

SELECTED STUDIES ON ELECTROSENSITIVITY (ES) AND ELECTROMAGNETIC HYPER-SENSITIVITY (EHS)

- *There are many thousands of peer-reviewed studies relevant to ES/EHS.*
- *This very limited selection of about 200 studies and references aims to provide an indication of the wide range of studies available.*
- *This selection does not attempt to give the earliest or most recent studies on any topic.*
- *This selection concentrates on positive studies which indicate the range of relevant evidence.*

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1. (a) General, reviews

* useful introductory or general studies

- *Buchner K et al.: "Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields - A Long-term Study under Real-life Conditions" *Umwelt-Medizin-Gesellschaft* (2011) ([article](#)).
- *Carpenter D (ed.): "[Idiopathic environmental intolerance](#)" *Rev Environ Health*. (2015).
- Choy RYS et al.: "Electrical Sensitivities in Allergy Patients" *Clin Ecol*. (1987) [pdf](#).
- Dahmen N et al.: "Blood laboratory findings in patients suffering from self-perceived electromagnetic hypersensitivity (EHS)" *Bioelectromagnetics*. (2009) [PMID: 19259984](#).
- *De Luca C et al: "[Metabolic and genetic screening of electromagnetic hypersensitivity subjects as a feasible tool for diagnostics and intervention](#)" *Mediators Inflamm*. (2014) [PHID: 24812443](#).
- Eger H: "Kausaler, juristisch anerkannter Nachweis des Schädigungspotenzials technischer hochfrequenter Felder - eine Patientenkasuistik" ["Causal, Legally Recognized Proof of the Damage Potential of Technical Highfrequency Fields - a Case Report"] *Umwelt-Medizin-Gesellschaft* (2014) [abstract](#).
- *Eger H et al.: "Specific Health Symptoms and Cell Phone Radiation in Selbitz, Bavaria, Germany: Evidence of a Dose-Response Relationship" *Umwelt Medizin Gesellschaft* (2010) [article in trans](#).
- *Genuis SJ et al.: "Electromagnetic hypersensitivity: fact or fiction?" *Sci Tot Env*. (2012) [PMID: 22153604](#); [article](#).
- Griesz-Brisson M: "Electrosensitivity from a neurological point of view" *Neuroepidemiology* (2013) [41: 275, no.227](#) (page 275).
- *Havas M et al.: "Dirty electricity and electromagnetic hypersensitivity: five case studies" *World Health Organization Workshop on Electrical Hypersensitivity, Prague* (2004) [pdf](#).
- *Hedendahl L et al.: "Electromagnetic hypersensitivity - an increasing challenge to the medical profession" *Rev Environ Health* (2015) [PMID: 26372109](#).
- *Hocking B: "Microwave sickness: a reappraisal" *Occup Med (Lond)*. (2001) [PMID: 11235831](#); [article](#).
- *Johansson O: "Electrohypersensitivity: a functional impairment due to an inaccessible environment" *Rev Environ Health* (2015) [PMID: 26613327](#); [pdf](#).
- *Kaszuha-Zwolińska J et al.: "Electromagnetic field induced biological effects in humans" *Przegl Lek*. (2015) Review. [PMID: 27012122](#); [pdf](#).
- *Levallois P et al.: "Study of self-reported hypersensitivity to electromagnetic fields in California" *Environ Health Perspect*. (2002) [PMID: 12194896](#); [article](#).
- Mueller CH et al.: "Project NEMESIS: perception of a 50 Hz electric and magnetic field at low intensities (laboratory experiment)" *Bioelectromagnetics*. (2002) [PMID: 11793403](#).
- *Navarro E et al.: "The Microwave Syndrome: A preliminary study in Spain" *Electromagn Biol Med*. (2003); [article](#).
- *Oberfeld G et al.: "[The Microwave Syndrome: Further Aspects of a Spanish Study](#)" (2002).
- Pall ML: "Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression" *J Chem Neuroanat*. (2015) [PMID: 26300312](#).
- Redmayne M et al: "Radiofrequency exposure in young and old: different sensitivities in light of age-relevant natural differences" *Rev Environ Health* (2015) [PMID: 26613328](#).
- Saravanamuttu S et al.: "A Survey on the Impact of RF-EMF from Wireless Devices on Information Technology Professionals" *Europ J Exper Biol*. (2016) [pdf](#).
- *Schilling CJ: "Effects of acute exposure to ultrahigh radiofrequency radiation on three antenna engineers" *Occup Environ Med*. (1997) [PMID: 9166136](#); [pdf](#).
- Smith CW: "Nursing the electrically-sensitive patient" *Complement Ther Nurs Midwifery* (1997) [PMID: 9439262](#).
- Tresidder A et al.: "Electrosensitivity: Sources, Symptoms, and Solutions" in Rosch PJ (ed.) [Bioelectromagnetic and Subtle Energy Medicine](#); CRC Press, (2014) 2nd ed.: 567-585.
- *Tuengler A et al.: "Hypothesis on how to measure electromagnetic hypersensitivity" *Electromagn. Biol. Med*. (2013) [PMID: 23301924](#); [article](#).

1. (b) Historical evidence

- Thompson SP: "A physiological effect of an alternating magnetic field" *Proc Roy Soc.* (1910) [CrossRef](#): *"I have, however, recently succeeded in demonstrating a real physiological effect due to magnetism ... I observed a faint visual effect when my forehead was placed close to the magnet ... I have found a means of producing the visual effect (which is physiological and subjective) in a way that succeeds with every person on whom it has yet been tried ... it has been noted by several observers that a sensation of taste in the mouth is excited after exposing the head for two or three minutes to the action of the alternating magnetic field."*
- Schliephake E: "Arbeitsgebiete auf dem Kurzwellengebiet" ["Fields of the Short-wave region"] *Dtsch Med Wochenschr.* (1932): [\[trans.\]](#) *"The symptoms of people working close to a short-wave radio station / mast were: first tiredness in day time and restless sleep in night time. Thereafter a feeling of "pull/pressure" on forehead and on top of head, developing to headaches, even intolerable ones. Eventually, depression and un-normal excitability / nervousness. Here, too, in our experience the wavelength is of a significant influence."*
- Likhterman BV et al.: "Terapevticheskoy primeneniy korotkikh voln" ["On the Therapeutic Application of Short Waves"] Sevastopol (1936), in Kholodov YuA "Vliyaniye elektromagnitnykh i magnitnykh poley na tsentral'nyuyu nervnyuyu sistemu" ["The Effect of Electromagnetic and Magnetic Fields on the Central Nervous System"] Academy of Sciences USSR, Moscow, (1966). Trans.: [NASA TT F-465](#): *"People subjected to the systematic influence of a UHF field complained of somnolence, headaches, fatigability and irascibility ... the reactions to a UHF field ... depend on the individual characteristics of the organism and upon the initial functional state."*
- Letavet AA, Gordon ZV (eds) "O biologicheskoy vozdetsviy sverchvysokich tchastot." *Izd.Akad. Med. Nauk., SSSR, Moscow* (1960) vol.1. ["The biological action of ultrahigh frequencies" (1962) Office of Technical Services, US Department of Commerce, JPRS-1271; summarized in: NIOSH 210-76-0145; "Radiofrequency /Microwave Radiation Biological Effects and Safety Standards: A Review" RL-TE-94-53; [pdf](#), p.9] *"The researchers reported that several CNS related disorders were discovered among 525 workers exposed to RF/MW radiation. The symptoms were listed as: hypotension, slower than normal heart rates, an increase in the histamine content of the blood, an increase in the activity of the thyroid gland, disruption of the endocrine-hormonal process, alterations in the sensitivity to smell, headaches, irritability, and increased fatigue. Other researchers have acknowledged similar biological responses."*
- Marha K: "Biologické účinky elektromagnetických vln o vysoké frekvenci" ["Biological effects of high-frequency electromagnetic waves"] *Prac Lek.* (1963) [PMID: 14108751](#); [ATDRep. trans.](#): *"about 1,000 studies have been published on this subject up to the present time [1963] ... Low-intensity EM waves cause difficulties ... These include headaches, pain in the eyes, tiredness and general weakness, dizziness after standing for a period of time, fitful sleep at night, sleepiness in the daytime, changing moods, irritability, hypochondriacal attitudes, fear, depressions, reduced intellectual capacity, and reduced memory. With longer exposure, laziness and an inability to make decisions result. Complaints are voiced regarding sensations of tension in the skin, head, and forehead, loss of hair, muscle aches, and pain around the heart ... Such people experience slight eyelid, tongue, and finger tremors accompanied by increased perspiration. During work in a higher field a marked reduction in blood pressure has been observed which leads to collapse ... women in general are more susceptible to such influence than men."*
- Carpenter DO: "The microwave syndrome or electro-hypersensitivity: historical background" *Rev Environ Health* (2015) [PMID: 26556835](#).

2. Specific ES/EHS symptoms from man-made environmental radiation

EHS's specific symptoms have been confirmed as consistent since the discovery of the condition in 1932. They are caused by a wide range of EM exposures. Most modern radiation devices like mobile phones and WiFi have both low and microwave frequencies, each producing symptoms.

- Carpenter DO: "Excessive exposure to radiofrequency electromagnetic fields may cause the development of electrohypersensitivity" *Altern Ther Health Med.* (2014) [Research Gate](#); [PMID: 25478802](#).

(a) Base Stations, Mobile Phone/Radio/TV Masts

- Abdel-Rassoul G et al.: "Neurobehavioral effects among inhabitants around mobile phone base stations" *Neurotoxicology* (2007) [PMID: 16962663](#).
- Blettner N et al.: "Mobile phone base stations and adverse health effects: phase 1 of a population-based, cross-sectional study in Germany" *Occup Environ Med.* (2009) [PMID: 19017702](#).
- Borkiewicz A et al.: "Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review" (Polish) *Med Pr.* (2004) [PMID: 15620045](#).
- Buchner K et al.: "Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields - A Long-term Study under Real-life Conditions" *Umwelt-Medizin-Gesellschaft* (2011) ([copy](#)).
- Eger H, Jahn M: "Specific Health Symptoms and Cell Phone Radiation in Selbitz, Bavaria, Germany - Evidence of a Dose-Response Relationship" *Umwelt Medizin Gesellschaft* (2010) [article in trans.](#)
- Gomez-Perretta C et al: "[Subjective symptoms related to GSM radiation from mobile phone base stations: a cross-sectional study](#)" *BMJ Open* (2013) [PMID: 24381254](#).
- Hutter H et al.: "Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations" *Occup Environ Med.* (2006) [PMID: 16621850](#).
- Huttunen P et al.: "Involuntary human hand movements due to FM radio waves in a moving van" *Acta Physiol Hung.* (2011) [PMID: 21616774](#).
- Khurana VG et al: "Epidemiological evidence for a health risk from mobile phone base stations" *Int J Occup Environ Health* (2010) [PMID: 20662418](#).
- Kolodynski AA, Kolodynska W: "Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia" *Sci Total Environ.* (1996) [PMID: 8717320](#).
- Santini R et al.: "Survey study of people living in the vicinity of cellular phone base stations" *Electromagn Biol Med.* (2003) [article](#).
- Santini R et al.: "Investigation on the health of people living near mobile telephone relay stations: I. Incidence according to distance and sex" *Pathol Biol. (Paris)* (2002) [PMID: 12168254](#).
- Santini R et al.: "Symptoms experienced by people in the vicinity of base stations: II. Incidence of age, duration of exposure, location of subjects in relation to the antennas and other electromagnetic factors" *Pathol Biol. (Paris)* (2003) [PMID: 12948762](#).
- Shahbazi-Gahrouei D et al.: "Health effects of living near mobile phone base transceiver station (BTS) antennae: a report from Isfahan, Iran" *Electromagn Biol Med.* (2014) [PMID: 23781985](#).
- Shinjyo T: [Signifikanter Rückgang klinischer Symptome nach Senderabbau – eine Interventionsstudie] "Significant Decrease of Clinical Symptoms after Mobile Phone Base Station Removal – An Intervention Study" *Umwelt-Medizin-Gesellschaft.* 27(4): (2014) [copy](#).

(b) Computers, TVs

- Eriksson N et al.: "The psychosocial work environment and skin symptoms among visual display terminal workers: a case referent study" *Int J Epidemiol.* (1997) [PMID: 9447405](#).

- Johansson O et al: "Cutaneous mast cells are altered in normal health volunteers sitting in front of ordinary TVs/PCs - results from open-field provocation experiments" *J Cut Pathol.* (2001) [PMID: 11737520](#).

(c) Mobile Phones

- Chiu CT et al: "Mobile phone use and health symptoms in children" *J Formos Med Assoc.* (2014) [PMID: 25115529](#).
- Eyvazlou M et al: "Association between overuse of mobile phones on quality of sleep and general health among occupational health and safety students" *Chronobiol Int.* (2016) [PMID: 26942630](#).
- Ikeda K et al: "Association between mobile phone use and depressed mood in Japanese adolescents: a cross-sectional study" *Environ Health Prev Med.* (2014) [PMID: 24347468](#).
- Manjunatha N et al.: "Idiopathic environmental intolerance (electromagnetic hypersensitivity syndrome)" *Natl Med J India.* (2011) [PMID: 22680087](#); [pdf](#).
- Redmayne M et al: "The relationship between adolescents' well-being and their wireless phone use: a cross-sectional study" *Environ Health* (2013) [PMID: 24148357](#).
- Szyjowska A et al: "The risk of subjective symptoms in mobile phone users in Poland - an epidemiological study" *Int J Occup Med Environ Health* (2014) [PMID: 24692074](#).
- Yogesh S et al.: "Mobile usage and sleep patterns among medical students" *Indian J Physiol Pharmacol.* (2014) [PMID: 25464686](#).

(d) MRI Scanners

The magnetic fields near MRI scanners, inducing electric currents in people moving through them, can cause specific ES/EHS symptoms. The Lorentz force of a magnetic field on the inner ear fluid's electrical currents may explain nystagmus or involuntary eye movements.

- Schaap K et al.: "Exposure to MRI-related magnetic fields and vertigo in MRI workers" *Occup Environ Med.* (2015) [doi:10.1136/oemed-2015-103019](#).
- Schaap K et al: "Occupational exposure of healthcare and research staff to static magnetic stray fields from 1.5-7 Tesla MRI scanners is associated with reporting of transient symptoms" *Occup. Environ. Med.* (2014) [PMID: 24714654](#).
- van Nierop LE et al.: "Simultaneous exposure to MRI-related static and low-frequency movement-induced time-varying magnetic fields affects neurocognitive performance: A double-blind randomized crossover study" *Magn Reson Med.* (2014) [PMID: 25224577](#).
- Ward BK et al.: "Vestibular stimulation by magnetic fields" *Ann N Y Acad Sci.* (2015) [PMID: 25735662](#).

(e) Power Lines, high frequency voltage transients

Linesmen working on telephone cables in during the late 19th century showed some of the first specific symptoms associated with electromagnetic exposure. Recently, high frequency voltage transients, or 'dirty' electricity, have been associated with similar specific symptoms.

- Ghadamgahi M et al: "Memory loss risk assessment for the students nearby high-voltage power lines - a case study" *Environ Monit Assess.* (2016) [PMID: 27194231](#).
- Havas M (2008) "Dirty electricity elevates blood sugar among electrically sensitive diabetics and may explain brittle diabetes" *Electromagn Biol Med.* 27(2): 135-146; [PMID: 18568931](#).
- Havas M: "Electromagnetic Hypersensitivity: Biological Effects of Dirty Electricity with Emphasis on Diabetes and Multiple Sclerosis" *Electromagn Biol Med.* (2006) [PMID: 17178585](#).
- Havas M et al.: "Power quality affects teacher wellbeing and student behavior in three Minnesota Schools" *Sci Total Environ.* (2008) [PMID: 18556048](#).

(f) Pre-natal Exposure

- Divan HA et al: "Prenatal and postnatal exposure to cell phone use and behavioral problems in children" *Epidemiology* (2008) [PMID: 18467962](#).

- Sudan M et al: "Prenatal and postnatal Cell Phone Exposure and Headaches in Children" *Open Pediatr. Med. Journal* (2012) [PMID: 23750182](#).

(g) Provocation Tests

- Havas M: "Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system" *Rev. Environ Health* (2013) [PMID: 24192494](#).
- Huttunen P et al.: "FM-radio and TV tower signals can cause spontaneous hand movements near moving RF reflector" *Pathophysiology* (2009) [PMID: 19268549](#).
- Huttunen P et al.: "Involuntary human hand movements due to FM radio waves in a moving van" *Acta Physiol Hung.* (2011) [PMID: 21616774](#).
- Köteles F et al: "Idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) and electrosensitivity (ES) - are they connected?" *Int J Hyg Environ Health* (2013) [PMID: 22698789](#).
- Leitgeb N: "Electromagnetic hypersensitivity" in *Proceedings, International Workshop on Electromagnetic Fields and Non-Specific Health Symptoms, Graz, Austria*. (COST 244bis: Biomedical Effects of EMFs, WHO, ICNIRP) (1998) [pdf](#).
- Leitgeb N et al.: "Electrosensitivity and electromagnetic hypersensitivity" *Bioelectromagnetics* (2003) [PMID: 12929157](#).
- McCarty DE et al.: "Electromagnetic hypersensitivity: evidence for a novel neurological syndrome" *Int J Neurosci.* (2011) [PMID: 21793784](#).
- Rea WJ et al.: "Electromagnetic field sensitivity" *J Bioelectricity* (1991) ([copy](#)).

(h) Smart Meters

- Lamech F: "Self-Reporting of Symptom Development From Exposure to Radiofrequency Fields of Wireless Smart Meters in Victoria, Australia: A Case Series" *Altern Ther Health Med.* (2014) [PMID: 25478801](#).

(i) WiFi

- Dasdag S et al.: "Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions" *Electromagn Biol Med.* (2015) [PMID: 24460421](#).
- Saili L et al.: "Effects of acute exposure to WIFI signals (2.45GHz) on heart variability and blood pressure in Albinos rabbit" *Environ Toxicol Pharmacol.* (2015) [PMID: 26356390](#).
- Shahin S et al: "2.45 GHz Microwave Radiation Impairs Learning and Spatial Memory via Oxidative/Nitrosative Stress Induced p53 Dependent/Independent Hippocampal Apoptosis: Molecular Basis and Underlying Mechanism" *Toxicol Sci.* (2015) [PMID: 26396154](#).

3. Other effects and mechanisms of non-thermal EM exposure

Many studies show biological effects at non-thermal levels of EM exposure, many times lower than current heating limits. These effects do not necessarily produce immediate conscious symptoms, even for people with ES/EHS who may be more susceptible to such effects.

(a) Amyotrophic lateral sclerosis (ALS)

- Li CY et al.: "Association between occupational exposure to power frequency electromagnetic fields and amyotrophic lateral sclerosis: a review" *Am J Ind Med.* (2003) [PMID: 12541277](#).

(b) Antibiotic resistance in bacteria

- Soghomonyan D et al.: "Millimeter waves or extremely high frequency electromagnetic fields in the environment: what are their effects on bacteria?" *Appl Microbiol Biotechnol.* (2016) [PMID: 27087527](#).

(c) ADHD (Attention Deficit Hyperactivity Disorder), Autism

- Alsaeed I et al.: "Autism-relevant social abnormalities in mice exposed perinatally to extremely low frequency electromagnetic fields" *Int J Dev Neurosci.* (2014) [PMID: 24970316](#).
- Herbert MR et al.: "Autism and EMF? Plausibility of a pathophysiological link - Part I" *Pathophysiology.* (2013) [PMID: 24095003](#); Part II [PMID: 24113318](#).
- Milham S: (2011) "Attention deficit hyperactivity disorder and dirty electricity" *J Dev Behav Pediatr.* (2011) [PMID: 21904211](#); [copy](#).

(d) Blood-brain barrier leakage

- Nittby H 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) [PMID: 19345073](#).

(e) Calcium flux, cell membrane permeability, phospholipids

- Pall ML: "Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects" *J Cell Mol Med.* (2013) [PMID: 23802593](#).
- Tolstikh GP et al.: "600ns pulse electric field-induced phosphatidylinositol4,5-bisphosphate depletion" *Bioelectrochemistry.* (2014) [PMID: 24530104](#).

(f) Cancers, immunodeficiency

- Dode A et al.: "Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil" *Sci Total Environ.* (2011) [PMID: 21741680](#).
- Eger H et al.: "Cancer incidence from residents within a mobile phone base station in Westphalia - interview-based pilot survey and risk assessment" *Umwelt Medizin Gesellschaft* (2009) [article \[German\]](#).
- Hardell L et al.: "Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones" *Rev Environ Health* (2013) [PMID: 24192496](#).
- IARC, WHO: "[Non-Ionizing Radiation, Part 1: Static and ELF Electric and Magnetic Fields](#)" *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans.* 80 (2002).
- IARC, WHO: "[IARC Classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans](#)" Press Release no. 208 (2011); [pdf](#) (2013).
- Johansson O: "Disturbance of the immune system by electromagnetic fields - A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment" *Pathophysiology.* (2009) [PMID: 19398310](#).
- Mangiacasale R et al.: "Normal and cancer-prone human cells respond differently to extremely low frequency magnetic fields" *FEBS Lett.* (2001) [PMID: 11163365](#).
- Milham S et al.: "A new electromagnetic exposure metric: high frequency voltage transients associated with increased cancer incidence in teachers in a California school" *Am J Ind Med.* (2008) [PMID: 18512243](#).
- West JG et al.: "Multifocal Breast Cancer in Young Women with Prolonged Contact between Their Breasts and Their Cellular Phones" *Case Rep Med.* (2013) [PMID: 24151509](#).
- Wolf R, Wolf D: "Increased incidence of cancer near a cell-phone transmitter station" *Int J Cancer Prev.* (2004) [article](#).

(g) Cardiovascular changes

- Hänninen O et al.: "Cardiovascular Responses to Electromagnetic Radiation" *J. Afr. Ass. Physiol. Sci.* (2013) [pdf](#).
- Havas M: "Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system" *Rev Environ Health.* (2013) [PMID: 24192494](#); [pdf](#).
- Shuvy M et al.: "Electromagnetic fields promote severe and unique vascular calcification in an animal model of ectopic calcification" *Exp Toxicol Pathol.* (2014) [PMID: 24882371](#).

(h) Fertility reduced:

(i) Female fertility

- Ahmadi SS et al.: "Effect of non-ionizing electromagnetic field on the alteration of ovarian follicles in rats" *Electron Physician*. (2016) [PMID: 27123226](#).

(ii) Male births

- Baste V et al.: "Radiofrequency electromagnetic fields; male infertility and sex ratio of offspring" *Eur J Epidemiol*. (2008) [PMID: 18415687](#).

(iii) Male fertility

- Adams JA et al.: "Effect of mobile telephones on sperm quality: a systematic review and meta-analysis" *Environ Int*. (2014) [PMID: 24927498](#).
- Zhang G et al.: "Effects of cell phone use on semen parameters: Results from the MARHCS cohort study in Chongqing, China" *Environ Int*. (2016) [PMID: 26949865](#).

(i) Gender differences

- Zhang Y et al.: "Effects of fetal microwave radiation exposure on offspring behavior in mice" *J Radiat Res*. (2015) [PMID: 25359903](#).

(j) Genetic variants

- De Luca C et al.: "[Metabolic and genetic screening of electromagnetic hypersensitivity subjects as a feasible tool for diagnostics and intervention](#)" *Mediators Inflamm*. (2014) [PHID: 24812443](#).

(k) Glucose metabolism, diabetes

- Havas M: "Dirty electricity elevates blood sugar among electrically sensitive diabetics and may explain brittle diabetes" *Electromagn Biol Med*. (2008) [PMID: 18568931](#).
- Havas M: "Electromagnetic Hypersensitivity: Biological Effects of Dirty Electricity with Emphasis on Diabetes and Multiple Sclerosis" *Electromagn Biol Med*. (2006) [PMID: 17178585](#).
- Meo SA et al.: "Association of Exposure to Radio-Frequency Electromagnetic Field Radiation (RF-EMFR) Generated by Mobile Phone Base Stations with Glycated Hemoglobin (HbA1c) and Risk of Type 2 Diabetes Mellitus" *Int J Environ Res Public Health*. (2015) [PMID: 26580639](#).
- Milham S: "Evidence that dirty electricity is causing the worldwide epidemics of obesity and diabetes" *Electromagn Biol Med*. (2014) [PMID: 23781992](#).
- Volkow ND et al.: (2011) "Effects of cell phone radiofrequency signal exposure on brain metabolism" *JAMA*. (2011) [PMID: 21343580](#).

(l) Heavy metals

- Byun YH et al.: "Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study" *PLoS One*. (2013) [PMID: 23555766](#).

(m) Magneto-reception

- Qin S et al.: "A magnetic protein biocompass" *Nat Mater*. (2015) [PMID: 26569474](#).

(n) Mast cells

- Johansson O et al.: "Cutaneous mast cells are altered in normal healthy volunteers sitting in front of ordinary TVs/PCs - results from open-field provocation experiments" *J Cutan Pathol*. (2001) [PMID: 11737520](#).

(o) Melatonin reduction, circadian effects

- Reiter RJ: "Static and extremely low frequency electromagnetic field exposure: reported effects on the circadian production of melatonin" *J Cell Biochem*. (1993) [PMID: 8098713](#).
- Sokolovic D et al.: "The Effects of Melatonin on Oxidative Stress Parameters and DNA Fragmentation in Testicular Tissue of Rats Exposed to Microwave Radiation" *Adv Clin Exp Med*. (2015) [PMID: 26467130](#).

(p) Myelin, Multiple Sclerosis (MS)

- Havas M: "Electromagnetic Hypersensitivity: Biological Effects of Dirty Electricity with Emphasis on Diabetes and Multiple Sclerosis" *Electromagn Biol Med.* (2006) [PMID: 17178585](#).
- Kudo M: "Environmental Pathology: SY09-2 Multiple Sclerosis (MS) and neurodegeneration: cause and pathogenesis in relation to electromagnetic fields (EMF)" *Pathology.* (2014) [PMID: 25188068](#).
- Redmayne M et al: "Could myelin damage from radiofrequency electromagnetic field exposure help explain the functional impairment electrosensitivity? A review of the evidence" *J Toxicol Environ Health B Crit Rev.* (2014) [PMID: 25205214](#).

(q) Neurological effects, anxiety, EEG, learning, memory, sleep

- Augner C et al.: "Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A" *Biomed Environ Sci.* (2010) [PMID: 20708499](#).
- Buchner K et al.: "Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields - A Long-term Study under Real-life Conditions" *Umwelt-Medizin-Gesellschaft* (2011) ([copy](#)).
- Deshmukh PS et al.: (2015) "Cognitive Impairment and Neurogenotoxic Effects in Rats Exposed to Low-Intensity Microwave Radiation" *Int J Toxicol.* (2015) [PMID: 25749756](#).
- Lustenberger C et al.: "Inter-individual and intra-individual variation of the effects of pulsed RF EMF exposure on the human sleep EEG" *Bioelectromagnetics.* (2015) [PMID: 25690404](#).
- Milham S et al.: "Dirty electricity, chronic stress, neurotransmitters and disease" *Electromagn Biol Med.* (2103) Erratum in (2014) [PMID: 23323864](#).
- Papageorgiou CC et al.: "Effects of wi-fi signals on the p300 component of event-related potentials during an auditory hayling task" *J Integr Neurosci.* (2011) [PMID: 21714138](#).
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SUMMARY: EM non-thermal exposure: key biological outcomes and date established			
Electrosensitivity, EHS ¹	1932	Depression, suicide ²	1979
Microwave hearing, tinnitus ³	1962	Alzheimer's disease ⁴	2009
Blood-brain barrier leakage ⁵	1974	Brain tumours, glioma etc. ⁶	2009
Childhood leukaemia ⁷	1979	Tumour promotion ⁸	2015

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4. Biological safety limits; criticism of heating-only limits

(a) Biological safety limits for vulnerable and sensitive people

Biological limits for electromagnetic exposure need to cover particularly vulnerable members of the general public, such as children, the ill, the elderly and those sensitive or intolerant to such EM exposure. The WHO's private group ICNIRP has told governments that they need to adopt non-thermal limits to protect such people.

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(b) Biological safety limits

Biological limits are provided by the expert groups in this field, such as Bioinitiative, Building Biology, EUROPAEM, Seletun, Salzburg, etc.

Typical values for sensitive people are: 10 nanoTesla (magnetic fields, 50 Hz), 0.006 Volts/metre (peak electric fields, microwave frequencies), 1 Volt/metre (electric fields, 50 Hz). Power Flux Density and SAR are heating metrics, not directly relevant to non-thermal ES/EHS.

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(c) Objective biological safety limits

Safety limits should be based on objective biological measures, such as DNA fragmentation, not on a heating hypothesis and modelling of tissue heating qualities which are irrelevant to EHS.

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(d) Criticism of heating-only safety limits

The long invalidated heating-only hypothesis, used by the small clique of regulators adopting this minority viewpoint, has been frequently criticised by the leading experts.

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(e) Appeal for Biological safety limits

The EMF Scientist Appeal, to the Secretary-General of the United Nations and the Director-General of the WHO, is now signed by over 200 experts in this field who accept the majority non-thermal viewpoint. It shows how urgently governments should adopt biological limits, like the USSR and a growing number of other countries since the 1950s, and not align with minority viewpoint represented by ICNIRP and a small clique of industry and pro-wireless activists.

- [The International Electromagnetic Field Scientist Appeal](#), submitted on May 11 2015 to His Excellency Ban Ki-moon, Secretary-General of the United Nations; Honorable Dr. Margaret Chan, Director-General of the World Health Organization; Honorable Achim Steiner, Executive Director of the U.N. Environmental Programme; U.N. Member Nations.

5. Living with EHS (functional impairment, socio-economic effects)

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6. Proposed diagnostic markers

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7. Differences between EHS and Electrophobia/Nocebo

Electromagnetic Hypersensitivity (EHS) (also called Electrosensitivity, Electrical Sensitivity or Intolerance, El-Allergy, Microwave Sickness, Radio Wave Sickness) was first described in 1932 in Germany. It was confirmed as a real physical condition in the USSR and Poland in the 1960s and accepted in the west by an international governmental group in 2000.

Electrophobia, a psychological fear or Nocebo effect, was first applied to man-made electromagnetic exposure in the 1990s. It depends on prior cognitive conditioning and therefore cannot include children, animals or unaware adults, although all can suffer EHS, and cannot explain established human, animal and plant sensitivity to natural geomagnetism. The World Health Organization's [Backgrounder 296](#) on EHS, dated 2005, confuses EHS with Electrophobia.

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8. Electromagnetic warfare

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9. Natural geomagnetic disturbances

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10. Further information

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