

Comments on RF Exposure Issues

ET Docket No. 13-84 | FCC Public Notice DA 26-997 | October 22, 2026

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1. Introduction

The Swedish Radiation Protection Foundation is a Swedish non-profit organization dedicated to research and dissemination of scientific information on potential adverse health effects of radiofrequency and electromagnetic fields (RF-EMF). Our research is performed in collaboration with Dr. Lennart Hardell, a cancer epidemiologist and a retired Professor at the Department of Oncology, Örebro University hospital, Sweden. Our work includes review of epidemiological, experimental, and environmental research. We submit these comments as an interested international organization working on health aspects related to exposure to RF radiation since 2012.

2. Findings from our research

In collaboration with Dr Lennart Hardell, we have found that individuals who had 5G antennas installed near their homes rapidly developed symptoms previously described as the microwave syndrome or radiofrequency sickness [1,2]. The onset of symptoms was temporally associated with the installation and activation of 5G base stations. We have published eight case studies and one summary of seven of the studies [2-11]. These case studies appear to be the only studies published so far on potential health effects on people living close to 5G antennas, thus representing real life exposure. The total number of persons studied was 17, their age varied between 4 and 83, including four children aged 4-8 years. The most frequently reported and most severe symptoms experienced after the deployment of 5G antennas were sleeping problems, fatigue, headache, agitation, concentration- and memory problems, and skin problems. Our measurements of RF-radiation in the studied person's homes showed that 5G antennas caused very high exposure. In the first case study [2] a base station providing 3G and 4G services had previously been operating at the same location, without the individuals studied reporting any associated health problems.

However, following the installation of 5G antennas, RF radiation exposure levels increased substantially, and both individuals developed severe health problems within two days. Similarly, in other case studies, we observed that individuals who had previously experienced no adverse health effects from exposure to 3G and 4G base stations developed health problems relatively rapidly following the upgrade of these base stations to 5G.

We also observed that when people moved from the 5G exposed apartment, house or office, to dwellings with much lower exposure, the reported symptoms subsided relatively quickly. This could be considered a classic provocation test.

Our case studies also included an eight-year-old boy who developed severe headaches while attending a school located approximately 200 meters from a 5G base station [10].

These findings are consistent with those of both earlier and more recent studies conducted by independent research groups, which have reported an increased risk of the same group of symptoms among individuals living in close proximity to mobile phone towers or base stations. Studies have also found increased risk of cancer, one study an increased risk of ALS, effects on antioxidants and DNA, among people living near base stations [12-49]. These effects have occurred at RF exposure levels well below the FCC limits.

We have also analyzed Swedish public health data from the Swedish National Board of Health and Welfare's national patient register on numbers of patients in specialized outpatient care diagnosed with codes for sleeping problems each year 2001 - 2024. A clear and rapid increase in the number of patients diagnosed with sleeping problems in the age groups 0-4, 5-19 and 20-39 years, was observed, mainly between 2010 and 2024 [50]. In addition we analyzed corresponding data on the diagnosis for memory problems each year in Sweden between 2001 and 2024 among children aged 5-19 years and also number of children aged 5-19 years that had consulted a physician in Norway for memory problems each year 2006-2024. In Norway the number of consultations increased from 179.51 in 2006 to 1,522.40 per 100,000 inhabitants in 2024, representing an 8.5-fold increase. The increase was particularly pronounced in recent years. A similar trend was observed in Sweden, where the annual number of patients diagnosed with mild cognitive impairment (R41.8) increased markedly, particularly from 2010 onwards. The number rose from 0.86 patients per 100,000 inhabitants in 2010 to 51.531 in 2024, representing an almost 60-fold increase over this period [51].

These trends of increased incidence of memory and sleeping problems may be associated with children's and adolescent's increasing exposure to microwave RF radiation during the studied time period. We refer to laboratory studies that, taken together, show convincing evidence for negative impact on memory and cognitive function [52-106,118,120, 121] as well as on other functions of the brain which may impact sleep.

Consequently, a) the findings in our case studies and studies on people living in the vicinity of mobile phone base stations and masts; b) the findings from laboratory studies confirming mechanistic effects on memory, cognitive and brain function; c) the increasing incidence of memory and sleep problems particularly among children and adolescents, that has coincided with the increasing exposure to RF-radiation, makes the evidence compelling for a real effect on brain function, particularly memory, cognition and sleep, that arises from long term non-thermal exposure at levels well below the FCC limits.

3. Results on effects on brain, oxidative stress, genetic effects, fertility

The BioInitiative Report (2012) compiled around 1,800 studies on biological effects and health effects from exposure to RF radiation, including 155 studies on neurological effects between 2007 and mid-2012. Of these, 98 showed effects and 57 showed no effects. [107]

Studies on non-thermal biological and health effects have been documented via the list of studies compiled by Professor Emeritus Henry Lai, and presented on SafeEMR by Dr Joel Moskowitz, concluding that the majority of RF-exposure studies published since 1990 has reported significant negative effects [108]. According to this compilation of 1,910 studies on oxidative stress, genetic effects, neurological effects and reproduction effects:

“89% (n=390) of 438 RFR oxidative effects (or free radical) papers published since 1997 reported significant effects including 96% (n=110) of 114 studies with a SAR (specific absorption rate) ≤ 0.40 Watt per kilogram (which is ten times less than the 4.0 W/kg threshold of harm that the FCC and the ICNIRP use to base their RFR exposure limits).

72% (n=396) of 550 RFR genetic effects papers published since 1990 reported significant effects including 192 (84%) of 228 studies on gene expression.

78% (n=396) of 507 RFR neurological papers published since 2007 reported significant effects.

85% (n=354) of 415 RFR reproduction and development papers published since 1990 reported significant effects. Among the low-intensity exposure studies that reported significant effects, 73 studies used an exposure with a SAR ≤ 0.40 W/kg and 53 studies had a SAR ≤ 0.08 W/kg.

260 low-intensity RFR exposure studies (SAR < 0.40 W/kg) published since 1990 reported significant effects.”

In addition scientists from ORSAA (Oceania Radiofrequency Scientific Advisory Association) have compiled a substantial number of studies in their database. In an article published in 2022 they conclude that “there is an extensive evidence base revealing that significant stress to human biological systems is being imposed by exposure to everyday wireless communication devices and supporting infrastructure.”

4. Children’s sensitivity

Studies have also reported harmful effects on children when exposed to the mother’s use of mobile phones during pregnancy, analyzed in a systematic review from Columbia University [110]. Large cohort studies have found an association with mother’s use of mobile phones during pregnancy and behavior problems, particularly hyperactivity/inattention problems [111]. In one of the cohorts from Denmark, the highest risk for behavioral problems was found in children exposed both during fetal period and after birth [112] while in a recent cohort behavioral problems in children were associated with use after birth [119]. Several animal studies confirm that exposure during fetal period may result in behavior changes and harmful effects on the brain and other organs. Yale University scientists observed that mice exposed to mobile phone radiation during fetal period were hyperactive and had impaired memory. The scientists found that the behavioral changes were caused by altered neuronal developmental programming [98]. Recent review of available evidence (65 studies) also showed that RF-EMF exposure may affect neurodevelopment and behavior through neurobiological mechanisms. [122].

A study published in 2026 found that Children may absorb 1.5–1.9 times higher whole-body SAR than adults at all sub-6 GHz frequencies [113].

In August 2026 ICBE-EMF (International Commission on the Biological Effects of Electromagnetic Fields) published a statement on children's sensitivity and the need for better protection of children: "The current body of research provides sufficient evidence to warrant the adoption of policies that mitigate risk by reducing exposure. Research has reported biological effects from exposure to non-ionizing electromagnetic fields (EMFs) at levels well below current FCC, ICNIRP, and IEEE exposure limits. Studies have reported numerous adverse effects, including cancer, oxidative stress, genetic impacts, blood-brain barrier permeability, sperm damage, structural and functional changes of the reproductive system, impairments in cognition, learning and memory, sleep impacts, EEG alterations, and other neurological effects as well as multi-systemic acute symptoms, including electromagnetic hypersensitivity." [114].

5. FCC must set significantly stricter maximum exposure limits in order to protect public health

271 RF-EMF scientists have called for better protection of the public and vulnerable groups by development of more protective limits in the EMF Scientist appeal [115]. It is signed by scientists who have published peer-reviewed papers on the biological or health effects of extremely low frequency fields and radiofrequency radiation.

The current limits are obviously insufficient to protect against harmful effects on the brain and central nervous system, negative effects oxidative stress, DNA damage, fertility and reproduction.

Based on our experience and strong scientific evidence from several thousand studies, involving both humans and animals, adverse health effects have been reported at exposure levels well below the limits established by the FCC and recommended by ICNIRP. There is also a considerable variation among people: some people are considerably more sensitive and react negatively at levels that others tolerate.

The limits proposed by EuropaEM published in 2016, EuropaEM EMF Guideline are so far the best option for the FCC to consider when setting new limits to protect the public against harmful long term non-thermal effects, taking into account also particularly sensitive groups.

We have analyzed the ICNIRP limits (similar to FCC limits that primarily only protect against acute thermal effects) and compared them with the EuropaEM EMF Guidelines, as well as with proposed precautionary limits from other organizations, in our article *Aspects on the International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 Guidelines on Radiofrequency Radiation*. The exposure limits proposed by EuropaEM are orders of magnitude lower—by factors of millions—than those recommended by ICNIRP [117].

6. Additional aspects to consider regarding conflicts of interests

Source of funding, conflicts of interests and direct or indirect ties to telecom or military industry must be considered when evaluating the evidence. It is a well-known fact that the telecommunication and military industry sectors are defending and promoting the FCC and ICNIRP thermal based limits, although they are insufficient to protect against many well documented negative health and

biological effects. As an example, a brochure from GSMA – a global organization representing mobile operators, promotes the ICNIRP 2020 limits [123].

These industries also fund studies/scientists that to a majority report no effects below these limits [124].

WHO's department for RF and health, the EMF Project, is biased in favor of the ICNIRP thermal based limits and consults mainly ICNIRP members as experts. The WHO EMF Project was financed by telecom industry organizations for around 10 years, from its creation in 1996 until 2006 [117]. Still today the WHO maintains an opinion of no effects below the ICNIRP limits, that benefits industry.

A report commissioned by former members of the European Parliament, Michèle Rivasi and Klaus Buchner, examined a network of ICNIRP-affiliated scientists and experts with ties to industry, describing a closely interconnected network of experts whose assessments consistently favor industry interests. These assessments from the WHO, EU, and national scientific reviews, repeatedly conclude that there are no adverse health effects at exposure levels below the ICNIRP and FCC limits and therefore that the ICNIRP limits provide sufficient protection against harmful health effects. The investigation found that “the majority of ICNIRP-scientists did perform research partly funded by industry” [118].

Limits should be set to protect the public against harmful effects on health, not industry needs.

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