ Indoor Environmental Quality Project
"The Board recognizes that multiple chemical sensitivities and electromagnetic sensitivities may be considered disabilities under the ADA if they so severely impair the neurological, respiratory or other functions of an individual that it substantially limits one or more of the individual's major life activities."

Nilsson et al. (2023)
"This study adds to previously available studies that show that the microwave syndrome or illness appears at levels much below the current guidelines recommended by the ICNIRP."

Leszczynski (2022)
"However, symptoms experienced by the self-declared EHS persons affect their well-being and, according to the Constitution of the WHO, are a health problem. Hence, independently of what causes EHS symptoms, this admitted well-being-impairment should be dealt with globally by developing an uniform health policy. Furthermore, WHO, ICNIRP and IEEE-ICES should be advocating and supporting research that would generate a reliable scientific evidence on what are the possible cause(s) of EHS. Without such research there is not possible to develop diagnostic methods as well as any possible mitigation approaches. There is an urgent need for the WHO to advocate for the national governments to urgently develop a comprehensive and common EHS health policy."

Hardell et al. (2021)
"In conclusion, there are at least three types of electromagnetic fields present in the working

room, which cause a long term exposure to the workers. Exposure to multiple source electromagnetic fields could be the cause for developing EHS related symptoms. However, the person had been exposed to ELF-EMF also at other locations in the building, so exposure to RF-EMF seems to be the most probable cause to her developed health problems."

Belpomme et al. (2020)
"Altogether, these data strongly suggest that EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented. Because EHS is becoming a new insidious worldwide plague involving millions of people, we ask the World Health Organization (WHO) to include EHS as a neurologic disorder in the international classification of diseases."

Stein et al. (2020)
"It is concluded that the mechanisms underlying the symptoms of EHS are biologically plausible and that many organic physiologic responses occur following EMF exposure. Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses. More relevant diagnostic tests for EHS should be developed. Exposure limits should be lowered to safeguard against biologic effects of EMF. Spread of local and global wireless networks should be decreased, and safer wired networks should be used instead of wireless, to protect susceptible members of the public. Public places should be made accessible for electrohypersensitive individuals."

Bevington (2019)
"The current evidence is assessed as indicating that, in addition to subconscious sensitivity, the prevalence of IEI-EMF/EHS is between about 5.0 and 30 per cent of the general population for mild cases, 1.5 and 5.0 per cent for moderate cases and < 1.5 per cent for severe cases."

Belyaev et al. (2016)
"It seems necessary now to take "new exposures" like electromagnetic fields (EMF) into account. Physicians are increasingly confronted with health problems from unidentified causes. Studies, empirical observations, and patient reports clearly indicate interactions between EMF exposure and health problems. Individual susceptibility and environmental factors are frequently neglected. New wireless technologies and applications have been introduced without any certainty about their health effects, raising new challenges for medicine and society…Common EHS symptoms include headaches, concentration difficulties, sleep problems, depression, a lack of energy, fatigue, and flu-like symptoms."

Carpenter (2015)
"There is increasing evidence that the "microwave syndrome" or "electro-hypersensitivity" (EHS) is a real disease that is caused by exposure to EMFs, especially those in the microwave range. The reported incidence of the syndrome is increasing along with increasing exposure to EMFs from electricity, WiFi, mobile phones and towers, smart meters and many other wireless devices. Why some individuals are more sensitive is unclear. While most individuals who report having EHS do not have a specific history of an acute exposure, excessive exposure to EMFs, even for a brief period of time, can induce the syndrome."

Health Impacts of Cell Phones

This section explores the health impacts of cell phone exposure.

Boileau et al. (2022)
"Using a mobile phone for calls for more than 30 min per day during pregnancy may have a negative impact on fetal growth. A prospective study should be performed to further evaluate this potential link."

Alkayyali et al. (2021)
"Our review revealed that mobile phone radiofrequency radiation (RFR) might be associated with thyroid gland insufficiency and alterations in serum thyroid hormone levels, with a possible disruption in the hypothalamic-pituitary-thyroid axis. The review also showed histopathological changes in the thyroid gland follicles after exposure of rats to non-ionizing radiation. The results were directly related to the amount and duration of exposure to EMF radiation."

Shih et al. (2020)
"Excessive smartphone use significantly increased the risk of breast cancer, particularly for participants with smartphone addiction, a close distance between the breasts and smartphone, and the habit of smartphone use before bedtime."

National Toxicology Program – U.S. Department of Health and Human Services (2018)
High exposure to 900 MHz used by (2G and 3G) cell phones was associated with:

- Clear evidence of an association with tumors (malignant schwannoma) in the hearts of male rats.
- Some evidence of an association with tumors (malignant glioma) in the brains of male rats.
- Some evidence of an association with tumors (benign, malignant, or complex combined pheochromocytoma) in the adrenal glands of male rats.

California Department of Public Health (2017)
The California Department of Public Health issued cell phone guidance for families, particularly those families with children including teens:

- Keep the phone away from the body
- Reduce cell phone use when the signal is weak
- Reduce the use of cell phones for audio or video streaming or for downloading or uploading large files
- Keep the phone away from the bed at night
- Remove headsets when not on a call
- Avoid products claiming to block radio frequency energy. These products may increase exposure

Gorpinchenko et al. (2014)
"A correlation exists between mobile phone radiation exposure, DNA–fragmentation level and decreased sperm motility."

Adams et al. (2014)
"We conclude that pooled results from in vitro and in vivo studies suggest that mobile phone exposure negatively affects sperm quality. "

West et al. (2013)
"We report a case series of four young women—ages from 21 to 39—with multifocal invasive breast cancer that raises the concern of a possible association with nonionizing radiation of electromagnetic field exposures from cellular phones. All patients regularly carried their smartphones directly against their breasts in their brassieres for up to 10 hours a day, for several years, and developed tumors in areas of their breasts immediately underlying the phones."

European Environment Agency Report (2013)
"Evidence is increasing that workers with heavy long-term use of wireless phones who develop glioma or acoustic neuroma should be compensated."

Volkow et al. (2011)
"In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna."

Divan et al. (2010)
"The findings of the previous publication were replicated in this separate group of participants demonstrating that cell phone use was associated with behavioural problems at age 7 years in children, and this association was not limited to early users of the technology."

Schüz et al. (2009)
"In conclusion, the excesses of migraine and vertigo observed in this first study on cellular telephones and CNS disease deserve further attention."

Divan et al. (2008)
"Exposure to cell phones prenatally-and, to a lesser degree, postnatally-was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school entry. These associations may be noncausal and may be due to unmeasured confounding. If real, they would be of public health concern given the widespread use of this technology."

Hardell et al. (2007)
"Results from present studies on use of mobile phones for ≥10 years give a consistent pattern of increased risk for acoustic neuroma and glioma. The risk is highest for ipsilateral exposure."

Health Impacts of Wi-Fi

This section explores the health impacts of Wi-Fi exposure.

Cappucci et al. (2022)
"All together, these data indicate that radiofrequency radiation emitted from WiFi devices could exert genotoxic effects in Drosophila and set the stage to further explore the biological effects of WiFi electromagnetic radiation on living organisms."

Pall (2018)
"Repeated Wi-Fi studies show that Wi-Fi causes oxidative stress, sperm/testicular damage,

neuropsychiatric effects including EEG changes, apoptosis, cellular DNA damage, endocrine changes, and calcium overload."

Dasdag et al. (2015)
"Long-term exposure of 2.4 GHz RF may lead to adverse effects such as neurodegenerative diseases originated from the alteration of some miRNA expression and more studies should be devoted to the effects of RF radiation on miRNA expression levels."

Özorak et al. (2013)
"In conclusion, Wi-Fi- and mobile phone-induced EMR caused oxidative damage by increasing the extent of lipid peroxidation and the iron level, while decreasing total antioxidant status, copper, and GSH values. Wi-Fi- and mobile phone-induced EMR may cause precocious puberty and oxidative kidney and testis injury in growing rats."

Avendaño et al. (2011)
"Ex vivo exposure of human spermatozoa to a wireless internet-connected laptop decreased motility and induced DNA fragmentation by a nonthermal effect. We speculate that keeping a laptop connected wirelessly to the internet on the lap near the testes may result in decreased male fertility."

Health Impacts of Cell Towers

This section explores the health impacts of cell tower exposure.

Rangkooy et al. (2023)
"The study aimed at investigating the effect of exposure to waves emitted from the base transceiver stations (BTS) on workers' health…The results revealed that blood parameters in the BTS operators showed more changes. Thus, it can be concluded that these health impacts result from occupational exposure to BTS waves."

Balmori et al. (2022)
"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)."

Clegg et al. (2020)
"A study by the Italian Ramazzini Institute that was conducted at lower intensities (below FCC limits) designed to mimic radiation from cell towers. The tumors found in these large-scale studies were of the same histotype as in some human epidemiological cell phone studies."

Falcioni et al. (2018)
"The RI [Ramazzini Institute] 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."

Meo et al. (2018)
"High exposure to RF-EMF produced by MPBSTs [Mobile Phone Base Stations] was associated with delayed fine and gross motor skills, spatial working memory, and attention in school adolescents compared to students who were exposed to low RF-EMF."

Meo et al. (2015)
"It is concluded that exposure to high RF-EMFR generated by MPBS [Mobile Phone Base Stations] is associated with elevated levels of HbA1c and risk of type 2 diabetes mellitus."

Dode et al. (2011)
"Base Station (BS) clusters and deaths by neoplasia in the Belo Horizonte municipality have been identified. The mortality rate has been higher for the residents within an area of 500 m from the BS. The radiation superposition near the BS has also been observed; the nearer the stronger."

Khurana et al. (2010)
"By searching PubMed, we identified a total of 10 epidemiological studies that assessed for putative health effects of mobile phone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. We found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations. None of the studies reported exposure above accepted international guidelines, suggesting that current guidelines may be inadequate in protecting the health of human populations. We believe that comprehensive epidemiological studies of long-term mobile phone base station exposure are urgently required to more definitively understand its health impact."

Abdel-Rassoul et al. (2007)
"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. So, revision of standard guidelines for public exposure to RER from mobile phone base station antennas and using of NBTB for regular assessment and early detection of biological effects among inhabitants around the stations are recommended."

Santini et al. (2003)
"Chronic exposure to ultra-high-frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, sleep, and memory disturbances. These biological effects, associated with others (skin problems, nausea, irritability) constitute what is known as radiofrequency sickness. It is advisable that cellular phone base stations (cell towers) should not be sited closer than 300 m (985 feet) to populations and most significantly because exposed people can have different sensitivities related particularly to their sex and their age."

Health Impacts of Fifth Generation Wireless Networks (5G)

This section explores the health impacts of 5G exposure.

Hardell et al. (2023)
"Within a couple of days, a new 5G base station caused severe symptoms in two previously healthy persons that correspond to the microwave syndrome…The symptoms quickly reversed when the couple moved to a dwelling with much lower exposure."

Hardell et al. (2023)
"This study confirms our previous publications on microwave syndrome caused by RF radiation emissions from 5G. Our three studies are to our knowledge among the first to have investigated health effects from 5G base stations. 5G substantially increases exposure to microwave radiation and in the present case, as well as in the previous case studies, the 5G deployment was followed by a rapid development of symptoms known as the microwave syndrome. Urgent attention is needed to the 5G health hazards by the responsible governmental agencies."

Nilsson et al. (2023)
"Within few weeks, a new 5G base station caused typical symptoms of the microwave syndrome or radiofrequency sickness in two men working and living in the office below the base station. The deployment of 5G also caused very high maximum (peak) microwave/RFR radiation non-thermal exposure, however far below the ICNIRP guidelines. The symptoms disappeared completely within some weeks after the men moved from the office to dwellings with much lower exposure."

McCredden et al. (2023)
"The evidence presented above suggests that there are credible risks of biological interference effects for frequencies planned for 5G, occurring well-below ICNIRP reference limits. Given the ubiquitous and often non-consensual nature of man-made wireless radiation exposures, the presence of even a small number of significant bioeffects requires follow up with more focused research."

Perov et al. (2022)
"The results suggest that exposure to multifrequency electromagnetic field simulating the effects of 5G systems affected functional activity of the hypothalamus-pituitary-adrenal axis and was stressful in nature."

Kin et al. (2022)
"It was found that the anxiety-like behaviour and spatial memory ability of mice did not change, but the depression-like behaviour was induced in mice after 4.9 GHz RF exposure. In addition, the number of neurons significantly reduced and the level of pyroptosis obviously increased in amygdala rather than hippocampus. These results suggested that 4.9 GHz RF exposure could induce depression-like behaviour, which might be associated with the neuronal pyroptosis in amygdala."

ICBE-EMF (2022)
"Thus, urgently needed are health protective exposure limits for humans and the environment. These limits must be based on scientific evidence rather than on erroneous assumptions, especially given the increasing worldwide exposures of people and the environment to RFR, including novel forms of radiation from 5G telecommunications for which there are no adequate health effects studies."

Nyberg et al. (2022)
"Altogether, this evidence establishes a high priority for the European Union towards (i) replacing the current flawed guidelines with protective thresholds, and (ii) placing a moratorium on 5G deployment so as to (iii) allow industry-independent scientists the time needed to propose new health-protective guidelines. This 2021 Appeal's relevance becomes even more pressing in the context of the EU plans to roll out the sixth generation of wireless technologies, 6G, further adding to the known risks of RFR technology for humans and the environment. This all leads to an important question: Do EU decision makers have the right to ignore EU´s own directives by prioritising economic gain over human and environmental health?"

Kim et al. (2022)
"In summary, the brightening effects of 5G EMR on the skin pigmentation were confirmed at multiple levels ranging from B16F10 cell line and an artificial human pigmented skin model as determined by reduced melanin content, and morphological regression of melanocyte activation. We can observe that 5G exposure attenuated melanin production by regulation melanogenic genes and ROS production. As compared with our previously published study, 5G exposure alone did not affect melanin synthesis, however co-exposure with melanin synthesis stimuli, such as α-MSH, showed an effect of suppressing α-MSH induced melanin as reported in the PMBT studies of the shorter wavelengths. Moreover, it is necessary to examine the effects of 5G EMR on melanin synthesis under more extreme exposure scenarios, such as stronger intensity or for a prolonged time, in the future."

European Parliamentary Research Service (EPRS) – Health Impact of 5G (2021)
"There is sufficient evidence in experimental animals for the carcinogenicity of radiofrequency radiation."

"There is sufficient evidence of adverse effects on the fertility of men."

"FR1 (450 to 6000 MHz): As a synthesis of what we have managed to analyse in the available scientific literature, in both human and animal studies, we can say that RF-EMF at FR1 frequencies exposure probably cause cancer, and in particular gliomas and acoustic neuromas in humans."

"FR1(450 to 6000 MHz): These frequencies *clearly* affect male fertility. These frequencies *possibly* affect female fertility. They *possibly* have adverse effects on the development of embryos, foetuses and newborns."

Hardell et al. (2020)
"In conclusion, this article demonstrates that the EU has given mandate to a 13-member, non-governmental private group, the ICNIRP, to decide upon the RF radiation guidelines. The ICNIRP, as well as SCENIHR, are well shown not to use the sound evaluation of science on the detrimental effects of RF radiation, which is documented in the research which is discussed above (9,10,21-24,54,55). These two small organizations are producing reports which seem to deny the existence of scientific published reports on the related risks. It should perhaps be questioned whether it is in the realm of protecting human health and the environment by EU and whether the safety of EU citizens and the environment can be protected by not fully understanding the health-related risks."

Kostoff et al. (2020)
"This article identifies adverse effects of non-ionizing non-visible radiation (hereafter called wireless radiation) reported in the premier biomedical literature. It emphasizes that most of the laboratory experiments conducted to date are not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate. Many experiments do not include pulsing and modulation of the carrier signal. The vast majority do not account for synergistic adverse effects of other toxic stimuli (such as chemical and biological) acting in concert with the wireless radiation. This article also presents evidence that the nascent 5G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have adverse systemic effects as well."

Russell (2019)
"Although 5G technology may have many unimagined uses and benefits, it is also increasingly clear that significant negative consequences to human health and ecosystems could occur if it is widely adopted. Current radiofrequncy (sic) radiation wavelengths we are exposed to appear to act as a toxin to biological systems. A moratorium on the deployment of 5G is warranted, along with development of independent health and environmental advisory boards that include independent scientists who research…"

5G Appeal (2017)
"We the undersigned, more than 180 scientists and doctors from 36 countries, recommend a moratorium on the roll-out of the fifth generation, 5G, for telecommunication until potential hazards for human health and the environment have been fully investigated by scientists independent from industry. 5G will substantially increase exposure to radiofrequency electromagnetic fields (RF-EMF) on top of the 2G, 3G, 4G, Wi-Fi, etc. for telecommunications already in place. RF-EMF has been proven to be harmful for humans and the environment."

Senator Blumenthal Calls Out Lack of 5G Safety Studies (2019)

During an exchange [see video of proceedings: 2:04:00] with wireless industry representatives, Senator Richard Blumenthal asked representatives from each of the major carriers whether they had supported research on the safety of 5G and millimeter wave (MMW) technology and potential links between radiofrequency and cancer – the industry representatives conceded they had not.

None of the five representatives from major telecom carriers or infrastructure builders sent to appear before Blumenthal's committee were aware of any funding spent on researching the health effects of 5G, nor could they contend that any such research was planned for the future.

"So there really is no research ongoing. We're kind of flying blind here, as far as health and safety is concerned." – U.S. Sen. Richard Blumenthal, February 2019

New Hampshire: Final Report of the Commission to Study The Environmental and Health Effects of Evolving 5G Technology (2020)

New Hampshire formed a State Commission to examine health effects of the evolving 5G technology and whether wireless radiation is indeed harmful to human health. The majority of the New Hampshire State Commission came to the conclusion that exposure to wireless radiation is harmful to human health and the environment. The commission was convened through bipartisan legislation that was signed by the governor and commission membership included unbiased experts in fields relating to health and radiation exposure. Their Final Report published in 2020 states,

"The majority of the Commission believes that the FCC has not exercised due diligence in its mission to manage the electromagnetic environment by not setting exposure limits that protect against health effects. They have failed to support technical means and investigations aimed at reducing human exposures to electromagnetic radiation (EMR) in telecommunications systems and optimize wireless modulations to reduce biological and health impacts."

Health Impacts of Millimeter Waves (MMW)

Frequencies ranging from 30 gigahertz to 300 gigahertz on the EMR spectrum are defined as MMW. This section explores the reported health impacts of MMW, a part of the 5G spectrum.

Redmayne et al. (2023)
"Once the 5G mmW band is internationally operational, a significant proportion of the world's population will be exposed to new hazards. The intensity and complexity of near-field exposure, such as when carrying a phone in a pocket or using it next to the head, will be different for 5G, and this is the first time mmW have been used for public telecommunications and the first time beamforming has been deliberately introduced for near-field use. Without research on the impact of near-field 5G, this global step is an experiment at the population level. Bearing this in mind, there is a vital and urgent need for targeted research and for a re-evaluation of the scientific relevance of the current RF human exposure standards' basic approach and assumptions."

Di Ciaula (2018)
"Preliminary observations showed that MMW increase skin temperature, alter gene expression, promote cellular proliferation and synthesis of proteins linked with oxidative stress, inflammatory and metabolic processes, could generate ocular damages, affect neuro-muscular dynamics. Further studies are needed to better and independently explore the health effects of RF-EMF in general and of MMW in particular. However, available findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principle, to define exposed subjects as potentially vulnerable and to revise existing limits."

Kostoff et al. (2020)
"It emphasizes that most of the laboratory experiments conducted to date are not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate. Many experiments do not include pulsing and modulation of the carrier signal. The vast majority do not account for synergistic adverse effects of other toxic stimuli (such as chemical and biological) acting in concert with the wireless radiation. This article also presents evidence that the nascent 5G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have adverse systemic effects as well."

Wu et al. (2015)
"Thus, thermal injury due to overexposure of mmWave is expected to produce superficial burns like those produced when a person touches hot objects or flames. In other words, mmWave-induced burns will likely generate blistering and local inflammatory responses that are similar to conventional burns rather than the deep tissue thermal injury characteristic of overexposure at microwave frequencies."

Alekseev et al. (2008)
"Millimeter waves penetrate into the human skin deep enough (delta = 0.65 mm at 42 GHz) to affect most skin structures located in the epidermis and dermis."

Health Impacts of Lower Frequency Electromagnetic Radiation

This section explores the health impacts of EMF exposure below 3 kilohertz on the electromagnetic radiation (EMR) spectrum.

Bioinitiative Report – Updated Research Summaries (2022)
"Clearly the trend continues that the great majority of studies report effects of low-intensity exposures to both ELF-EMF and RFR, and a small percentage of published studies report that no effects are seen."

Hosseini et al. (2022)
"It may be concluded that involvement of ELF-EMF and prenatal stress in potential induction of anxiety-like behavior via the hippocampus may be different such that ELF-EMF may initiate anxiety-like behavior by increasing 25(S)-OHC and PNMDAr2/NMDAr2 in the hippocampus while prenatal stress probably increases anxiety-like behavior by elevating corticosterone and decreasing serotonin."

Seomun et al. (2021)
"Significant associations were observed between exposure to ELF-MFs and childhood leukemia. Furthermore, a possible dose-response effect was also observed."

Carles et al. (2020)
"We found significant associations between cumulated duration living at <50 m to high voltage lines and: i) all brain tumors (OR 2.94; 95%CI 1.28–6.75); ii) glioma (OR 4.96; 95%CI 1.56–15.77). Further investigations are needed, particularly to improve the quality and availability of geographical and technical data on power lines."

Havas (2017)
"The key points of this commentary are as follows: (1) Application of the IR model to NIR is inappropriate as the mechanisms of biological interactions are different; (2) Sufficient scientific evidence exists of cellular damage caused by NIR at levels well below thermal guidelines; and (3) Various mechanisms have been documented that involve oxidative stress and can account for the increase in tumors documented in epidemiological studies at both low frequency and radio

frequency electromagnetic exposure. Indeed, this type of oxidative stress may account for damage to sperm exposed to RFR and to some of the symptoms classified as electrohypersensitivity (EHS)."

Benassi et al. (2015)
Extremely Low Frequency Magnetic Field (ELF-MF) exposure sensitizes SH-SY5Y cells to the Pro-Parkinson's Disease Toxin.

Mechanisms of Harm

This section explores the biophysical mechanisms by which EMF exposure produces health impacts.

Panagopoulos et al. (2021)
"The present study reviews the DNA damage and related effects induced by human-made EMFs. The ion forced-oscillation mechanism for irregular gating of voltage-gated ion channels on cell membranes by polarized/coherent EMFs is extensively described. Dysfunction of ion channels disrupts intracellular ionic concentrations, which determine the cell's electrochemical balance and homeostasis. The present study shows how this can result in DNA damage through reactive oxygen species/free radical overproduction. Thus, a complete picture is provided of how human-made EMF exposure may indeed lead to DNA damage and related pathologies, including cancer."

Yakymenko et al. (2015)
"In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation."

Bioinitiative Report – Summary for the Public (2007)
"Oxidative stress through the action of free radical damage to DNA is a plausible biological mechanism for cancer and diseases that involve damage from ELF to the central nervous system."

Precautionary Approach Recommendations

This section explores various expert recommendations calling for a precautionary approach for the 5G/wireless buildout.

European Parliamentary Research Service (EPRS) – Effects of 5G Wireless Communication on Human Health (2020)
"Various studies suggest that 5G would affect the health of humans, plants, animals, insects, and microbes – and as 5G is an untested technology, a cautious approach would be prudent."

"The European Environment Agency (EEA) has long advocated precaution concerning EMF exposure, pointing out that there were cases of failure to use the precautionary principle in the

past, which have resulted in often irreversible damage to human health and environments. Appropriate, precautionary and proportionate actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise from future perspectives. The EEA requests that EU Member States do more to inform citizens about the risks of EMF exposure, especially to children."

Frank (2019)
"The author, an experienced epidemiologist, concludes that one cannot dismiss the growing health concerns about RF-EMFs, especially in an era when higher population levels of exposure are occurring widely, due to the spatially dense transmitters which 5G systems require. Based on the precautionary principle, the author echoes the calls of others for a moratorium on the further roll-out of 5G systems globally, pending more conclusive research on their safety."

Miligi (2019)
"Epidemiological studies and metanalyses on the relationship between cancer and RFs, particularly those on mobile phones, still identify areas of uncertainty that need to be investigated, and studies on non-cancer effects are growing in number, suggesting the possibility of new risks. The relative scenarios that will open with the 5G trial are likely to change the overall exposure level of the population as a result of major changes in the network architecture. Therefore, it is important to adopt a strongly precautionary approach. Given the strong concerns of the population, the competent institutions should implement information and awareness programmes through adequate risk communication."

Russell (2018)
"Radiofrequency radiation (RF) is increasingly being recognized as a new form of environmental pollution. Like other common toxic exposures, the effects of radiofrequency electromagnetic radiation (RF EMR) will be problematic if not impossible to sort out epidemiologically as there no longer remains an unexposed control group. This is especially important considering these effects are likely magnified by synergistic toxic exposures and other common health risk behaviors. Effects can also be non-linear. Because this is the first generation to have cradle-to-grave lifespan exposure to this level of man-made microwave (RF EMR) radiofrequencies, it will be years or decades before the true health consequences are known. Precaution in the roll out of this new technology is strongly indicated."

Di Ciaula (2018)
"Preliminary observations showed that MMW increase skin temperature, alter gene expression, promote cellular proliferation and synthesis of proteins linked with oxidative stress, inflammatory and metabolic processes, could generate ocular damages, affect neuro-muscular dynamics. Further studies are needed to better and independently explore the health effects of RF-EMF in general and of MMW in particular. However, available findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principle, to define exposed subjects as potentially vulnerable and to revise existing limits."

European Environment Agency (EEA) – Late Lessons from Early Warnings: Science, Precaution, Innovation (2013)
"The benefits of mobile telecommunications are many but such benefits need to be accompanied by consideration of the possibility of widespread harms. Precautionary actions now to reduce

head exposures would limit the size and seriousness of any brain tumour risk that may exist. Reducing exposures may also help to reduce the other possible harms that are not considered in this case study."

Kheifets et al. (2005)
"Concerns about the potential vulnerability of children to radio frequency (RF) fields have been raised because of the potentially greater susceptibility of their developing nervous systems; in addition, their brain tissue is more conductive, RF penetration is greater relative to head size, and they will have a longer lifetime of exposure than adults…This article is based on discussions from the workshop and provides background information on the development of the embryo, fetus, and child, with particular attention to the developing brain; an outline of childhood susceptibility to environmental toxicants and childhood diseases implicated in EMF studies; and a review of childhood exposure to EMFs. It also includes an assessment of the potential susceptibility of children to EMFs and concludes with a recommendation for additional research and the development of precautionary policies in the face of scientific uncertainty."

The Inadequacy of Federal Exposure Guidelines

This section explores the fundamental flaws of current federal RF exposure guidelines.

Thousands of peer-reviewed studies show biological effects induced below the Federal Communications Commission's (FCC)'s exposure limits.

In a historic win for CHD against the FCC in 2021, the D.C. Circuit Court of Appeals ruled that the FCC's 2019 order (to not review its 1996 exposure guidelines) was "arbitrary and capricious in its failure to respond to record evidence that exposure to RF radiation at levels below the Commission's current limits may cause negative health effects unrelated to cancer."

Furthermore, the court held:

"That failure undermines the Commission's conclusions regarding **the adequacy of its testing procedures, particularly as they relate to children**, and its conclusions regarding **the implications of long-term exposure to RF radiation**, **exposure to RF pulsation or modulation**, and **the implications of technological developments that have occurred since 1996**, all of which depend on the premise that exposure to RF radiation at levels below its current limits causes no negative health effects. Accordingly, we find those conclusions arbitrary and capricious as well. Finally, we find the Commission's order arbitrary and capricious in its complete failure to respond to comments concerning environmental harm caused by RF radiation."

The ruling calls into question the underlying basis for the FCC's exposure guidelines.

Captured Agency: How the Federal Communications Commission Is Dominated by the Industries It Presumably Regulates (2015)

Norm Alster, in his book published by Edmond J. Safra Center for Ethics at Harvard University states,

"Most insidious of all, the wireless industry has been allowed to grow unchecked and virtually unregulated, with fundamental questions on public health impact routinely ignored. Industry controls the FCC through a soup-to-nuts stranglehold that extends from its well-placed campaign spending in Congress through its control of the FCC's congressional oversight committees to its persistent agency lobbying."