

Radio frequency radiation (RF-EMR) from mobile phone networks and Wi-Fi: studies showing harmful bio-effects

NOTE: The peer-reviewed studies as shown here apply to WiFi, 3G, 4G, low-frequency 5G, and high-frequency 5G

1. US National Toxicology Program study: 'clear link' with heart and brain tumours <https://www.niehs.nih.gov/health/topics/agents/cellphones/index.cfm>

The ten-year, \$30million US Department of Health National Toxicology Program study (2018) of 3000 mice & rats and mobile phone radio frequency radiation (RFR) as used in 2G and 3G showed:

- **Clear evidence of tumors in the hearts of male rats.** *The tumors were malignant schwannomas.*
- **Some evidence of tumors in the brains of male rats.** *The tumors were malignant gliomas [an aggressive, almost always fatal form of brain tumour].*
- **Some evidence of tumors in the adrenal glands of male rats.** *The tumors were benign, malignant, or complex combined pheochromocytoma.*

The final conclusions represent the consensus between NTP and a panel of external scientific experts who thoroughly reviewed the draft NTP technical reports at a public meeting in March 2018.'

Further findings:

Female rats showed 'equivocal' evidence of increased tumour risk.

Irradiated rats had lower birth rates and higher rates of infant mortality.

Some evidence of DNA damage in tissues was also found.

Cancers of the skin, lung, prostate and liver were also elevated in exposed rats, but was not conclusively linked with RFR.

Schwann and glial cells of the heart and brain seemed to be the most affected; it was speculated that this is due to their role in electrical insulation of nerve cells in the body.

See also: **Smith-Roe et al (2018)**. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environmental and Molecular Mutagenesis*.

Questions/criticisms:

Rats were exposed across the whole body rather than in certain specific sites as tends to be the case with humans in real-life situations (although this is not the case for mobile phone masts or Wi-Fi which expose the entire body).

The rats had decreased rates of kidney disease for unexplained reasons which caused a statistical overall increased life expectancy.

The FDA denied the conclusions of the report, since everyday exposure of mobile radiation to humans is lower than in the tests. However, similar results were found with exposure levels typical of that of ordinary human use (see Ramazzini study, below). The NTP study was reviewed by 15 external physicians who concurred with the finding of 'clear evidence' of cancer.

Comments on the NTP study from independent oncologists

Hardell L, Carlberg M (2019). Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. *Int J Oncol.* 54(1):111-127. <https://www.ncbi.nlm.nih.gov/pubmed/30365129>

The main aim of this study was to compare earlier human epidemiological studies with NTP findings, including a short review of animal studies. We conclude that there is clear evidence that RF radiation is a human carcinogen, causing glioma and vestibular schwannoma (acoustic neuroma). There is some evidence of an increased risk of developing thyroid cancer, and clear evidence that RF radiation is a multi-site carcinogen. Based on the Preamble to the IARC Monographs, RF radiation should be classified as carcinogenic to humans, Group 1.

The ICNIRP critique of the Program: <https://www.icnirp.org/cms/upload/publications/IC-NIRPnote2018.pdf>

Ronald Melnick MD who led the NTP study has scientifically refuted every criticism made by ICNIRP: <https://www.emfacts.com/2018/10/us-scientist-criticizes-icnirps-exposure-guideline-spin/>

Dr Fiorella Belpoggi of the Ramazzini Institute for cancer research study's response to the ICNIRP critique of the UN study and the Ramazzini study (below): <https://www.ramazzini.org/comunicato/onde-elettromagnetiche-listituto-ramazzini-risponde-allicnirp/>

NB rats have almost identical disease patterns to humans, according to the Human Genome Project research. <https://www.genome.gov/11511308/2004-release-scientists-compare-rat-genome>

2. Ramazzini Institute Study: links with heart and brain cancer

A 2018 study of 2448 rats exposed to 'far-field' radio frequency radiation (replicating exposure to laptops, phones which are turned on but not in use, etc) over a lifetime found similar results to the NTP study.

'The findings...are consistent with and reinforce the results of the NTP study...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 [International Agency for Research on Cancer] conclusions regarding the carcinogenic potential of RFR in humans [currently classed as a '2B possible carcinogen'].

Belpoggi F et al (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. *Environmental Research* 165:496-503. <https://www.ncbi.nlm.nih.gov/pubmed/29530389>

3. Brain glioma rates in England have doubled

New research of 79,241 brain tumours in patients in England shows that, whilst overall rates of brain tumour have not increased, the specific type of tumour associated with RFR - aggressive brain gliomas - in the above studies more than doubled from 1995-2015.

Mobile phone/cordless phone radiation were suggested as factors, especially considering the site of tumours. CT scans and atomic bomb fallout were also suggested.

Phillips, A et al (2018). Brain Tumours: Rise in Glioblastoma Multiforme Incidence in England 1995–2015 Suggests an Adverse Environmental or Lifestyle Factor. *Journal of Environmental and Public Health*. Volume 2018 <https://www.hindawi.com/journals/jeph/2018/7910754/>

Brain gliomas and tumours of the central nervous system are also increasing rapidly in Denmark <https://stopsmartmeters.org.uk/record-high-number-of-new-brain-tumors-in-2015-in-denmark/>

4. Brain glioma rates in France have quadrupled

In July 2019 (updated in September 2019), the French Public Health Agency Santé Publique France published national estimates of cancer incidence and mortality in metropolitan France between 1990 and 2018. Brain glioma rates have quadrupled in twenty years. Brain radiation therapy and pesticides are cited as possible factors; the latest research from the National Toxicology Program and the Ramazzini Institute suggest that RF-EMR may also be a cause, particularly given that the rise has occurred since the use of mobile phones became widespread.

5. Mobile phone radiation causes brain tumours

From the International Journal of Oncology previous to the 2018 studies cited above. Includes information on the INTERPHONE study <https://www.spandidos-publications.com/10.3892/ijo.2015.2908>

6. Lancet article: majority of studies show harm to all living things from RF-EMR

Bandara P and Carpenter D (2012). Planetary electrosmog: it's time to assess its impact. *The Lancet Planetary Health* 2(12). [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(18\)30221-3/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext)

'Mounting scientific evidence suggests that prolonged exposure to radiofrequency electromagnetic radiation has serious biological and health effects. However, public exposure regulations in most countries continue to be based on the guidelines of the International Commission on Non-Ionizing Radiation Protection...A recent evaluation of 2266 studies (including in-vitro and in-vivo studies in human, animal, and plant experimental systems and population studies) found that most studies (n=1546, 68.2%) have demonstrated significant biological or health effects associated with exposure to anthropogenic electromagnetic fields...This weight of scientific evidence refutes the prominent claim that the deployment of wireless technologies poses no health risks at the currently permitted non-thermal radiofrequency exposure levels. Instead, the evidence supports the [International EMF Scientist Appeal](#) by 244 scientists from 41 countries who have published on the subject in peer-reviewed literature and collectively petitioned the WHO and the UN for immediate measures to reduce public exposure to artificial electromagnetic fields and radiation.'

A database of studies ('the largest categorised online database') from the Oceania Radiofrequency Scientific Advisory Association, independent scientists who are also campaigners, is available here: <https://www.orsaa.org/research-papers.html>

This article also contains references to studies.

7. Five studies by Swedish oncologist Lennart Hardell:

Young people using mobile phones have a 5 x higher risk of fatal brain glioma

Risk is higher for those aged <20 years. Cordless phones also increase risk x 4. Most tumours develop decades after the exposure period so much epidemiological evidence may be yet to come.

L. Hardell and M. Carlberg (2015). "Mobile phone and cordless phone use and the risk for glioma—analysis of pooled case-control studies in Sweden, 1997–2003 and 2007–2009," *Pathophysiology* 22 (1),1–13.
<https://www.ncbi.nlm.nih.gov/pubmed/25466607>

Mobile phones increase risk of brain tumour on same side of head used for phone calls
1617 brain tumour patients were studied. Mobile phones were found to increase risk but no clear association was found for cordless phones. The risk was increased for tumours located in the temporal area on the same side of the brain that was used during phone calls; especially acoustic neuroma.

Hardell L et al (2002) Cellular and cordless telephones and the risk for brain tumours. *Eur J Cancer Prev* 11 (4) 377–386 <https://www.ncbi.nlm.nih.gov/pubmed/12195165>

Mobile phone use linked with glioma and acoustic neuroma

Ten studies of brain glioma were evaluated and nine of acoustic neuroma. *We conclude that this meta-analysis gave a consistent pattern of an association between mobile phone use and ipsilateral glioma and acoustic neuroma using > or =10-years latency period.*

Hardell et al (2008). Meta-analysis of long-term mobile phone use and the association with brain tumours. *Int J Oncol.* 32(5):1097-103. <https://www.ncbi.nlm.nih.gov/pubmed/18425337>

Mobile phone use increases risk of tumours on same side of head

Ipsilateral (same side) use of a cellular telephone increased the risk of tumours in the temporal, temporoparietal and occipital areas, with OR 2.42, 95% CI 0.97-6.05 (i.e. the anatomical areas with highest exposure to microwaves from a mobile phone).

Hardell L et al (2001). Ionizing radiation, cellular telephones and the risk for brain tumours. *Eur J Cancer Prev.* 10(6):523-9. <https://www.ncbi.nlm.nih.gov/pubmed/11916351>

Gliomas linked with low-frequency EMFs

Hardell et al (2017). Case-control study on occupational exposure to extremely low-frequency electromagnetic fields and glioma risk. *Am J Ind Med.* 60(5):494-503. <https://www.ncbi.nlm.nih.gov/pubmed/28394434>

An increased risk in late stage (promotion/progression) of astrocytoma grade IV [aggressive gliomas] for occupational ELF-EMF exposure was found.

8. Six studies of cancer clusters for people living <500m phone masts

The standard advice from Cancer Research UK is that proximity to cell masts does not increase cancer risk. A *British Medical Journal* article claims there is no association, based on a study of children whose mothers lived by base stations during pregnancy and followed up for 4 years [despite the fact that cancer is likely to take longer to develop, and the amount of time the pregnant women spent actually in the homes near the masts was not factored into the data]. The study is widely cited by the press and government bodies.

Yet other studies show clear health effects:

1. Dode et al (2011). Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. *Sci Total Environ*. 2011 Sep 1;409(19): 3649-65. <https://www.ncbi.nlm.nih.gov/pubmed/21741680>

This 10-year study showed increase in cancer; masts were subsequently removed and litigation cases begun.

2. Santini et al (2002). Study of the health of people living in the vicinity of mobile phone base stations. *Pathologie Biologie* 50: 369-73. <https://www.ncbi.nlm.nih.gov/pubmed/12168254>

This study found significant health effects on people living within 300m of base stations.

(See also):

Santini, Symptoms Experienced by People in Vicinity of Base stations: II / Incidences of Age, Duration of Exposure, Location of Subjects in Relation to The Antennas and Electromagnetic Other Factors, *Pathol Biol (Paris)*. 2003 Sep; 51 (7): 412-5

Santini, Investigation on The Health of People Living near Mobile telephone Relay stations: I / Incidence according to Distance and Sex, *Pathol Biol (Paris)* 2002 Jul; 50 (6): 369-73

3. Netherlands Organisation for Applied Scientific Research (TNO); Study for the Netherlands Ministries of Economic Affairs, Housing, Spatial Planning and the Environment, and Health, Welfare and Sport (2003). Effects of Global Communications System Radio-Frequency Fields on Well Being and Cognitive Function of Human Subjects With and Without Subjective Complaints.

This study found significant effects on wellbeing from 3G mast emissions well below accepted 'safety' levels (less than 1/25,000th of ICNIRP guidelines). Those who had previously been noted as 'electrosensitive' under a scheme in that country were shown to have more pronounced ill-effects, though others were also shown to experience significant effects.

4. Gerd, O et al. The Microwave Syndrome - further aspects of a Spanish study. Presented at an international conference in Kos (Greece), 2004. https://www.researchgate.net/publication/237410769_THE_MICROWAVE_SYNDROME_-_FURTHER_ASPECTS_OF_A_SPANISH_STUDY

This study found significant levels of: depression, fatigue, insomnia, concentration problems, cardiovascular issues.

'Based on the data of this study the advice would be to strive for levels not higher than 0.02V/m for the sum total, which is equal to a power density of 0.0001 μ W/cni² or 1 μ W/m², which is the indoor exposure value for GSM base stations proposed on empirical evidence by the Public Health Office of the Government of Salzburg

in 2002.”

5. Wolf R & Wolf D (2004). Increased incidence of cancer near a cell phone transmitter station. *International Journal of Cancer Prevention* 1(2).

This study...showed a fourfold increased incidence of cancer generally compared with the general population of Israel, and a tenfold increase specifically among women, compared with the surrounding locality further from the mast.

6. Naila Study, Germany (Nov 2004); report by 5 medical doctors

www.tetrawatch.net/papers/naila.pdf

1.000 patients were evaluated...the relative risk of getting cancer had trebled for the residents of the area in the proximity of the installation compared to the inhabitants of Naila outside the area.

Classic microwave sickness: <https://pdfs.semanticscholar.org/fd41/bacfeceabc-c404142c7e961ad8acf63e7f7b.pdf>

In 2008 a cancer cluster was reported in the area around a tower in Dudley found to have the highest levels of radiation in the UK (yet still within safety guidelines).

Note that with 5G masts added to existing stations that radiation levels will be greater [find exact levels; compare with Simon Mann of PHE and ICNIRP ‘there may be a slight increase’].

9. The 2010 INTERPHONE Study - increased risk for those using mobile phones >30 mins daily; and problems with the study

The INTERPHONE study was a set of international case-controlled studies by IARC, the International Agency for Research on Cancer, involving 50 scientists. IARC is an independent organisation which was tasked by WHO for the study. The study was part-funded by telecoms companies, but subject to guarantees that results would remain independent. 5000 people with glioma or meningioma were interviewed from 2000-2006. Scientists disagreed on interpretations and the results were therefore not released until 2010.

The study found an overall decreased risk of cancer for mobile phone users, but increased risk of glioma at the highest exposure levels and, after correcting for bias, an eighty per cent higher likelihood of having a brain glioma for ‘heavy users’ (30 minutes daily). The authors concluded that *“biases and error prevent a causal interpretation”* and that the num-

ber of people using their mobile phones >30 minutes daily in the study was relatively small. Michael Thun of the American Cancer Society stated that "The majority of participants in this study were not heavy cell phone users compared to today's practices."

One INTERPHONE study showed that risk of an acoustic neuroma (a usually benign tumour which can cause deafness or be fatal if left untreated) on the same side of the head as reported phone use was raised for use for 10 years or longer: Shoemaker MJ et al (2005). Mobile phone use and risk of acoustic neuroma: results of the Interphone case-control study in five North European countries. *Br J Cancer*. 93(7):842-8. <https://www.ncbi.nlm.nih.gov/pubmed/16136046>

The INTERPHONE Study Group Author Notes (2010). Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *International Journal of Epidemiology* 39 (3) 675-694. <https://academic.oup.com/ije/article/39/3/675/631387>

Note: The WHO classified radio frequency radiation as a Group 2B 'possible classification' in 2011 after the INTERPHONE study. Scientists are disputing this and demanding a 'probable carcinogen' or 'carcinogen' classification.

Emeritus Professor and epidemiologist Anthony Miller, an expert cancer researcher and advisor to the World Health Organization International Agency for Research on Cancer (WHO/IARC) (International Agency for Research on Cancer) has issued his scientific opinion that radiofrequency (RF) radiation from any source – such as the signals emitted by cell phones, other wireless and cordless and sensor devices, and wireless networks – fully meets criteria to be classified as a "Group 1 carcinogenic to humans" agent, based on scientific evidence associating RF exposure to cancer development and cancer promotion.

He says, 'The evidence indicating wireless is carcinogenic has increased and can no longer be ignored.' His opinion includes recent scientific publications which include the 2017 re-analysis of data from the Interphone study, the 2014 French National CERENAT Study, several new publications on Swedish cancer data, and the 2016 results of the National Toxicology Program.

10. Current knowledge justifies warnings from public health bodies

Miller et al (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health* 7:223. <https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223/full>

'A broad range of adverse human health effects associated with RFR have been reported since the IARC review. In addition, three large-scale carcinogenicity studies in rodents exposed to levels of RFR that mimic lifetime human exposures have shown significantly increased rates of Schwannomas and malignant gliomas, as well as chromosomal DNA damage. Of particular concern are the effects of RFR exposure on the developing brain in

children. Compared with an adult male, a cell phone held against the head of a child exposes deeper brain structures to greater radiation doses per unit volume, and the young, thin skull's bone marrow absorbs a roughly 10-fold higher local dose. Experimental and observational studies also suggest that men who keep cell phones in their trouser pockets have significantly lower sperm counts and significantly impaired sperm motility and morphology, including mitochondrial DNA damage. Based on the accumulated evidence, we recommend that IARC re-evaluate its 2011 classification of the human carcinogenicity of RFR, and that WHO complete a systematic review of multiple other health effects such as sperm damage. In the interim, current knowledge provides justification for governments, public health authorities, and physicians/allied health professionals to warn the population that having a cell phone next to the body is harmful, and to support measures to reduce all exposures to RFR.'

11. Radiation levels in city centres are higher than Bioinitiative physicians' recommendations; radiation levels are invariably a tiny fraction of ICNIRP limits even when high

Hardell et al (2019). High ambient radiofrequency radiation in Stockholm city, Sweden. *Oncol Lett.* 17(2):1777-1783. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6341832/>

All measurements exceeded the target level of 30-60 $\mu\text{W}/\text{m}^2$ based on non-thermal (no heating) effects, according to the BioInitiative Report... These environmental RF radiation levels are expected to increase with the introduction of 5G for wireless communication.

Even when close to a mast, ICNIRP limits are so high that measurements taken will always be far beneath them. ICNIRP's limit is $10\text{W}/\text{m}^2$ (10 watts per metre squared) or $10,000\text{mW}/\text{m}^2$ or $10,000,000\mu\text{W}/\text{m}^2$. Total mean radiation level for the apartment photographed in the above study was $3.811\text{mW}/\text{m}^2$. The hotspot for that apartment which was on the balcony outside the living room was only just under $25\text{mW}/\text{m}^2$. That's within 12 metres line of sight direct communication with the base station and the maximum level was still just 1/400th of ICNIRP's limits. [Info provided by Simon Hodges; to be corroborated with ICNIRP limits].

12. 'Standards set by most national and international bodies are not protective of human health.'

Belpomme D et al (2018). Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environ Pollut.* 242(Pt A):643-658. <https://www.ncbi.nlm.nih.gov/pubmed/30025338>

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... 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. Bioeffects include cancer, DNA damage, reproductive health damage, electrohypersensitivity.

13. Sperm damage from ‘even a small amount of WiFi exposure.’

Rats exposed to low-frequency radiation from WiFi for differing amounts of time showed damage to sperm for all exposure groups.

Shokri S et al (2015). Effects of Wi-Fi (2.45 GHz) Exposure on Apoptosis, Sperm Parameters and Testicular Histomorphometry in Rats: A Time Course Study. *Cell J.* 17(2):322-331. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4503846/>

14. Damage to ovaries

Okatan DÖ et al (2018). Continuous 900-megahertz electromagnetic field applied in middle and late-adolescence causes qualitative and quantitative changes in the ovarian morphology, tissue and blood biochemistry of the rat. *Int J Radiat Biol.* 94(2):186-198. <https://www.ncbi.nlm.nih.gov/pubmed/29268055>

Oxidative stress was significantly higher in an EMF-exposed group of rats whilst follicles were significantly lower.

15. A range of harmful bio-effects from Wi-Fi.

Pall, M (2018). WiFi is an important threat to human health. *Environmental Research* 164; 405-416. <https://www.sciencedirect.com/science/article/pii/S0013935118300355>

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. Each of these effects are also caused by exposures to other microwave frequency EMFs, with each such effect being documented in from 10 to 16 reviews. Therefore, each of these seven EMF effects are established effects of Wi-Fi and of other microwave frequency EMFs...EMF effects are often cumulative; and EMFs may impact young people more than adults.

Pall is an emeritus professor of biochemistry at Washington State University, an expert in electromagnetic radiation and its bio-effects, and an outspoken critic of 5G. Pall describes in some detail the biochemical mechanisms for damage. He also criticises the Foster & Moulder review of Wi-Fi as not relating to ‘genuine’ Wi-Fi and points out the particular dangers of pulsed EMF. Foster responded that the F & M study did acknowledge effects of Wi-Fi but said that they were difficult to interpret. https://www.researchgate.net/publication/328436881_Response_to_Pall_Wi-Fi_is_an_important_threat_to_human_health

More of Pall’s peer-reviewed work on voltage-gated calcium channels:

<https://www.ncbi.nlm.nih.gov/pubmed/23802593>

16. EMFs cause neuropsychiatric effects including depression

Pall, M (2016). Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. *J Chem Neuroanat.* 75(Pt B):43-51. <https://www.ncbi.nlm.nih.gov/pubmed/26300312>

An explanation of how microwaves impact the nervous system via voltage-gated calcium channels and cause a range of harmful neuro-effects including insomnia, headache, depression, fatigue, dysesthesia, attention dysfunction, memory changes, dizziness, irritability, loss of appetite/body weight, restlessness/anxiety, nausea, skin burning/tingling/dermographism and EEG changes.

17. Rebuttal of claims that only thermal effects need to be considered

Pall M (2015). Scientific evidence contradicts findings and assumptions of Canadian Safety Panel 6: microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action. *Rev Environ Health.* 30(2):99-116. <https://www.ncbi.nlm.nih.gov/pubmed/25879308>

'It is time for a paradigm shift away from only thermal effects toward VGCC activation and consequent downstream effects.'

Pall's booklet can be downloaded for free here: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=2ahUKEwjD58yMuu7k-AhWRiVwKHcXgCwoQFjACegQIAhAC&url=https%3A%2F%2Fwww.emfdata.org%2Fdownload.php%3Ffield%3Dfilename_en%26id%3D164%26class%3DCUSTOM_Docu&usg=AOvVaw2NVRbOgzG82Qhdn2Jtj01E

18. Mobile phone radiation adversely affects RNA expression in the brain

Dasdag S et al (2015). Long term and excessive use of 900 MHz radiofrequency radiation alter microRNA expression in brain. *Int J Radiat Biol.* 91(4):306-11. <https://www.ncbi.nlm.nih.gov/pubmed/25529971>

Conclusion: *'900 MHz RF radiation can alter some of the miRNA, which, in turn, may lead to adverse effects.'*

19. Mobile phone radiation adversely affects human sperm.

Zalata A et al (2015). In vitro effect of cell phone radiation on motility, DNA fragmentation and clusterin gene expression in human sperm. *Int J Fertil Steril.* 9(1):129-36. <https://www.ncbi.nlm.nih.gov/pubmed/25918601>

Conclusion: 'Cell phone emissions have a negative impact on exposed sperm motility index, sperm acrosin activity, sperm DNA fragmentation and seminal CLU gene expression.'

20. Harmful effects on neurotransmitters

About E et al (2013). The effect of pulsed electromagnetic radiation from mobile phone on the levels of monoamine neurotransmitters in four different areas of rat brain. *Eur Rev Med Pharmacol Sci* 17(13):1782-8. <https://www.ncbi.nlm.nih.gov/pubmed/23852905>

Conclusion: The exposure of adult rats to EMR may cause disturbances in monoamine neurotransmitters and this may underlie many of the adverse effects reported after EMR including memory, learning, and stress.

21. Neurobehavioral effects around base stations

Abdel-Rassoul G et al (2007). Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotoxicology.* 28(2):434-40. <https://www.ncbi.nlm.nih.gov/pubmed/16962663>

85 inhabitants living near a mobile phone mast in Egypt were matched with a control group and completed a questionnaire relating to neurological health. Neuropsychiatric complaints were higher amongst subjects living near the mast.

Conclusions: 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 RFR 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.

22. Oxidative stress and circadian rhythm disruption from radio frequency fields

Cao H et al (2015). Circadian rhythmicity of antioxidant markers in rats exposed to 1.8 GHz radiofrequency fields. *Int J Environ Res Public Health.* 12(2):2071-87. <https://www.ncbi.nlm.nih.gov/pubmed/25685954>

The overall results indicate that there may be adverse effects of RF exposure on antioxidant function, in terms of both the daily antioxidative levels, as well as the circadian rhythmicity.

23. Significantly reduced memory function in rats

Nittby H et al (2007). Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation. *BioElectric Magnetism*. <https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.20386>

24. Adverse effects on children's memory function

Krause C et al (2005). Mobile phone effects on children's event-related oscillatory EEG during an auditory memory task. *International Journal of Radiation Biology* 82(6). <https://www.tandfonline.com/doi/abs/10.1080/09553000600840922?journalCode=irab20>

Conclusions: The current findings suggest that EMF emitted by mobile phones has effects on brain oscillatory responses during cognitive processing in children.

25. Damage to the blood-brain barrier

Tang, J et al (2015). Exposure to 900 MHz electromagnetic fields activates the mmp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats. *Brain Research* 1601; pp 92-101. <https://www.sciencedirect.com/science/article/abs/pii/S000689931500030X?via%3Dihub>

'These results demonstrated that exposure to 900 MHz EMF radiation for 28 days can significantly impair spatial memory and damage BBB permeability in rat by activating the mmp-1/ERK pathway.'

26. Memory adversely affected in adolescents

Anna Schoeni, Katharina Roser, Martin Rösli (2015). Memory performance, wireless communication and exposure to radiofrequency electromagnetic fields: A prospective cohort study in adolescents. *Environment International* 85; pp 343-351. <https://www.sciencedirect.com/science/article/pii/S0160412015300659?via%3Dihub>

A change in memory performance over one year was negatively associated with cumulative duration of wireless phone use and more strongly with RF-EMF dose.

27. Non-thermal effects on human brain cells

Leszczynski D et al (2002). Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related effects. *Differentiation* 70 (2-3), 120-129. <https://www.sciencedirect.com/science/article/pii/S0301468109604400?via%3Dihub>

We postulate that these events, when occurring repeatedly over a long period of time, might become a health hazard because of the possible accumulation of brain tissue dam-

age. Furthermore, our hypothesis suggests that other brain damaging factors may co-participate in mobile phone radiation-induced effects.

28. Effects on human glucose metabolism in the brain

Henry Lai, PhD; Lennart Hardell, MD, PhD (2011). Cell Phone Radiofrequency Radiation Exposure and Brain Glucose Metabolism. *JAMA*. 305(8):828-829. <https://jamanetwork.com/journals/jama/article-abstract/645719>

29. Increased blood-brain barrier permeability in mammalian brain

Note: The integrity of the blood-brain barrier is critical to brain health. The BBB should act as a type of 'smart sieve', keeping toxins out and letting nutrients in. It has previously been claimed that wireless radiation does not damage the blood-brain barrier but studies show this is not the case.

Nitby H et al (2009). Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. *Pathophysiology*. 2009 Aug;16(2-3):103-12. <https://www.ncbi.nlm.nih.gov/pubmed/19345073>

Also see: Dr. Salford, Dr. Nitby, and Dr. Persson in 'Effects of Electromagnetic Fields From Wireless Communication upon the Blood Brain Barrier' The Bioinitiative Report 2012.

And a study in detail showing BBB damage here: <https://ecfsapi.fcc.gov/file/7520941992.pdf>

30. People living near phone masts have neurological symptoms

A study of 530 people showed that those living within 300m of base stations had significantly more symptoms such as headaches, insomnia, dizziness, memory loss, nausea and depression.

Santini R et al (2002). Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex. *Pathol Biol (Paris)*. 50(6):369-73. <https://www.ncbi.nlm.nih.gov/pubmed/12168254>

'This first study on symptoms experienced by people living in vicinity of base stations shows that, in view of radioprotection, minimal distance of people from cellular phone base stations should not be < 300 m.'

31. Measurable biomarkers of electro-sensitivity under controlled conditions

Note that this condition is denied in the UK but medically-recognised in Sweden and recognised by UK doctors such as Dr Andrew Tressider and Dr Erica Mallory-Blythe. ES-UK believe there are 800K sufferers in the UK alone.

Rea, W J et al (2009). Electromagnetic Field Sensitivity. *Journal of Bioelectricity* 10 (1-2). <https://www.tandfonline.com/doi/abs/10.3109/15368379109031410>

'16 of the EMF-sensitive patients (64%) had positive signs and symptoms scores, plus autonomic nervous system changes...this study gives strong evidence that electromagnetic field sensitivity exists, and can be elicited under environmentally controlled conditions.'

32. Rats develop lung and liver cancer when exposed to radio frequency electromagnetic fields well below exposure limits.

Lerchl A et al (2015). Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. *Biochemical and Biophysical Research Communications*. 459(4): 585-90. <https://www.ncbi.nlm.nih.gov/pubmed/25749340>

This study confirmed findings of a previous study linking carcinogen-treated mice with tumours from mobile phone radiation. Note that humans are exposed to multiple carcinogens which are thought to interact synergistically with RFR. *Our findings may help to understand the repeatedly reported increased incidences of brain tumors in heavy users of mobile phones.*

33. WiFi causes DNA damage to rat testes

Adage et al (2016). Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce DNA damage in various tissues of rats? *J Chem Neuroanat*. 75(Pt B):116-22.

This study showed DNA damage from Wi-Fi to testes only and identified them as a more sensitive organ to RF radiation.

34. Wi-Fi causes oxidative stress to brain and liver

Çelik Ö, Kahya MC, Nazıroğlu M (2016). Oxidative stress of brain and liver is increased by Wi-Fi (2.45GHz) exposure of rats during pregnancy and the development of newborns. *J Chem Neuroanat*. 75(Pt B):134-9.

In conclusion, Wi-Fi-induced oxidative stress in the brain and liver of developing rats was the result of reduced GSH-Px, GSH and antioxidant vitamin concentrations. Moreover, the brain seemed to be more sensitive to oxidative injury compared to the liver in the development of newborns.

35. Microwave radiation alters circadian patterns, DNA structure and blood cell counts

Note 2.45 GHz is used in WiFi

Chaturvedi CM et al (2011). 2.45 GHz (CW) MICROWAVE IRRADIATION ALTERS CIRCADIAN ORGANIZATION, SPATIAL MEMORY, DNA STRUCTURE IN THE BRAIN CELLS AND BLOOD CELL COUNTS OF MALE MICE, MUS MUSCULUS. *Progress In Electromagnetics Research B*, Vol. 29, 23–42.

Chronic exposure to microwave radiation alters blood picture and has degenerative effects on brain performance...prolonged exposure may lead to neurodegenerative disorder.

36. Wi-Fi radiation has a mutagenic effect on the brain

Kesari KK, Behari J, Kumar S (2010). Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol.* 86(4):334-43.

The study concludes that the chronic exposure to these radiations may cause significant damage to brain, which may be an indication of possible tumour promotion.

37. Sperm damage

Decreased semen volume, sperm concentration, count, motility, viability.

El-Hamd MA, Aboeldahab S (2018). Cell phone and male infertility: An update. *J Integr Nephrol Androl* 5:1-5 <http://www.journal-ina.com/article.asp?issn=2394-2916;year=2018;volume=5;issue=1;spage=1;epage=5;aulast=El-Hamd>

Nakata, K (2019). Presented at ASPIRE conference. WiFi damages sperm: https://www.bionews.org.uk/page_142704

<https://www.aspire-reproduction.org/mounting-evidence-of-harmful-effects-of-wifi-router-electromagnetic-waves-on-sperm/>

38. DNA damage through oxidative stress

Radio frequency electromagnetic radiation causes DNA damage apparently through oxidative stress [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(18\)30221-3/fulltext?fbclid=IwAR28ftbPVxNPr5WcdkSytvBluMI7iUKmsjKI7xAGJsCK3--bLjm8zybmfM](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext?fbclid=IwAR28ftbPVxNPr5WcdkSytvBluMI7iUKmsjKI7xAGJsCK3--bLjm8zybmfM)

39. Non-ionising radiation has similar effect to ionising

<https://ec.europa.eu/energy/sites/ener/files/documents/CELEX-32013L0059-EN-TXT.pdf>

40. Children absorb more radiation

https://www.sciencedirect.com/science/article/pii/S2213879X14000583?fbclid=IwAR3_Pv412Yj1pSI270x_fFa1p1a6TSVh7ugQRxKuA60o2a0CdDg8MkETcsQ

41. Mobile radiation kills brain cells and may trigger Alzheimer's

http://news.bbc.co.uk/1/hi/health/2728149.stm?fbclid=IwAR19K0qVnFwovmtIL-F7V4JYV3f9kB4U-Bn0vUv5_ai_1uY552dQ0XhcCbpo

42. Autoimmune disease: EMF shielding improves symptoms

https://www.greenmedinfo.health/blog/groundbreaking-study-shows-shielding-emf-improves-autoimmune-disease?fbclid=IwAR2q-40U4udtxhk430hqYdvl-bMe4oJ-xk_e-EYsl2IL97uOoFOjb08kLMZQ

43. Malignant melanomas of the head and neck correlate with EMFs and EMRs

https://pdfs.semanticscholar.org/fa2b/49a478248ae8813438699f1ea682ade2a0d7.pdf?_ga=2.124934530.945145993.1573828364-998329069.1570040490

Industry-funded studies confound results:

Sept 2019: <https://microwavenews.com/short-takes-archive/industry-funding-sways-emf-results>

- Research has shown that industry-funded studies are less likely than independent studies to show a link with wireless radiation and health problems. Researcher Henry Lai has shown that of 2000 studies, when industry studies are removed, 68% show harmful bio-effects from RF-EMR.
- Prasad et al (2017) write: "In our review of the literature and meta-analysis of case-control studies, we found evidence linking mobile phone use and risk of brain tumours especially in long-term users (greater than 10 years). We also found a significantly positive correlation between study quality and outcome in the form of risk of brain tumour associated with use of mobile phones. Higher quality studies show a statistically significant association between mobile phone use and risk of brain tumour. Even the source of funding was found to affect the quality of results produced by the studies."
- The UK's multi-million pound, mobile phone industry-funded MTHR Study found no increased risk of brain tumour <https://www.ispreview.co.uk/index.php/2014/02/11-year-mthr-study-finds-danger-wireless-mobile-phone-radiation.html> but this study includes for example the highly inadequate pregnant women and base stations study. Crucially the MTHR study did not include young people who are most susceptible and no convincing reasons were given for this; this despite the Swedish research showing young people are most at risk. <https://www.independent.co.uk/news/science/mobile-phone-use-raises-childrens-risk-of-brain-cancer-fivefold-937005.html> The MTHR study did not follow sub-

jects and included only 60 chosen papers, whilst excluding 1000s of papers which show harm.

Further lists of peer-reviewed studies:

<https://www.ncbi.nlm.nih.gov/pubmed/?term=RF-EMR>
<https://ehtrust.org/science/peer-reviewed-research-studies-on-wi-fi/>
<https://www.powerwatch.org.uk/science/studies.asp>
<https://pastelink.net/EMFList>

Research summaries and abstracts from Henry Lai: <https://bioinitiative.org/research-summaries/?fbclid=IwAR3ZL10Jychs4RIWVywGwT63C-mmkg8Q32vgu1ERZIfLAXUa-zPw-NBNp5vA>

New research: <https://www.ncbi.nlm.nih.gov/pubmed/30247338>

Studies showing effects of RF-EMR on wildlife (without the addition of 5G)

Review of 113 studies of effects of RF-EMF on wildlife (birds, insects, plants) shows harmful effects

Note: these are ecological studies; more rigorous studies are urgently needed but difficult to perform

Cucurachia S et al (2012). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environment International* (51); 116-140 <https://www.ncbi.nlm.nih.gov/pubmed/23261519>

'In 65% of the studies, ecological effects of RF-EMF (50% of the animal studies and about 75% of the plant studies) were found both at high as well as at low dosages...There is an urgent need for repetitions of studies finding effects and investigations into effects on ecosystems.'

Review of available evidence: RF-EMR is a likely environmental hazard; controls are needed

"At the present time, there are reasonable grounds for believing that microwave radiation constitutes an environmental and health hazard.... Controls must be introduced and technology rendered safe to the environment, since this new ubiquitous and invisible pollutant could deplete the efforts devoted to species conservation."

Balmori, A (2014). Electrosmog and species conservation. *Science of the Total Environment* 496 (2014) 314–316 <http://cdn.impresa.pt/e30/4d1/8979766/Electrosmog-and-species-conservation.pdf>

Lists of studies showing harmful effects

P38 of this report: https://www.powerwatch.org.uk/news/20080917_warne_birds_bees.pdf

<https://ehtrust.org/science/bees-butterflies-wildlife-research-electromagnetic-fields-environment/>

Mast 140m away causes high tadpole mortality

Balmori A et al (2010). Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: the city turned into a laboratory. *Electromagn Biol Med*. 2010 Jun;29(1-2):31-5. doi: 10.3109/15368371003685363. <https://www.ncbi.nlm.nih.gov/pubmed/20560769>

90% of tadpoles died versus 4.2% protected by a Faraday cage. *'This research may have huge implications for the natural world, which is now exposed to high microwave radiation levels from a multitude of phone masts.'*

Typical (pre-5G) levels cause interference with orientation

Balmori A (2015). Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. *Sci Total Environ*. 518-519:58-60.

Current evidence indicates that exposure at levels that are found in the environment (in urban areas and near base stations) may particularly alter the receptor organs to orient in the magnetic field of the earth. These results could have important implications for migratory birds and insects.

RF-EMR: a 'credible threat' to wildlife

Several studies are linked here: <https://www.buglife.org.uk/news-and-events/news/could-our-obsession-with-mobile-technology-destroy-wildlife>

Including:

The EKLIPSE review:

The Eclipse Report, funded by the EU, reviewed 97 studies on how electromagnetic radiation may affect the environment and concluded that it could indeed pose a risk to bird and insect orientation and plant health. <http://www.eclipse-mechanism.eu/documents/15803/0/>

[EMR-KnowledgeOverviewReport_FINAL_27042018.pdf/1326791c-f39f-453c-8115-0d1c9d0ec942](https://www.researchgate.net/publication/320474864_More_than_75_percent_decline_over_27_years_in_total_flying_insect_biomass_in_protected_areas)

Insects: The authors state that there is a lack of field evidence available but that it is warranted given that insects navigate electromagnetically.

Small mammals: *'More and more evidence is accumulating that mammals (e.g. bats and mice) have a magnetic sense which might be based on radical-pairs and as such will likewise be affected by RF.'*

Plants: *'Significant changes have been demonstrated at cellular and molecular levels.'*

Buglife: *'from the 97 useable papers the scientists highlighted electro-magnetic radiation as a potential risk to bird and insect orientation and movement, and to plant metabolic health. Serious impacts on the environment could not be ruled out.'*

Unexplained dramatic decline in insect mass over the last 27 years

Hallmann, Sorg and Jongejans (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE* 12(10):1-21 https://www.researchgate.net/publication/320474864_More_than_75_percent_decline_over_27_years_in_total_flying_insect_biomass_in_protected_areas

'Our analysis estimates a seasonal decline of 76%, and midsummer decline of 82% in flying insect biomass over the 27 years of study. We show that this decline is apparent regardless of habitat type, while changes in weather, land use, and habitat characteristics cannot explain this overall decline. This yet unrecognized loss of insect biomass must be taken into account in evaluating declines in abundance of species depending on insects as a food source, and ecosystem functioning in the European landscape.'

Expert panel warns: 5G in urban areas will expose wildlife to more near-field microwave radiation

The Chair of the British Ecological Society, Professor William Sutherland, Miriam Rothschild Professor of Conservation Biology, University of Cambridge, together with 24 International Environmental experts, in 2018 has identified anthropogenic electromagnetic radiation as one of the top 15 emerging issues that could affect global biological diversity, natural capital and ecosystem services, and conservation efforts.

[https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347\(17\)30289-6](https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(17)30289-6)

Botanist's anecdotal report to unesco about Birds and bats

After 3G installation in 2009, 27 bird species disappeared from Mt Nardi, Australia, and insect volumes 'dropped dramatically.'

https://ehtrust.org/botanist-report-links-increasing-amounts-of-electromagnetic-radiation-and-species-disappearance/?fbclid=IwAR0j4-Jl-aYy4Xfv0rdjMK7tvlrB-dDbJct1_9qLsm-S3A5KJ4jHCTMYIWec

PDF from US wildlife and conservation professor Albert Manville

- currently no standards for wildlife exposure
- issues with not wanting to experiment on wildlife species; dearth of information
- published results of European studies are 'troubling'
- living systems well-documented to be affected by EMF
- brain, heart, cell membranes are electrical
- a number of studies show damage
- comments on 36 studies

<https://www.mainecoalitiontostopsmartmeters.org/wp-content/uploads/2016/07/Manville-7-14-2016-Radiation-Briefing-Memo-Public.pdf>

Avian mortality information

https://www.youtube.com/watch?v=uWlr_UEWOiY&feature=youtu.be&fbclid=IwAR1oOjY-drbIZslt7DWmC0TFZVa91cvINxcVan5QyUH38NFBfJ4HYakby634

Bees

Studies have yielded mixed results but a number show positive results for harmful effects and several call for an urgent need for more research.

Avoidance of EMF petri dishes by honey bees

The authors of this study (showing avoidance of magnetic fields by bees) also cite a wide range of studies with varying effects including several showing disruption of normal behaviour in bees when exposed to RF-EMR. <https://www.biorxiv.org/content/biorxiv/early/2019/04/13/608182.full.pdf>

Effect of Electromagnetic Field (EMF) and Electric Field (EF) on Some Behavior of Honeybees (*Apis mellifera* L.)

Effect Of Electromagnetic Field On Honeybees

Ya ar ERDO AN1* and Mahir Murat CENG Z2

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2-Atatürk University, Erzurum Vocational High School Department of Horse Training. Erzurum, Turkey

Conclusion

The present results showed that honeybees are sensitive to the modification of EMF or electric field intensity.

Changes in glucose and behavioural disturbances

Kumar, N; Sangwan, S; Badotra, P (2011). Exposure to cell phone radiations produces biochemical changes in worker honey bees. *Toxicology International* 18(1):70-72.

'...as the exposure time increased, it appeared that the bees having assessed the source of the disturbance decided to move and a large scale movement of the workers toward the talk-mode (not toward the listening mobile) was observed. Also, the bees became slightly aggressive and started beating their wings in agitation.' <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3052591/>

Abnormal magnetic fields [eg from solar storms] disrupt bee navigation

Ferrari, T E (2014) Magnets, magnetic field fluctuations and geomagnetic disturbances impair the homing ability of honey bees (*Apis mellifera*). *Journal of Apicultural Research* **53(4): 452-465.**

'How abnormal magnetic fields and fluctuations relate to the epidemiology of honey bee losses is consistent with their behaviour and development.'

Negative effects and no honey in mobile phone hive

Sharma, V; Kumar, N (2010). Changes in honey bee behaviour and biology under the influence of cell phone radiations. *Current science* 98(10):1376-1378

We have compared the performance of honeybees in cellphone radiation exposed and unexposed colonies. A significant ($p < 0.05$) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment.

Full PDF: http://www.gammel.felo.no/2010_Bier%20Sharma-Kumar-%7Cfelo%7Ccontent%7Cdownload%7C3923%7C33892%7Cfile%7C2010_Bier%20Sharma-Kumar.pdf.pdf

Press article on the study: <https://www.telegraph.co.uk/news/earth/wildlife/7778401/Mobile-phones-responsible-for-disappearance-of-honey-bee.html> Tim Lovett, of the British

Beekeepers Association, said that hives have been successful in London where there was high mobile phone use.

Higher mortality after high-frequency RF

Darney, K (2016). Effect of high-frequency radiations on survival of the honeybee (*Apis mellifera* L.) *Apidologie* 47(5); 703-10

Increase in mortality after high-frequency and ultra high-frequency exposure of over 2 hours daily.

Honey bee worker piping signals increase signalling swarming or disturbance

Favre, D (2011). Mobile phone-induced honeybee worker piping. *Apidologie*. 42(3); 270-9.

Further confirmation of the current results and their implications regarding a direct correlation between erratic honeybee behavior and mobile phone-generated electromagnetic fields would substantiate one more explanation for the “disappearance” of bee colonies around the world. This phenomenon accounts for 43% of all bee losses, apart from overwintering (39%), mite disease, (15%) and pesticides (3%) as recently described in a national survey performed in the United States (Bee Alert Technology 2007).

Pollinators negatively effected by RF-EMR

Lazaro et al (2016). Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. *Journal of Insect Conservation* 20(2):1-10

[Negative result from short term study

Mall, P & Kumar, Y (2014). Effect of electromagnetic radiations on brooding, honey production and foraging behavior of European honeybees (*Apis mellifera* L.) *African Journal of Agricultural Research* 9(13) pp 1078-1085

This 3-month long study found no result but with the proviso: *Indeed, the EMRs may harm the health of living creature in long run however; the immediate and direct impact is yet need intensive research to draw a firm conclusion.]*

Interference with planetary climate systems

A 2018 *Lancet* article stated that: “The potential effects of these anthropogenic electromagnetic fields on natural electromagnetic fields, such as the Schumann Resonance that

controls the weather and climate, have not been properly studied”. [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(18\)30221-3/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext)

Environmental pollution

Wireless radiation is being increasingly recognised as an environmental pollutant. <https://www.sciencedirect.com/science/article/pii/S0013935118300161?via%3Dihub>

Mining

Millions of new transmitters will need to be deployed, including 25 m high towers for rural coverage, medium-sized small cells on lamp posts, buildings and under manhole covers, and tiny micro-transmitters embedded in domestic objects. These transmitters contain metals including gold, copper, silver and lithium all of which have to be mined. Mining is a highly-polluting industry which often takes place in conflict zones such as the Democratic Republic of Congo and which is a cause of child mortality.

Microbes

Sharma A et al (2018). Effect of Mobile Tower Radiation on Microbial Diversity in Soil and Antibiotic Resistance.’ Power Energy, Environment and Intelligent Control (PEEIC), International Conference. <https://ieeexplore.ieee.org/document/8665432>

Antibiotic resistance found in microbes near base stations. *Conclusion: ‘Mobile tower radiations can significantly alter the vital systems in microbes and turn them multi drug resistant which is a most important current threat to public health.’*

Trees and plants

‘Significant differences’ between exposed trees and non-exposed.

Waldmann-Selsam C et al (2016). Radiofrequency radiation injures trees around mobile phone base stations. *Sci Total Environ.* 572:554-569. <https://www.ncbi.nlm.nih.gov/pubmed/27552133>

Carbon footprint: ‘alarming’ data use increases

'Perfect storm' of power use says Huawei analyst: *'5G will result in vastly increased data transfer which requires huge fuel use. By 2025 the ICT industry could be using up to 20% of the world's electricity, hampering global attempts to meet climate change targets....The situation is alarming. We have a tsunami of data approaching. Everything which can be is being digitalised. It is a perfect storm.* <https://www.climatechangenews.com/2017/12/11/tsunami-data-consume-one-fifth-global-electricity-2025/>

Projection of power use for the coming decade: https://www.researchgate.net/publication/320225452_Total_Consumer_Power_Consumption_Forecast

Mobile devices set to have bigger footprint than entire aviation industry: https://www.theguardian.com/commentisfree/2018/jul/17/internet-climate-carbon-footprint-data-centres?fbclid=IwAR0gea3zb5ZVn6ik4MHkjLI027qFsO6VfMZT0li83_IMPEQHla8ZKRwb-Z0o

Satellites and fuel

Satellites require huge amounts of rocket fuel to launch and Elon Musk's 'Starlink' programme satellites plus those from other private companies totalling around 20K satellites would need to be relaunched every five years due to expiry. 20K satellites will mean that no part of the biosphere is free of microwave radiation. Satellites may also deplete the ozone layer: <https://greenworldwarriors.com/2019/02/12/20-000-satellites-for-5g-to-be-launched-sending-beams-of-intense-microwave-radiation-over-the-entire-earth/>

Further studies re environment

EarthPulse: EMF Animal Behaviour, including comprehensive research list What is 5G: Information and Environmental Impacts

EH Trust: Bees, Butterflies and Wildlife, including research list

EH Trust Electromagnetic Fields, Tree and Plant Growth

Anthropogenic RF EMF as an emerging threat to Wildlife Orientation

Studies of millimetre radiation as used for high-frequency 5G:

Di Ciaula (2018). [Int J Hyg Environ Health](#). 2018 Apr;221(3):367-375. Towards 5G communication systems: Are there health implications?

RF-EMF promote oxidative stress, a condition involved in cancer onset, in several acute and chronic diseases and in vascular homeostasis. Although some evidences are still controversial, the WHO IARC classified RF-EMF as "possible carcinogenic to humans", and more recent studies suggested reproductive, metabolic and neurologic effects of RF-EMF, which are also able to alter bacterial antibiotic resistance. In this evolving scenario, al-

though the biological effects of 5G communication systems are very scarcely investigated, an international action plan for the development of 5G networks has started, with a forthcoming increment in devices and density of small cells, and with the future use of millimeter waves (MMW). 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. An adequate knowledge of pathophysiological mechanisms linking RF-EMF exposure to health risk should also be useful in the current clinical practice, in particular in consideration of evidences pointing to extrinsic factors as heavy contributors to cancer risk and to the progressive epidemiological growth of noncommunicable diseases. https://www.ncbi.nlm.nih.gov/pubmed/29402696?fbclid=IwAR3eif_oMkwmpypYfE4qEm-H2hSURtPbRNQ7hT1t0txQ4law7GfLqrcCWGI

Health issues specific to 5G microwave radiation:

5G antennas will greatly increase levels of existing wireless radiation. The UK radiation level limits are already set much higher than in other countries (see chart below, under 'ICNIRP') and in addition the ICNIRP have voted to relax guidelines.

5G will use current frequencies in addition to high millimetre wave and sub-millimetre wave frequencies of 100GHz and beyond. Therefore bioeffects from both increased cumulative effects of existing radiation, which may be synergistic and not just additive as well as those specific to high-frequency radiation may be anticipated.

Professor Joel Moskowitz of the University of California

Joel M. Moskowitz is a Professor Emeritus of radiation at the School of Public Health at the University of California Berkeley and an expert in mobile phone radiation and electromagnetic fields. He states:

- Millimetre waves such as those in use by 5G are absorbed by the first 1-2 mm of skin and the eye cornea. Since the skin contains nerve endings and capillaries, bio-effects may be transmitted further.
- Thermal (or heating) effects as used by the military's ADS system occur when the power density of the waves is above 5–10 mW/cm². The maximum permissible exposure that the FCC permits for the general public is 1.0 mW/cm² averaged over 30 minutes for frequencies that range from 1.5 GHz to 100 GHz. This guideline was adopted in 1996 to protect humans from acute exposure to thermal levels of radiofrequency radiation. How-

ever, the guidelines were not designed to protect us from nonthermal risks that may occur with prolonged or long-term exposure to radiofrequency radiation.

- With the deployment of fifth generation wireless infrastructure (aka 5G), much of the nation will be exposed to MMWs for the first time on a continuous basis. Due to FCC guidelines, these exposures will likely be of low intensity. Hence, the health consequences of 5G exposure will be limited to non-thermal effects produced by prolonged exposure to MMWs [ie high-frequency millimetre waves] in conjunction with exposure to low- and mid-band radiofrequency radiation [from existing radiation]. Few studies have examined prolonged exposure to low-intensity MMWs, and no research has focused on exposure to MMWs combined with other radiofrequency radiation. It has not therefore been proven safe.
- Biologic effects of low-intensity MMWs have been studied for decades, particularly in Eastern Europe, study results are often inconsistent because the effects are related to many factors including the frequency, modulation, power density, and duration of the exposures, as well as the type of tissue or cells being investigated. Therefore results vary across studies with not all showing harmful effects.
- MMWs have been shown to induce or inhibit cell death and enhance or suppress cell proliferation. Some studies found that the radiation inhibits cell cycle progression, and some studies reported no biologic effects (Le Drean et al., 2013)
- A review of the research in 2010 noted that “A large number of cellular studies have indicated that MMW may alter structural and functional properties of membranes.” Exposure to MMWs may affect the plasma membrane either by modifying ion channel activity or by modifying the phospholipid bilayer. Water molecules also seem to play a role in these effects. Skin nerve endings are a likely target of MMWs and the possible starting point of numerous biological effects. MMWs may activate the immune system through stimulation of the peripheral neural system (Ramundo-Orlando, 2010).
- In 1998, five scientists employed by U.S. Army and Air Force research institutes published a seminal review of the research on MMWs. They reported:
 - Increased sensitivity and even hypersensitivity of individual specimens to MMW may be real. Depending on the exposure characteristics, especially wavelength, a low-intensity MMW radiation was perceived by 30 to 80% of healthy examinees (Lebedeva, 1993, 1995). Some clinical studies reported MMW hypersensitivity, which was or was not limited to a certain wavelength (Golovacheva, 1995).
 - It is important to note that, even with the variety of bioeffects reported, no studies have provided evidence that a low-intensity MMW radiation represents a health hazard for human beings but they have also not looked at health risks. In view of numerous bioef-

fects and growing usage of MMW technologies this research objective seems very reasonable. Such MMW effects as alterations of cell growth rate and UV light sensitivity, biochemical and antibiotic resistivity changes in pathogenic bacteria, as well as many others are of potential significance for safety standards, but even local and short-term exposures were reported to produce marked effects. It should also be realized that biological effects of a prolonged or chronic MMW exposure of the whole body or a large body area have never been investigated. Safety limits for these types of exposures are based solely on predictions of energy deposition and MMW heating, but in view of recent studies this approach is not necessarily adequate.” (Pakhomov et al., 1998)

- Microbes are also affected by MMW radiation. In 2016 a review of the research on the effects of MMWs on bacteria was published (Soghomonyan et al., 2016). The authors summarized their findings as follows: “...bacteria and other cells might communicate with each other by electromagnetic field of sub-extremely high frequency range. These MMW affected *Escherichia coli* and many other bacteria, mainly depressing their growth and changing properties and activity. These effects were non-thermal and depended on different factors. The significant cellular targets for MMW effects could be water, cell plasma membrane, and genome....The consequences of MMW interaction with bacteria are the changes in their sensitivity to different biologically active chemicals, including antibiotics....These effects are of significance for understanding changed metabolic pathways and distinguish role of bacteria in environment; they might be leading to antibiotic resistance in bacteria.”
- Changing the sensitivity of bacteria to antibiotics by MMW irradiation can be important for the understanding of antibiotic resistance in the environment. In this respect, it is interesting that bacteria [that] survived near telecommunication-based stations like *Bacillus* and *Clostridium* spp. have been found to be multidrug resistant (Adebayo et al. 2014), (Soghomonyan et al. 2016)
- In 1977, N.P. Zalyubovskaya published a study, "Biological effects of millimeter waves," in a Russian-language journal, "Vracheboyne Delo." The CIA declassified this paper in 2012. The study examined the effects of exposing mice to millimeter radiation (37-60 GHz; 1 milliwatt per square centimeter) for 15 minutes daily for 60 days. The animal results were compared to a sample of people working with millimeter generators. Here is a brief summary of the paper: studies conducted on humans and animals showed structural alterations in the skin and internal organs, changes in blood and bone marrow composition, changes in enzymatic activity and nucleic metabolism. ‘the degree of unfavourable effect of radiation depended on the duration of the radiation and individual characteristics of the organism.’
- In sum, the peer-reviewed research demonstrates that short-term exposure to low-intensity millimeter wave (MMW) radiation not only affects human cells, it may result in the

growth of multi-drug resistant bacteria harmful to humans. Since little research has been conducted on the health consequences from long-term exposure to MMWs, widespread deployment of 5G or 5th generation wireless infrastructure constitutes a massive experiment that may have adverse impacts on the public's health.

The research review **5G Wireless Expansion: Public Health and Environmental Impli-**

cations documents the range of reported adverse effects of RF and millimeter waves.

These effects range from cancer to changes in bacteria growth and even to DNA damage. The study concludes that “a moratorium on the deployment of 5G is warranted” and “the addition of this added high frequency 5G radiation to an already complex mix of lower frequencies, will contribute to a negative public health outcome ... from both physical and mental health perspectives” (Russell 2018).²⁹

Tissue damage

(Neufeld & Kuster, 2018) showed that due to the heating effect of 5G electromagnetic waves, the exposure times ‘tolerated by the International Council on Non-Ionizing Radiation Protection guidelines may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines.’³⁰

Kuster, N & Neufeld, E (2018). Systematic Derivation of Safety Limits for Time-Varying 5G Radiofrequency Exposure Based on Analytical Models and Thermal Dose. *Health Phys* 115(6): 705-711.

Sweat ducts

A 2018 study entitled *The human skin as a sub-THz receiver - Does 5G pose a danger to it or not?* showed that sweat ducts act as mini antennas:³¹

In the interaction of microwave radiation and human beings, the skin is traditionally considered as just an absorbing sponge stratum filled with water. In previous works, we showed that this view is flawed when we demonstrated that the coiled portion of the sweat duct in upper skin layer is regarded as a helical antenna in the sub-THz band....The presence of the sweat duct led to a high specific absorption rate (SAR) of the skin in extremely

high frequency band. In this paper, we summarize the physical evidence for this phenomenon and consider its implication for the future exploitation of the electromagnetic spectrum by wireless communication. Starting from July 2016 the US Federal Communications Commission (FCC) has adopted new rules for wireless broadband operations above 24 GHz (5 G). This trend of exploitation is predicted to expand to higher frequencies in the sub-THz region. One must consider the implications of human immersion in the electromagnetic noise, caused by devices working at the very same frequencies as those, to which the sweat duct (as a helical antenna) is most attuned. We are raising a warning flag against the unrestricted use of sub-THz technologies for communication, before the possible consequences for public health are explored.

Heart Problems

A study from 1992 reported that frequencies in the higher 5G spectrum, ranging from 53-78GHz impacted the heart rate variability in rats. In other words, higher spectrum 5G could probably cause heart arrhythmia in humans. Another Russian study on frogs whose skin was exposed to these millimeter waves found that they cause heart arrhythmia.

<https://www.ncbi.nlm.nih.gov/pubmed/1330714>

Eye Problems

In 1994, a study was carried out in Poland to determine whether or not millimeter radiation impacted the eye's transmission of light through its lens. They found that low level millimeter wave radiation produced lens opacity in rats: associated with cataracts forming.

So 5G could cause human beings to develop eye problems and cataracts, it would seem.

This one is difficult to find a copy of, although the academic citation for it can be found at "*Chernyakov, GM and Korochkin, VL and Babenko, AP and Bigdai E. Reactions of biological systems of various complexity to the action of low-level EHF radiation No Title. Millim Waves Med Biol. 1989; 1: 141–167.*"

In addition, a Japanese experiment was conducted to see whether or not the feared 60 GHz frequency band could cause ocular problems. It found that "*millimeter-wave antennas can cause thermal injuries of varying types of levels. The thermal effects induced by millimeter waves can apparently penetrate below the surface of the eye.*"

This one is also difficult to find, but can be found at the academic citation "*Kojima M, Hanazawa M, Yamashiro Y, Sasaki H, Watanabe S, Taki M, Suzuki Y, Hirata A, Kamimura Y, Sasaki K. ACUTE OCULAR INJURIES CAUSED BY 60-GHZ MILLIMETER-WAVE EXPOSURE. Health Phys [Internet]. 2009 [cited 2018 Mar 19]; 97: 212–8. doi: 10.1097/HP.0b013e3181abaa57.*"

Immune problems

A 2002 Russian study that set out to explore the effects of 42 GHz frequencies determined that when healthy mice were exposed to them, they had a drastic reduction of activity with cells involved with immunity: about 50%.

In other words, 42 GHz frequencies, close to the middle of the 5G spectrum, cause mice to suffer from immune system problems.

They concluded: *“the whole-body exposure of healthy mice to low-intensity EHF EMR has a profound effect on the indices of nonspecific immunity.”*

Protein Changes in Macrophages Induced by Plasma From Rats Exposed to 35 GHz Millimeter Waves.

<https://apps.dtic.mil/dtic/tr/fulltext/u2/a533666.pdf>

“In agreement with this, prior studies conducted by our laboratory showed intravascular aggregation of leukocytes and upregulation of genes associated with immune cell recruitment and activation in the skin of rats at 6 and 24 h after exposure to 35 GHz MMWs at 75 mW/cm² until colonic temperature reached 41–42°C [Millenbaugh et al., 2008]. Previous investigations also indicate that sustained MMW exposure can cause heating of internal tissues, presumably due to thermal conduction, and effects in peripheral blood cells and tissues distal to the initial site of energy absorption.

A series of experiments performed in rats demonstrated that exposure to 35 GHz MMWs at 75 mW/cm² for approximately 44–80 min produced elevations in skin and colonic temperatures and changes in heart rate, respiration rate, and blood pressure, with eventual circulatory collapse [Frei et al., 1995; Kalns et al., 2000; Millenbaugh et al., 2006].

In addition, increased levels of the oxidative stress marker, 3-nitrotyrosine (3-NT), were detected in peripheral blood lymphocytes and neutrophils of rats exposed to 35 GHz MMWs at 75 mW/cm² for 44–60 min until body core temperature reached 41–42°C [Kalns et al., 2000]. Based on these results, we hypothesized that 35 GHz MMWs can elicit the release of biologically active mediators into the systemic circulation leading to downstream responses in cells and tissues. The ability to elicit effects in immune cells has also been observed for other MMW frequencies”

High-frequency 5G and bees

Arno Thielens, Duncan Bell, David B. Mortimore, Mark K. Greco, Luc Martens & Wout Joseph

Scientific Reports 8, Article number: 3924 (2018) [Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz](#)

Insects that are smaller than 1 cm show a peak in absorption at frequencies (above 6 GHz), which ...are planned to be used in the next generation of wireless telecommunication systems.

German bee expert Prof. Martin Lindauer, one of the most important German-speaking bee and behavioural researchers, discovered that bees communicate with each other with the help of electromagnetic fields. Eskov and Sapozhnikov (1974): bees produce frequen-

cies between 180 Hz and 250 Hz with magnetite crystals in their bodies; mobile comms have a pulse frequency of 217 Hz which may have serious implications.

Biophysicist and Doctor of Natural Sciences Dr. Ulrich Warnke: "In 50 Hz alternating fields with field strengths of 110 V/cm [electric field strength], the bee colonies in their habitation are very restless...members of the hive kill each other...new progeny is no longer created...all individuals suffer death by heat and suffocation. "

Scientists at the American Beltsville Farming Research Institute warn of complete extinction of bees due to 5G:

"It is extremely alarming that dying is accompanied by symptoms that have never been described before. The immune system of the animals seems to have collapsed, some bees suffer from five to six infections simultaneously. "But how can that be explained? The immune system works optimally only if cell communication is working properly. The diverse biochemical processes in the cells are controlled by means of electromagnetic pulses. It is precisely these electromagnetic impulses that are massively disturbed by mobile communications, so that the biochemical processes within the immune system are waning. Bees get sick and die. This would also explain the strong parasite infestation of many bee colonies with the Varroa mite, which beekeepers and researchers have been fighting for decades. The disturbed bee immune system cannot defend itself any more against this highly dangerous bee enemy. Conclusion: In view of these facts, as already exist in the mobile generations up to 4G, to now want to introduce a fifth generation with unevenly higher radiation exposure, could mean the complete extinction of the bees.'

Research on mm waves/5G

Metal can Increase Wireless Radiation Absorption into the Body: Braces, Earrings, hip Replacements etc., including list of published research

Health Phys: 2018, Systematic Derivation of Safety Limits for Time-Varying 5G RF Exposure Human Sweat Gland Ducts as Antennas in the Sub-THz frequency

Effect of Extremely Low Electromagnetic Frequency on Ion Channels, cells etc., Mario Ledda, Institute of Neurobiology and Molecular Medicine, National Research Council INMM, Rome, Italy

Medical Physics, Dept School of Medicine, Shiraz University: 5G Technology, Why should we expect a shift from RF induced Brain Cancers to Skin Cancers

Resistance to 5G is Rapidly Increasing

The Danger of 5G Can't be Overstated, Make Freeman

Further general research on EMR

International Journal of Oncology: WHO, RF Radiation and Health, Spandidos Publication Elsevier: WiFi is an Important Threat to Human Health, Martin L Pall

Physicians for Safe Technology: Electromagnetic Radiation, General paper and 153 References BioInitiative Report 2012 Section 1 Cindy Sage MA

European EMF Guideline 2016, de Gruyter, Environ Health stating strong evidence of risk factors Parliamentary Assembly Resolution 1815, The Potential Dangers of EMF and their Effects

Weak low-frequency electromagnetic fields are biologically interactive: Abe R. Liboff, Center for Molecular Biology and Biotechnology, Florida Atlantic University, Boca Raton, FL, USA

Journal of Microscopy and Ultrastructure: Why children absorb more microwave radiation than adults

Journal of Chemical Neuroanatomy: Microwave frequency electromagnetic fields produce widespread neuropsychiatric effects including depression

Pregnancy, Wireless and Electromagnetic Fields: EHTrust Listed Research
Alan Cooke Royal Society of Medicine: Is there a link between EMF's and Alzheimer's Disease?

Brain Tumours: Rise in Glioblastoma Multiforme Incidence in England 1995–2015

Journal of Microscopy and Ultrastructure, effects of 900 MHz

Early papers

Rome Laboratory Air Force Material Command, Griffiss Air Force Base, Radiofrequency/Microwave Radiation, Biological effects, AD-A 282886

Naval Medical Research Institute, Bethesda, Maryland: Glaser PhD, 4 October 1971 Bibliography of reported Biological (effects) and Clinical Manifestations attributed to Microwave and RF Exposure

CIA Science Applications Int Corp

EM Facts: 1309 Russian Translation Microwave Radiation Influence on Man and Animals (1970)

