



## American Academy of Environmental Medicine

### Electromagnetic and Radiofrequency Fields Effect on Human Health

For over 50 years, the American Academy of Environmental Medicine (AAEM) has been studying and treating the effects of the environment on human health. In the last 20 years, our physicians began seeing patients who reported that electric power lines, televisions and other electrical devices caused a wide variety of symptoms. By the mid 1990's, it became clear that patients were adversely affected by electromagnetic fields and becoming more electrically sensitive. In the last five years with the advent of wireless devices, there has been a massive increase in radiofrequency (RF) exposure from wireless devices as well as reports of hypersensitivity and diseases related to electromagnetic field and RF exposure. Multiple studies correlate RF exposure with diseases such as cancer, neurological disease, reproductive disorders, immune dysfunction, and electromagnetic hypersensitivity.

The electromagnetic wave spectrum is divided into ionizing radiation such as ultraviolet and X-rays and non-ionizing radiation such as ultrasound and radiofrequency (RF), which includes WiFi, cell phones, and Smart Meter wireless communication. It has long been recognized that ionizing radiation can have a negative impact on health. However, the effects of non-ionizing radiation on human health recently have been seen. Discussions and research of non-ionizing radiation effects centers around thermal and non-thermal effects. According to the FCC and other regulatory agencies, only thermal effects are relevant regarding health implications and consequently, exposure limits are based on thermal effects only.<sup>1</sup>

While it was practical to regulate thermal bioeffects, it was also stated that non-thermal effects are not well understood and no conclusive scientific evidence points to non-thermal based negative health effects.<sup>1</sup> Further arguments are made with respect to RF exposure from WiFi, cell towers and smart meters that due to distance, exposure to these wavelengths are negligible.<sup>2</sup> However, many *in vitro*, *in vivo* and epidemiological studies demonstrate that significant harmful biological effects occur from non-thermal RF exposure and satisfy Hill's criteria of causality.<sup>3</sup> Genetic damage, reproductive defects, cancer, neurological degeneration and nervous system dysfunction, immune system

dysfunction, cognitive effects, protein and peptide damage, kidney damage, and developmental effects have all been reported in the peer-reviewed scientific literature.

Genotoxic effects from RF exposure, including studies of non-thermal levels of exposure, consistently and specifically show chromosomal instability, altered gene expression, gene mutations, DNA fragmentation and DNA structural breaks.<sup>4-11</sup> A statistically significant dose response effect was demonstrated by Mashevich *et al.*, who reported a linear increase in aneuploidy as a function of the Specific Absorption Rate(SAR) of RF exposure.<sup>11</sup> Genotoxic effects are documented to occur in neurons, blood lymphocytes, sperm, red blood cells, epithelial cells, hematopoietic tissue, lung cells and bone marrow. Adverse developmental effects due to non-thermal RF exposure have been shown with decreased litter size in mice from RF exposure well below safety standards.<sup>12</sup> The World Health Organization has classified RF emissions as a group 2 B carcinogen.<sup>13</sup> Cellular telephone use in rural areas was also shown to be associated with an increased risk for malignant brain tumors.<sup>14</sup>

The fact that RF exposure causes neurological damage has been documented repeatedly. Increased blood-brain barrier permeability and oxidative damage, which are associated with brain cancer and neurodegenerative diseases, have been found.<sup>4,7,15-17</sup> Nittby *et al.* demonstrated a statistically significant dose-response effect between non-thermal RF exposure and occurrence of albumin leak across the blood-brain barrier.<sup>15</sup> Changes associated with degenerative neurological diseases such as Alzheimer's, Parkinson's and Amyotrophic Lateral Sclerosis (ALS) have been reported.<sup>4,10</sup> Other neurological and cognitive disorders such as headaches, dizziness, tremors, decreased memory and attention, autonomic nervous system dysfunction, decreased reaction times, sleep disturbances and visual disruption have been reported to be statistically significant in multiple epidemiological studies with RF exposure occurring non-locally.<sup>18-21</sup>

Nephrotoxic effects from RF exposure also have been reported. A dose response effect was observed by Ingole and Ghosh in which RF exposure resulted in mild to extensive degenerative changes in chick embryo kidneys based on duration of RF exposure.<sup>24</sup> RF emissions have also been shown to cause isomeric changes in amino acids that can result in nephrotoxicity as well as hepatotoxicity.<sup>25</sup>

Electromagnetic field (EMF) hypersensitivity has been documented in controlled and double blind studies with exposure to various EMF frequencies. Rea *et al.* demonstrated that under double blind placebo controlled conditions, 100% of subjects showed reproducible reactions to that frequency

to which they were most sensitive.<sup>22</sup> Pulsed electromagnetic frequencies were shown to consistently provoke neurological symptoms in a blinded subject while exposure to continuous frequencies did not.<sup>23</sup>

Although these studies clearly show causality and disprove the claim that health effects from RF exposure are uncertain, there is another mechanism that proves electromagnetic frequencies, including radiofrequencies, can negatively impact human health. Government agencies and industry set safety standards based on the narrow scope of Newtonian or “classical” physics reasoning that the effects of atoms and molecules are confined in space and time. This model supports the theory that a mechanical force acts on a physical object and thus, long-range exposure to EMF and RF cannot have an impact on health if no significant heating occurs. However, this is an incomplete model. A quantum physics model is necessary to fully understand and appreciate how and why EMF and RF fields are harmful to humans.<sup>26,27</sup> In quantum physics and quantum field theory, matter can behave as a particle or as a wave with wave-like properties. Matter and electromagnetic fields encompass quantum fields that fluctuate in space and time. These interactions can have long-range effects which cannot be shielded, are non-linear and by their quantum nature have uncertainty. Living systems, including the human body, interact with the magnetic vector potential component of an electromagnetic field such as the field near a toroidal coil.<sup>26,28,29</sup> The magnetic vector potential is the coupling pathway between biological systems and electromagnetic fields.<sup>26,27</sup> Once a patient’s specific threshold of intensity has been exceeded, it is the frequency which triggers the patient’s reactions.

Long range EMF or RF forces can act over large distances setting a biological system oscillating in phase with the frequency of the electromagnetic field so it adapts with consequences to other body systems. This also may produce an electromagnetic frequency imprint into the living system that can be long lasting.<sup>26,27,30</sup> Research using objective instrumentation has shown that even passive resonant circuits can imprint a frequency into water and biological systems.<sup>31</sup> These quantum electrodynamic effects do exist and may explain the adverse health effects seen with EMF and RF exposure. These EMF and RF quantum field effects have not been adequately studied and are not fully understood regarding human health.

Because of the well documented studies showing adverse effects on health and the not fully understood quantum field effect, AAEM calls for exercising precaution with regard to EMF, RF and general frequency exposure. In an era when all society relies on the benefits of electronics, we must find ideas and technologies that do not disturb bodily function. It is clear that the human body uses electricity from the chemical bond to the nerve impulse and obviously this orderly sequence can be

disturbed by an individual-specific electromagnetic frequency environment. Neighbors and whole communities are already exercising precaution, demanding abstention from wireless in their homes and businesses.

Furthermore, the AAEM asks for:

- An immediate caution on Smart Meter installation due to potentially harmful RF exposure.
- Accommodation for health considerations regarding EMF and RF exposure, including exposure to wireless Smart Meter technology.
- Independent studies to further understand the health effects from EMF and RF exposure.
- Recognition that electromagnetic hypersensitivity is a growing problem worldwide.
- Understanding and control of this electrical environmental bombardment for the protection of society.
- Consideration and independent research regarding the quantum effects of EMF and RF on human health.
- Use of safer technology, including for Smart Meters, such as hard-wiring, fiber optics or other non-harmful methods of data transmission.

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## **Bibliography: Electromagnetic and Radiofrequency Fields Effect on Human Health**

1. California Council on Science and Technology. (Internet). (2011). Health Impacts of Radiofrequency Exposure from Smart Meters. Available from:  
<http://www.ccst.us/publications/2011/2011smartA.pdf>
2. Electric Power Research Institute. (Internet). (2011). Radio-Frequency Exposure Levels from Smart Meters: A Case Study of One Model. Available from:  
[https://www.nvenergy.com/NVEnergize/documents/EPRI\\_1022270\\_caseStudy.pdf](https://www.nvenergy.com/NVEnergize/documents/EPRI_1022270_caseStudy.pdf)
3. Hill, AB. The Environment and Disease: Association or Causation? *Proceedings of the Royal Society of Medicine*. 1965; 58: 295-300.
4. Xu S, Zhou Z, Zhang L, et al. Exposure to 1800 MHz radiofrequency radiation induces oxidative damage to mitochondrial DNA in primary cultured neurons. *Brain Research*. 2010; 1311: 189-196.
5. Phillips JL, Singh NP, Lai H. Electromagnetic fields and DNA damage. *Pathophysiology*. 2009; 16: 79-88.
6. Ruediger HW. Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology*. 2009; 16(2): 89-102.
7. Zhao T, Zou S, Knapp P. Exposure to cell phone radiation up-regulates apoptosis genes in primary cultures of neurons and astrocytes. *Neurosci Lett*. 2007; 412(1): 34-38.
8. Lee S, Johnson D, Dunbar K. 2.45 GHz radiofrequency fields alter gene expression on cultured human cells. *FEBS Letters*. 2005; 579: 4829-4836.
9. Demisia G, Vlastos D, Matthopoulos DP. Effect of 910-MHz electromagnetic field on rat bone marrow. *The Scientific World Journal*. 2004; 4(S2): 48-54.
10. Lai H, Singh NP. Magnetic-field-induced DNA strand breaks in brain cells of the rat. *Environmental Health Perspectives*. 2004; 112(6): 687-694. Available from:  
<http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.6355>
11. Mashevich M, Foldman D, Kesar, et al. Exposure of human peripheral blood lymphocytes to electromagnetic fields associated with cellular phones leads to chromosomal instability. *Bioelectromagnetics*. 2003; 24: 82-90.
12. Magras IN, Xenos TD. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics*. 1997; 18:455-461.
13. Ban R, Grosse Y, Lauby-Secretan B, et al. Carcinogenicity of radiofrequency electromagnetic fields. *The Lancet Oncology*. 2011; 12(7): 624-626. Available from:

[http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045\(11\)70147-4/fulltext?\\_eventId=login](http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(11)70147-4/fulltext?_eventId=login)

14. Hardell L, Carlberg M, Hansson Mild K. Use of cellular telephones and brain tumour risk in urban and rural areas. *Occup. Environ. Med.* 2005; 62: 390-394.
15. Nittby H, Brun A, Eberhardt J, et al. Increased blood-brain barrier permeability in mammalian brain 7 days after exposure to the radiation from a GSM-900 mobile phone. *Pathophysiology.* 2009; 16: 103-112.
16. Awad SM, Hassan NS. Health Risks of electromagnetic radiation from mobile phone on brain of rats. *J. Appl. Sci. Res.* 2008; 4(12): 1994-2000.
17. Leszczynski D, Joenvaara S. 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.* 2002; 70: 120-129.
18. Santini R, Santini P, Danze JM, et al. Study of the health of people living in the vicinity of mobile phone base stations: 1. Influences of distance and sex. *Pathol Biol.* 2002; 50: 369-373.
19. Abdel-Rassoul G, Abou El-Fateh O, Abou Salem M, et al. Neurobehavioral effects among inhabitants around mobile phone base stations. *Neurotox.* 2007; 28(2): 434-440.
20. Hutter HP, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup. Environ. Med.* 2006; 63: 307-313.
21. Kolodynski AA, Kolodynska VV. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. *Sci. Total Environ.* 1996; 180: 87-93.
22. Rea WJ, Pan Y, Fenyves EJ, et al. Electromagnetic field sensitivity. *Journal of Bioelectricity.* 1991; 10(1 &2): 243-256.
23. McCarty DE, Carrubba S, Chesson AL, et al. Electromagnetic hypersensitivity: Evidence for a novel neurological syndrome. *Int. J. Neurosci.* 2011; 121(12): 670-676.
24. Ingole IV, Ghosh SK. Cell phone radiation and developing tissues in chick embryo – a light microscopic study of kidneys. *J. Anat. Soc. India.* 2006; 55(2): 19-23.
25. Lubec G, Wolf C, Bartosch B. Amino acid isomerisation and microwave exposure. *Lancet.* 1989; 334: 1392-1393.
26. Smith CW. Quanta and coherence effects in water and living systems. *Journal of Alternative and Complimentary Medicine.* 2004; 10(1): 69-78.

27. Smith CW (2008) Fröhlich's Interpretation of Biology through Theoretical Physics. In: Hyland GJ and Rowlands P (Eds.) Herbert Fröhlich FRS: A physicist ahead of his time. Liverpool: University of Liverpool, 2<sup>nd</sup> edition, pp 107-154.
28. Del Giudice E, Doglia S, Milani M, et al. Magnetic flux quantization and Josephson behavior in living systems. *Physica Scripta*. 1989; 40: 786-791.
29. Tonomura A, Osakabe N, Matsuda T, et al. Evidence for Aharonov-Bohm effect with magnetic field completely shielded from electron wave. *Phys. Rev. Lett.* 1986; 56(8):792-75.
30. Del Giudice E, De Ninno A, Fleischmann, et al. Coherent quantum electrodynamics in living matter. *Electromagn. Biol. Med.* 2005; 24: 199-210.
31. Cardella C, de Magistris L, Florio E, Smith C. Permanent changes in the physic-chemical properties of water following exposure to resonant circuits. *Journal of Scientific Exploration*. 2001; 15(4): 501-518.