

Harmful Electromagnetic Radiation Citations

FOR AUTONOMOUS CARS DISCUSSION

REFERENCES FOR POST BY BEATTY.FYI ON ELECTROMAGNETIC HEALTH IMPACTS

ATTACHED:

1. Dr. Ronald Kostoff Commentary (as posted at the Environmental Health Trust)
2. References from Environmental Health Trust on harm from electromagnetic radiation

NOTE:

The Environmental Health Trust references do not include every electromagnetic frequency existing in a car or an autonomous car, but that should only serve to spur further investigation and research for it fails to prove safety of other frequencies nor does it prove the safety of any number of combination of frequencies and other frequency variables. Other frequencies to limit are those emitted by sensors, any causing interference, or any artificial electromagnetic frequency generated by the cars or the attendant infrastructure.

The citations for wireless radiation are recent, but the citations relevant to magnetic fields are a mix of old and new.

Recent Science on Wireless Radiation

Epidemiology only proves the past; Experimental/Toxicology Studies indicate future risks/harms

From time to time people ask, “what are the studies I should share with people who state that there is “no evidence?”

Frank JW, [Electromagnetic fields, 5G and health: what about the precautionary principle?](#) J Epidemiol Community Health Published Online First: 19 January 2021. doi: 10.1136/jech-2019-213595

[Anthony B. Miller, L. Lloyd Morgan, Iris Udasin and Devra Lee Davis. “Cancer Epidemiology Update, following the 2011 IARC Evaluation of Radiofrequency Electromagnetic Fields \(Monograph 102\)”](#)

Environmental Research, September 6, 2018.

- Increased risk of brain, vestibular nerve and salivary gland tumors are associated with mobile phone use.
- Literature review: Based on the evidence reviewed it is our opinion that IARC’s current categorization of RFR as a possible human carcinogen (Group 2B) should be upgraded to Carcinogenic to Humans (Group 1).

Priyanka Bandara, David O Carpenter, [Planetary electromagnetic pollution: it is time to assess its impact](#), The Lancet Planetary Health, Volume 2, Issue 12, 2018, Pages e512-e514,ISSN 2542-5196, [https://doi.org/10.1016/S2542-5196\(18\)30221-3](https://doi.org/10.1016/S2542-5196(18)30221-3).

- 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.

IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. [“IARC monographs on the evaluation of carcinogenic risks to humans. Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields.”](#) IARC Monographs on the Evaluation of Carcinogenic Risks to Humans/World Health Organization, International Agency for Research on Cancer vol. 102, 2013.

Schuermann D, Mevissen M. [Manmade Electromagnetic Fields and Oxidative Stress—Biological Effects and Consequences for Health](#). *International Journal of Molecular Sciences*. 2021; 22(7):3772. <https://doi.org/10.3390/ijms22073772>

- “In summary, indications for increased oxidative stress caused by RF-EMF and ELF-MF were reported in the majority of the animal studies and in more than half of the cell studies. Investigations in Wistar and Sprague-Dawley rats provided consistent evidence for oxidative stress occurring after RF-EMF exposure in the brain and testes and some indication of oxidative stress in the heart. Observations in Sprague-Dawley rats also seem to provide consistent evidence for oxidative stress in the liver and kidneys. In mice, oxidative stress induced by RF-EMF was predominantly demonstrated in the brain and testes, as well as in liver, kidneys, and ovaries. These observations were made with a variety of cell types, exposure times, and dosages (SAR or field strengths), within the range of the regulatory limits and recommendations.”
- “Adverse conditions, such as diseases (diabetes, neurodegenerative diseases), compromise the body’s defense mechanisms, including antioxidant protection mechanisms, and individuals with such pre-existing conditions are more likely to experience health effects. The studies show that very young or old individuals can react less efficiently to oxidative stress, which of course also applies to other stressors that cause oxidative stress. Further investigations under standardized conditions are necessary to better understand and confirm these phenomena and observations.”

Lai H. [Genetic effects of non-ionizing electromagnetic fields](#). *Electromagn Biol Med*. 2021 Feb 4:1-10. doi: 10.1080/15368378.2021.1881866. Epub ahead of print. PMID: 33539186.

Henry Lai (2019) Exposure to Static and Extremely-Low Frequency Electromagnetic Fields and Cellular Free Radicals, *Electromagnetic Biology and Medicine*, 38:4, 231-248, DOI: 10.1080/15368378.2019.1656645 [FCC Filing](#)

- “Changes in free radical activities, including levels of cellular reactive oxygen (ROS)/nitrogen (RNS) species and endogenous antioxidant enzymes and compounds that maintain physiological free radical concentrations in cells, is one of the most consistent effects of EMF exposure. These changes have been reported to affect many physiological functions such as

DNA damage; immune response; inflammatory response; cell proliferation and differentiation; wound healing; neural electrical activities; and behavior. An important consideration is the effects of EMF-induced changes in free radicals on cell proliferation and differentiation. These cellular processes could affect cancer development and proper growth and development in organisms. On the other hand, they could cause selective killing of cancer cells, for instance, via the generation of the highly cytotoxic hydroxyl free radical by the Fenton Reaction. This provides a possibility of using these electromagnetic fields as a non-invasive and low side-effect cancer therapy.”

Belpomme D, Hardell L, Belyaev I, Burgio E, Carpenter DO. [Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective.](#) Environ Pollut. 2018 Nov;242(Pt A):643-658. doi: 10.1016/j.envpol.2018.07.019. Epub 2018 Jul 6. PMID: 30025338.

Kostoff, Ronald N., and Clifford GY Lau. [“Combined biological and health effects of electromagnetic fields and other agents in the published literature.”](#) Technological Forecasting and Social Change vol. 80, no. 7, 2013, no. 1331-49.

- The present study examined the scope of the combined effects; i.e., identified effects on biological systems from combined exposure to electromagnetic fields/radiation and at least one other agent, concluding that EMF health impacts increase substantially when EMFs function as co-promoters and thus inclusion of co-promoters is essential for modeling real-world effects.

Yakymenko, Igor, et al. [“Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation.”](#) Electromagnetic Biology and Medicine, vol. 35, no. 2, 2016, pp. 186-202.

Pall M., [Wi-Fi is an important threat to human health](#), Environmental Research Volume 164, July 2018, Pages 405-416

Russell CL. [5G wireless telecommunications expansion:Public health and environmental implications.](#) Environmental Research. April 2018.

Di Ciaula, [Towards 5G communication systems: Are there health implications?](#), Int J Hyg Environ Health. 2018 Feb 2.

Ronald N. Kostoff, Paul Heroux, Michael Aschner, Aristides Tsatsakis, [Adverse health effects of 5G mobile networking technology under real-life conditions.](#) Toxicology Letters, Volume 323, 2020, Pages 35-40,

[Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective](#), Environmental Pollution, Volume 242, Part A, 2018, Pages 643-658, ISSN 0269-7491, <https://doi.org/10.1016/j.envpol.2018.07.019>.

Phillips JL, Singh NP, Lai H. 2009 [Electromagnetic fields and DNA damage](#). Pathophysiology 16:79-88.

Ruediger HW. 2009 [Genotoxic effects of radiofrequency electromagnetic fields](#). Pathophysiology 16:89-102.

Pall, M. [Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects](#). Journal of Cellular and Molecular Medicine, vol. 17, no. 8, 2013 pp. 958-965

- This article reviews a substantially supported set of targets, voltage-gated calcium channels, whose stimulation produces non-thermal EMF responses by humans/higher animals with downstream effects involving Ca²⁺/calmodulin-dependent nitric oxide increases, which may explain therapeutic and pathophysiological effects of electromagnetic fields.

Hinrikus, Hiie, et al. [“Mechanism of low-level microwave radiation effect on nervous system.”](#) Electromagnetic Biology and Medicine, 2016.

- Results support the proposed model of excitation by low-level microwave radiation based on the influence of water polarization on hydrogen bonding forces between water molecules, caused by this the enhancement of diffusion and consequences on neurotransmitters transit time and neuron resting potential.

Cucurachi, C., et al. [“A review of the ecological effects of radiofrequency electromagnetic fields \(RF-EMF\).”](#) Environment International, vol. 51, 2013, pp. 116–40.

Singh R., Nath R., Mathur A.K., Sharma R.S., [Effect of radiofrequency radiation on reproductive health](#). *Indian J Med Res.* 2018;148(Suppl):S92–S99. doi:10.4103/ijmr.IJMR_1056_18

Sangün Ö, Dündar B, Çömlekçi S, Büyükgebiz A., [The Effects of Electromagnetic Field on the Endocrine System in Children and Adolescents](#). *Pediatr Endocrinol Rev*. 2015 Dec;13(2):531-45.

Kim JH, Lee JK, Kim HG, Kim KB, Kim HR. [Possible Effects of Radiofrequency Electromagnetic Field Exposure on Central Nerve System](#). *Biomol Ther (Seoul)*. 2019;27(3):265–275.
doi:10.4062/biomolther.2018.152

Clegg, F., Sears, M., Friesen, M., Scarato, T., Metzinger, R., & Russell, C. et al. (2020). [Building science and radiofrequency radiation: What makes smart and healthy buildings](#). *Building And Environment*, 176, 106324. <https://doi.org/10.1016/j.buildenv.2019.106324>

Stein Y, Udassin IG. [Electromagnetic hypersensitivity \(EHS, microwave syndrome\) – Review of mechanisms](#). *Environmental Research*. vol. 186. Available online 30 March 2020, 109445.

Cancer

Luo, J., et al [Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut](#), *Environmental Research*, Volume 182, 2020

- The interaction between cell phone use and genetic variants on thyroid cancer was investigated in this study. When some genetic variants were present, cell phone use was significantly associated with thyroid cancer. The association increased when cell phone use duration and frequency increased.

Smith-Roe SL., et al., [Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure](#), *Environ Mol Mutagen* 2020; 61 (2): 276-290

National Toxicology Program (NTP) Carcinogenesis Studies of Cell Phone Radiofrequency Radiation, [Final Reports](#)

The NTP studies found that high exposure to RFR used by cell phones was associated with:

- 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.
- Some evidence of tumors in the adrenal glands of male rats. The tumors were benign, malignant, or complex combined pheochromocytoma.
- Resources on the NTP study:
 - [National Institutes of Health Cell Phone Webpage](#): This page has the key findings, final reports and a factsheet for the public.
 - [Factsheet on NTP Study for Public \(January 2020\)](#)
 - [Study on DNA damage from the NTP](#)
 - [PPT on Peer Review](#)
 - [Toxicology and Carcinogenesis Studies in Hsd:Sprague Dawley SD Rats Exposed to Whole-Body Radio Frequency Radiation at a Frequency \(900 MHz\) and Modulations \(GSM and CDMA\) Used by Cell Phones](#)
 - [Toxicology and Carcinogenesis Studies in B6C3F1/N Mice Exposed to Whole-Body Radio Frequency Radiation at a Frequency \(1,900 MHz\) and Modulations \(GSM and CDMA\) Used by Cell Phones](#)

Carlberg, Michael and Lennart Hardell. [“Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation.”](#) BioMed Research International, vol. 2017, 2017.

- When considered vis a vis deductive public health principles, the combined evidence from epidemiology and laboratory studies indicate that meningioma and glioma in the temporal lobe can be considered to be caused by cumulative RF radiation exposure. Experimental findings that RF increases production of reactive oxygen species suggest a potential mechanism.

Lerchl, Alexander, et al. [“Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans.”](#) Biochemical and Biophysical Research Communications, vol. 459, no. 4, 2015, pp. 585-90.

- Numbers of tumors of the lungs and livers in exposed animals were significantly higher than in sham-exposed controls. In addition, lymphomas were also found to be significantly elevated by exposure.

Prasad, M., et al. [“Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes.”](#) Neurological Sciences, 2017.

- Studies with higher quality are more likely to find higher risk of brain tumour, while lower quality studies tend to indicate lower risk/protection

Belpoggi 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 base station environmental emission](#)" Environmental Research

- "Our findings of cancerous tumors in rats exposed to environmental levels of RF are consistent with and reinforce the results of the US NTP studies on cell phone radiation, as both reported increases in the same types of tumors of the brain and heart in Sprague-Dawley rats. Together, these studies provide sufficient evidence to call for the International Agency for Research on Cancer (IARC) to re-evaluate and re-classify their conclusions regarding the carcinogenic potential of RFR in humans"

Hardell, Lennart and Michael Carlberg. "[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, vol. 22, no. 1, 2015, pp. 1-13.

- Mobile phone and cordless phone use increased the risk of glioma, with highest risk in the >15–20 years latency group Highest ORs overall were found for ipsilateral mobile or cordless phone use, while the highest risk was found for glioma in the temporal lobe. First use of mobile or cordless phone before the age of 20 gave higher OR for glioma than in later age groups.

Carlberg, Michael and Lennart Hardell. "[Decreased survival of glioma patients with astrocytoma grade IV \(glioblastoma multiforme\) associated with long-term use of mobile and cordless phones.](#)"

International Journal of Environmental Research and Public Health, vol. 11, no. 10, 2014, pp. 10790-805.

- Elevated HR (decreased survival) for the most malignant glioma type, astrocytoma grade IV, was found for long-term use of mobile and cordless phones. Highest HR was found for cases with first use before the age of 20 years.

Coureau, Gaëlle, et al. "[Mobile phone use and brain tumours in the CERENAT case-control study.](#)" Occupational and Environmental Medicine, vol. 71, no. 7, 2014, pp. 514-22.

- No association with brain tumours was observed when comparing regular mobile phone users with non-users, however, the positive association was statistically significant in the heaviest users when considering life-long cumulative duration and number of calls for gliomas. Risks were higher for gliomas, temporal tumours, occupational and urban mobile phone use.

West JG, Kapoor NS, Liao S, Chen JW, Bailey L, Nagourney RA. (2013). [Multifocal Breast Cancer in Young Women with Prolonged Contact between Their Breasts and Their Cellular Phones](#). Case Reports in Medicine. Volume 2013, Article ID 354682.

- Researchers report a four case series of women-ages from 21 to 39-with multifocal invasive breast cancer, all which regularly carried their cell phones against their breast for up to 10 hours/day for several years, had no family history of breast cancer, tested negative for BRCA1 and BRCA2, and have highly similar case pathology and morphology.

Yang, M., et al. [“Mobile phone use and glioma risk: A systematic review and meta-analysis.”](#) PLoS One, vol. 12, no. 5, 2017.

- Meta-analysis found significant positive association between long-term mobile phone use (minimum, 10 years) and glioma. And there was a significant positive association between long-term ipsilateral mobile phone use and the risk of glioma. Long-term mobile phone use was associated with 2.22 times greater odds of low-grade glioma occurrence.

Head and Neck Tumors

Carlberg, Michael, et al. [“Increasing incidence of thyroid cancer in the Nordic countries with main focus on Swedish data.”](#) BMC Cancer, vol. 16, no. 426, 2016.

- The main finding of this register based study was an increasing incidence of thyroid cancer in Sweden during the whole study period 1970–2013 in both women and men, although not statistically significant in men. In both genders the incidence increased during the more recent study period, from 2001 in women and from 2005 in men.

Sadetzki, Siegal, et al. [“Cellular Phone Use and Risk of Benign and Malignant Parotid Gland Tumors—A Nationwide Case-Control Study.”](#) American Journal of Epidemiology, vol. 167, no. 4, 2007, pp. 457-67.

- Our results suggest a relation between long-term and heavy cellular phone use and parotid gland tumors. This association was seen in analyses restricted to regular users, analyses of laterality of phone use, and analyses of area of main use.

Siqueira, Elisa Carvalho, et al. [“Cell phone use is associated with an inflammatory cytokine profile of parotid gland saliva.”](#) Journal of Oral Pathology & Medicine, vol. 45, no. 9, 2016, pp. 682-6.

- Cell phone exposure was associated with an increased level of IL-1 β (a pro-inflammatory cytokine) and decreased IL-10 level (anti-inflammatory cytokine) in the exposed parotid gland saliva .

Reproduction

Houston, B.J., et al. [“The effects of radiofrequency electromagnetic radiation on sperm function.”](#) Reproduction, vol. 152, no. 2, 2016, pp. R263-76.

- Documented impacts of RF-EMR on the male reproductive system include decreased sperm motility, elevated levels of reactive oxygen species, increased DNA damage, and decreased antioxidant levels.

Adams, Jessica A., et al. [“Effect of mobile telephones on sperm quality: A systematic review and meta-analysis.”](#) Environmental International, vol. 70, 2014, pp. 106-12.

- Following a systematic review and meta-analysis to determine whether exposure to RF-EMR emitted from mobile phones affects human sperm quality, researchers found that exposure to mobile phone was associated with reduced sperm motility and overall quality.

De Iuliis, Geoffrey N., et al. [“Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro.”](#) PloS one, vol. 4, no. 7, 2009.

- RF-EMR in both the power density and frequency range of mobile phones (1.8 GHz covering a SAR range from 0.4 to 27.5 W/kg) were shown to enhance mitochondrial reactive oxygen species generation, decrease the motility and vitality, stimulating DNA base adduct formation and ultimately cause DNA fragmentation within the human spermatozoa.

Atasoy, Halil I., et al. [“Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices.”](#) Journal of Pediatric Urology, vol. 9, no. 2, 2013, pp. 223-9.

- Researchers observed significant increases in serum 8-hydroxy-2'-deoxyguanosine levels and 8-hydroxyguanosine staining in the testes of the experimental group indicating DNA damage due to exposure ($p < 0.05$) and effects on enzyme activity.

Avendano, Conrado, et al. [“Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation.”](#) Fertility and Sterility, vol. 97, no. 1, 2012, pp. 39-45.

- Sperm samples, mostly normozoospermic, exposed ex vivo during 4 hours to a wireless internet-connected laptop showed a significant decrease in progressive sperm motility and an increase in sperm DNA fragmentation.

Brain

Aldad, Tamir S., et al. [“Fetal radiofrequency radiation exposure from 800-1900 Mhz-rated cellular telephones affects neurodevelopment and behavior in mice.”](#) Scientific Reports, vol. 2, no. 312, 2012.

- In a study examining the association between prenatal cell phone use and hyperactivity in children, researchers found that mice exposed in-utero were hyperactive and had impaired memory, and in addition, recordings of excitatory postsynaptic currents revealed that these behavioral changes were due to altered neuronal developmental programming.

Byun, Yoon-Hwan, et al. [“Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study.”](#) PLoS One, vol. 8, no. 3, 2013.

Foerster M., Thielens A., Joseph W., Eeftens M., Rössli M. (2018) [A prospective cohort study of adolescents' memory performance and individual brain dose of microwave radiation from wireless communication.](#) Environmental Health Perspectives.

Kim, Ju Hwan, et al. [“Long-term exposure to 835 MHz RF-EMF induces hyperactivity, autophagy and demyelination in the cortical neurons of mice.”](#) Scientific Reports, vol. 7, 2017.

- The neuronal effects of 835 MHz RF-EMF on the cerebral cortex of the mouse brain at 4.0 W/kg for 5 hours/day for 12 weeks included induction of autophagy genes, production of proteins, accumulation of autolysosome, demyelination in cortical neurons and hyperactivity-like behavior.

Volkow, Nora D., et al. [“Effects of cell phone radiofrequency signal exposure on brain glucose metabolism.”](#) JAMA, vol. 305, no. 8, 2011, pp. 808-13.

- Researchers concluded that compared to individuals with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna.

Bas, O., et al. [“Chronic prenatal exposure to the 900 megahertz electromagnetic field induces pyramidal cell loss in the hippocampus of newborn rats.”](#) Toxicology and Industrial Health, vol. 25, no. 6, 2009, pp. 377-84.

- It was found that 900 megahertz of electromagnetic field significantly reduced the total pyramidal cell number in the cornu ammonis of the electromagnetic field group ($P < 0.001$).

Deshmukh, Pravin Suryakantrao, et al. [“Cognitive impairment and neurogenotoxic effects in rats exposed to low-intensity microwave radiation.”](#) International Journal of Toxicology, vol. 34, no. 3, 2015, pp. 284-90.

- Rats exposed to low-intensity microwave radiation showed declined cognitive function, elevated HSP70 level, and DNA damage within the brain, compared to control animals.

Herbert, Martha R., and Cindy Sage. [“Autism and EMF? Plausibility of a pathophysiological link–Part I.”](#) Pathophysiology, vol. 20, no. 3, 2013, pp. 191-209.

- Authors review pathophysiological damage to core cellular processes that are associated both with autism spectrum conditions and with biological effects of EMF/RFR exposures that contribute to chronically disrupted homeostasis

Herbert, Martha R., and Cindy Sage. [“Autism and EMF? Plausibility of a pathophysiological link part II.”](#) Pathophysiology, vol. 20, no. 3, 2013, pp. 211-34.

- Authors document how behaviors in autism spectrum conditions may emerge from alterations of electrophysiological oscillatory synchronization, how EMF/RFR could contribute to these by de-tuning the organism, and policy implications of these vulnerabilities.

Odaci, E., O. Bas, and S. Kaplan. [“Effects of prenatal exposure to a 900MHz electromagnetic field on the dentate gyrus of rats: a stereological and histopathological study.”](#) Brain Research, no. 1238, 2008, pp. 224-9.

- The results showed that prenatal EMF exposure caused a decrease in the number of granule cells in the dentate gyrus of the rats ($P < 0.01$), suggesting that prenatal exposure to a 900 MHz EMF affects the development of the dentate gyrus granule cells in the rat hippocampus.

Sonmez, O.F., et al. [“Purkinje cell number decreases in the adult female rat cerebellum following exposure to 900 MHz electromagnetic field.”](#) Brain Research, no. 1356, 2010, pp. 95-101.

- Results showed that the total number of Purkinje cells in the cerebellum of the EMFG was significantly lower than those of CG ($p < 0.004$) and SG ($p < 0.002$), suggesting that long duration exposure to 900 MHz EMF leads to decreases of Purkinje cell numbers in the female rat cerebellum.

Tang, Jun, et al. [“Exposure to 900MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats.”](#) Brain Research, no. 1601, 2015, pp. 92-101.

- Results demonstrate that exposure to 900 MHz EMF radiation for 28 days can significantly impair spatial memory and damage BBB permeability in rat by activating the mkp-1/ERK pathway.

Papageorgiou, Charalabos C., et al. [“Effects of wi-fi signals on the p300 component of event-related potentials during an auditory hayling task.”](#) Journal of Integrative Neuroscience, vol. 10, no. 2, 2011, pp. 189-202.

- The present study focused on the possible gender-related effects of Wi-Fi electromagnetic fields (EMF) on the attention and working memory operations of the brain, concluding that Wi-Fi exposure may exert gender-related alterations on neural activity associated with the amount of attentional resources engaged during a linguistic test.

Ntzouni, Maria P, et al. [“Transient and cumulative memory impairments induced by GSM 1.8 GHz cell phone signal in a mouse model.”](#) Electromagnetic Biology and Medicine, vol. 32, no. 1, 2013, pp. 95-120.

- The data suggest that visual information processing mechanisms in hippocampus, perirhinal and entorhinal cortex are gradually malfunctioning upon long-term daily exposure, a phenotype that

persists for at least 2 weeks after interruption of radiation, returning to normal memory performance levels 4 weeks later.

Environment

Several literature reviews warn that non-ionizing EMFs are an “emerging threat” to wildlife ([Balmori 2015](#), [Curachi 2013](#), [Sivani 2012](#)) and impacts to pollinators are documented in published studies ([Favre 2011](#), [Kumar et.al., 2011](#), [Lazaro et al., 2016](#)). Field research has found years of exposure to cell tower radiation damages trees ([Waldmann-Selsam, C., et al. 2016](#), [Helmut 2016](#), [Haggerty 2010](#)) and plants ([Halgamuge 2017](#), [Pall 2016](#), [Halgamuge and Davis 2019](#)). Radiofrequency radiation has been found to affect the magnetic sense of invertebrates (including insects) ([Tomanová and Vácha, 2016](#); [Vácha et al., 2009](#)) birds ([Engels et al., 2014](#)) and mammals ([Malkemper et al., 2015](#)). Furthermore, [research](#) shows bees and pollinators could suffer serious impacts from the higher frequencies to be used in 5G as the higher frequencies resonate with their bodies resulting in up to 370% higher absorbed power.

Balmori, Alfonso. [“Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation.”](#) Science of The Total Environment, vol. 518–519, 2015, pp. 58–60

- The growth of wireless telecommunication technologies causes increased electrosmog. Radio frequency fields in the MHz range disrupt insect and bird orientation.
- Radio frequency noise interferes with the primary process of magnetoreception. Existing guidelines do not adequately protect wildlife. Further research in this area is urgent.

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

Waldmann-Selsam, C., et al. [“Radiofrequency radiation injures trees around mobile phone base stations.”](#)Science of the Total Environment 572 (2016): 554-69.

Breunig, Helmut. [“Tree Damage Caused By Mobile Phone Base Stations An Observation Guide.”](#) (2017).

You can also download the Tree Observation Guide at: [Competence Initiative for the Protection of Humanity, the Environment and Democracy](#)

S Sivani, D Sudarsanam, [Impacts of radio-frequency electromagnetic field \(RF-EMF\) from cell phone towers and wireless devices on biosystem and ecosystem ? A review.](#) Volume 4, Issue 4, Pages 202–216, 2012

Haggerty, Katie. [“Adverse Influence of Radio Frequency Background on Trembling Aspen Seedlings.”](#)International Journal of Forestry Research2010.836278 (2010).

Halgamuge, M.N. [“Weak radiofrequency radiation exposure from mobile phone radiation on plants.”](#) Electromagnetic Biology and Medicine, vol. 36, no. 2, 2017, pp. 213-235.

Martin Pall. [“Electromagnetic Fields Act Similarly in Plants as in Animals: Probable Activation of Calcium Channels via Their Voltage Sensor”](#) Current Chemical Biology, Volume 10 , Issue 1 , 2016

Shikha Chandel, et al. [“Exposure to 2100 MHz electromagnetic field radiations induces reactive oxygen species generation in Allium cepa roots.”](#) Journal of Microscopy and Ultrastructure 5.4 (2017): 225-229.

Halgamuge MN, Davis D. [Lessons learned from the application of machine learning to studies on plant response to radio-frequency.](#) Environ Res. 2019. doi:10.1016/j.envres.2019.108634

Compliance Testing and Exposures

Gandhi, O. P. (2019). [Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body.](#) IEEE Access, 7, 47050-47052.

Fernández, A.A. de Salles, M.E. Sears, R.D. Morris, D.L. Davis, [Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality,](#) Environmental Research, 2018, ISSN 0013-9351

Ferreira, Juliana Borges, and Álvaro Augusto Almeida de Salles. [“Specific Absorption Rate \(SAR\) in the head of Tablet users.”](#) 7th Latin American Workshop On Communications, 2015

- The psSAR simulations in heterogeneous models (adult and child) show higher levels in the children model.

Gultekin, David H., and Lothar Moeller. [“NMR imaging of cell phone radiation absorption in brain tissue.”](#) Proceedings of the National Academy of Sciences, vol. 110, no. 1, 2013, pp. 58-63.

- A method is described for measuring absorbed electromagnetic energy radiated from cell phone antennae into ex vivo brain tissue.

Morris, Robert D., Lloyd L. Morgan, and Devra L. Davis. [“Children Absorb Higher Doses of Radio Frequency Electromagnetic Radiation From Mobile Phones Than Adults.”](#) IEEE Access, vol. 3, 2015, pp. 2379-87.

Gandhi, Om P., et al. [“Exposure limits: the underestimation of absorbed cell phone radiation, especially in children.”](#) Electromagnetic Biology and Medicine, vol. 31, no. 1, 2012, pp. 34-51.

- Researchers indicate that the existing cell phone certification process is outdated and greatly underestimates the SAR for typical phone users, especially children, and thus call for a new certification process that incorporates different modes of use, head size, tissue properties, and anatomically based models.

Cardis, Elisabeth, et al. [“Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries.”](#) Occupational and Environmental Medicine, vol. 68, no. 9, 2011, pp. 631-40.

- Authors found suggestions of an increased risk of glioma in long-term mobile phone users with high RF exposure and of similar, but apparently much smaller, increases in meningioma risk.

Cells

Markovà, Eva, Lars OG Malmgren, and Igor Y. Belyaev. [“Microwaves from mobile phones inhibit 53BP1 focus formation in human stem cells more strongly than in differentiated cells: possible mechanistic link to cancer risk.”](#) Environ Health Perspect, vol. 118, no. 3, 2010, pp. 394-9.

- Microwaves from mobile phones inhibited formation of 53BP1 foci in human primary fibroblasts and mesenchymal stem cells. These data parallel our previous findings for human lymphocytes.

Belyaev, Igor Y., et al. [“Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/γ-H2AX DNA repair foci in human lymphocytes.”](#) Bioelectromagnetics, vol. 30, no. 2, 2009, pp. 129-41.

- Researchers described frequency-dependent effects of mobile phone microwaves on human lymphocytes from persons reporting hypersensitivity to electromagnetic fields and healthy persons, concluding that microwaves from universal global telecommunications system (UMTS) mobile phones affect chromatin and inhibit formation of DNA double-strand breaks in human lymphocytes from both hypersensitive and healthy persons.

NON-THERMAL EFFECTS AND MECHANISMS OF INTERACTION

BETWEEN ELECTROMAGNETIC FIELDS AND LIVING MATTER RAMAZZINI INSTITUTE

Edited by Livio Giuliani and Morando Soffritti https://20f26590-b7e8-4680-97ed-4c278e3cde44.filesusr.com/ugd/71af9c_bb3a19dd1379425aa765fc5de60498e5.pdf

Impacts to Insects and Wildlife

A 2020 report of the “biological effects of electromagnetic fields on insects” by high voltage, mobile communications and WLAN came to the conclusion that, in addition to pesticides and the loss of habitats, mobile communications radiation also has negative effects on insects and is therefore another factor in weakening the insect world. [Read “Biological effects of electromagnetic fields on insects” by Alain Thill](#)

Several literature reviews warn that non-ionizing EMFs are an “emerging threat” to wildlife ([Balmori 2015](#), [Curachi 2013](#), [Sivani 2012](#)) and impacts to pollinators are documented in published studies ([Balmori 2021](#), [Favre 2011](#), [Kumar et.al., 2011](#), [Lazaro et al., 2016](#)). Field research has found years of exposure to cell tower radiation damages trees ([Waldmann-Selsam, C., et al. 2016](#), [Helmut 2016](#), [Haggerty 2010](#)) and plants ([Halgamuge 2017](#), [Pall 2016](#), [Halgamuge and Davis 2019](#)). Radiofrequency radiation has been found to affect the magnetic sense of invertebrates (including insects) ([Tomanová and Vácha, 2016](#); [Vácha et al., 2009](#)) birds ([Engels et al., 2014](#)) and mammals ([Malkemper et al., 2015](#)). Furthermore [research](#) shows bees and pollinators could suffer serious impacts from the higher frequencies to be used in 5G as the higher frequencies resonate with their bodies resulting in up to 370% higher absorbed power.

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- [ELF-EMF/Static Field Free Radical \(Oxidative Damage\) Abstracts \(2019\)](#)
- [ELF-EMF Comet Assay Abstracts \(2017\)](#)

- [ELF-EMF/Static Field Neurological Effects Abstracts \(2019\)](#)

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Amyotrophic lateral sclerosis

A 2021 study ([Baaken et al 2021](#)) found “a relative risk of ≥ 1.14 for Amyotrophic lateral sclerosis and occupational exposure to ELF-MF” and recommends a pooled analysis is to establish a study protocol and additional research. ALS has long been associated with “electrical” occupations, especially welding. A meta-analysis ([Zhou et al., 2012](#)) indicates that there might be a slight but statistically significant increase in ALS risk among people with jobs related to higher levels of EMF exposure.

Environmental Health Trust has [resources on how to reduce magnetic field EMFs HERE](#).

Reducing Exposure to ELF-EMF in Your Home

ELF-EMF fields from electronics and appliances fall off rapidly with distance. Experts are less concerned about the brief exposures to ELF-EMF we encounter every day but far more concerned about longer-term chronic exposures, such as every night. Here are some ways to reduce your daily exposure:

- Do not rest a laptop or electric on your lap. Keep electronics on a table.
- Do not sleep near a charging cell phone or a charging laptop or digital device. Always charge devices away from sleeping/living spaces and preferable during the daytime. Charging generates high EMFs near the cord and batteries can catch fire during charging.
- Do not use a cell phone while it is charging as the ELF-EMF field is high. Likewise- try to use your laptop on battery, rather than while charging. Always unplug the laptop once it is charged.
- Corded alarm clocks and radios can have intense EMFs, so replace your alarm clock with a battery powered alarm clock. This will reduce your exposure at night.
- Do not sleep with your head or body near a wall that has the electric panel, electric meter or appliance on the other side.
- Unplug appliances and electronics such as TV's and microwaves ovens when not in use. This reduces ELF and also reduces energy consumption. An easy way to do this for electronics is to get a powerstrip that you can easily switch off.
- Remove electronics from the bedroom—especially around your bed and the crib.
- Avoid sleeping with electric blankets and heating pads; if you use an electric blanket to preheat your bed, unplug it before sleeping. If you only turn it off, the EMF will still be present.
- Do not stand near a microwave oven when it is on. Better yet, use a toaster oven.
- EMFs from electrical wiring can be reduced if you flip the switch on the breaker for the electrical circuits near the bedroom at night. However circuits are not designed to be flipped every night. Some people use a “kill switch” so all you have to do is flip one switch at night to turn off breakers all at once.

- Get a magnetic field meter to take measurements in your home. If your ELF measurements show high levels in your home, it could be faulty wiring which an electrician can fix. Often simple fixes can greatly reduce ELF-EMF exposure.
- Take measurements in your home if you live near powerlines because levels can be high throughout the house from the EMF emanating from high voltage powerlines.

Dr. Ronald N. Kostoff on Automotive Radar and Electromagnetic Field Exposure in Cars

Sep 16, 2018

EHT is posting information from Dr. Ronald N. Kostoff- Ph.D. in Aerospace and Mechanical Sciences from Princeton University in 1967, and subsequently worked for: Bell Laboratories, Department of Energy, Office of Naval Research, and MITRE Corp. Present;y Research Affiliate at Georgia Institute of Technology.

Dr. Kostoff has published over 200 peer-reviewed articles, served as Guest Editor of four journal Special Issues since 1994, and obtained two text mining system patents. His published peer-reviewed literature includes:

- Kostoff RN, Lau CGY. [Modified Health Effects of Non-ionizing Electromagnetic Radiation Combined with Other Agents Reported in the Biomedical Literature.](#) in C.D. Geddes (ed.), Microwave Effects on DNA and Proteins. Chapter 4. 97-157. © Springer International Publishing AG 2017. DOI 10.1007/978-3-319-50289-2_4.
- Kostoff RN, Lau CGY. [Combined biological and health effects of electromagnetic fields and other agents in the published literature.](#) Technological Forecasting & Social Change. 80:7. 1331-1349. 2013.

From: Dr. Ronald N. Kostoff

Subject: Automotive Radar

BACKGROUND

Non-ionizing radiation has become ubiquitous in our daily lives, and is expanding rapidly. One of the least appreciated sources/environments is the cabin of modern-day vehicles. There are myriad non-ionizing radiation sources originating within the cabin and entering the cabin, and probably the least recognized is automotive radar. The following discussion addresses only a few aspects of this potentially toxic stimulus.

PERSONAL INTEREST

I'm in the process of looking for a replacement car. One of the criteria is minimum exposure to RFR and ELF-EMF. I've made some measurements in the cabin of candidate vehicles at power frequencies

and cell phone/WiFi RFR frequencies. Given the commonality of Bluetooth and other RFR sources even in base low-tech models, I have found that RFR readings in the cabin are non-negligible. Additionally, some ELF measurements I've made in one hybrid showed magnetic fields can be high near the driver's head and even lower body. I've read about other hybrid ELF measurements where highest readings occur at other seating positions, and, over the past decade, have read about non-hybrid (gasoline-only) vehicles where high ELF readings have been recorded.

AUTOMOTIVE RADAR

However, there is another wireless radiation problem that seems to be relatively overlooked. Many new cars routinely include a suite of 'safety' sensors even in the lowest-tech base model. Many of these sensing devices emit radar. I don't know how much of the radar radiation feeds back into the cabin from the sensors installed today. Hopefully none, but that may depend on the beam spread characteristics.

However, the outward radar beams travel for substantial distances, and can impinge on other cars and pedestrians. While the metal surrounding the target car should be able to block the impinging radar, the glass will be transparent to many radar frequencies. I don't know about penetration/absorption in non-metal composite car structures.

The radar radiation adverse effects problem could be serious. Unfortunately, I haven't found anything on the Web (other than hand-waving) that shows quantitatively how much radar radiation flux could be impinging on car passengers/drivers and pedestrians. Additionally, I haven't found portable meters that could measure the magnitude of the radar signals at the automotive radar frequencies (~24 GHz and ~77 GHz). I'm both surprised and appalled at the lack of quantitative information about this potentially serious problem. If anyone can direct me to quantitative studies of automotive radar, and meters that would operate at these frequencies, I would be most appreciative.

DELIBERATE IN-CABIN RADAR

In searching the Web for automotive radars, I recently came across some interesting articles on near-future applications of such radars. One such article is the following: [DSP Inside TI Radar Puts AI on Edge | EE Times](#)

In this article, the statement is made:

“For example, the digital processing capability inside the mmWave sensor can filter out noise, said Wasson, allowing TI's radar chips to detect very small movements, even the breathing that indicates the presence of a person or animal inside a vehicle.

Wasson noted that “child occupancy detection” is likely to become a feature in the Euro NCAP roadmap. This, he believes, will open the door for TI's radars in body, chassis, and in-cabin applications. As tier ones and OEMs look for the right sensing technology to enable such detection possibilities, Wasson noted that radars are much better-positioned.

Radar, for example can “see” through a blanket to determine whether a child is underneath. TI's radar chips can even distinguish between a person and a static object like a duffel bag, explained Wasson, because their on-chip digital signal processing can detect a heartbeat.”

The aim seems to be to *deliberately radiate the cabin with radar RFR*, for various detection purposes. They make no mention about potential power levels.

I have seen other such articles where the radar would be *aimed at the driver continuously*, to insure alertness and awareness. For example, consider the following article:

<https://www.cnet.com/roadshow/news/volkswagen-invests-100-million-to-develop-solid-state-battery-tech/>

In this article, the statement is made:

“Sudipto Bose, director of marketing for automotive radar at Texas Instruments, points out that in-cabin radar offers a number of benefits. It can alert parents if they’ve left children in a car, and it can be used for gesture controls, which let drivers control navigation, phone and stereo with hand motions. This proximity radar could also identify if a driver’s attention is not focused out the windshield.... If automakers take Texas Instruments up on its new radar sensors, a production vehicle with radar-based gesture control would still be *two to five years away*.”

The time frame is relatively short!

COMBINATIONS OF TOXIC STIMULI INCLUDING NON-IONIZING RADIATION

So, if you’re driving a hybrid vehicle with a full load of passengers, you will be subject to:

- ELF-EMF from the tires and other sources unique to hybrids (which I measured two weeks ago)
- RFR from your cell phone and the cell phones of the other passengers
- RFR from Bluetooth (which I measured a couple of weeks ago)
- RFR from the WiFi ‘hot spot’ and the devices communicating with the hot spot
- RFR from the myriad cell towers that dot the sides of most highways
- RFR from the radar sensors of other cars
- RFR from on-board radar sensors to detect motions and driver alertness within the cabin

Almost all these radiation sources will also be operable in a gasoline-powered car, and there will be some bouncing around of the radiation within the cabin because of the surrounding metal.

Our studies on combinations of toxic stimuli including non-ionizing radiation showed the adverse health effects are exacerbated when non-ionizing radiations of different characteristics are combined. I can only imagine the effects of the above complex combination! And, I’m not even sure I caught all the sources of exposure in the cabin. When we add in the combination of the non-ionizing radiation cocktail above with the surrounding air pollution, and the other toxic stimuli to which the occupants of the car are exposed in the car and in their daily lives, we have a very serious situation.

Also, it’s not clear to me how the FCC exposure limits (which are already six orders of magnitude too high for protective purposes) would apply to limit in-cabin radiation levels. Would they apply to each source, or to the total radiation? I suspect the former. If that is the case, cabin occupants could be exposed theoretically to radiation levels well in excess of the present FCC limits.

PRIOR EMAILS WITH MORE DETAIL

I have appended three emails that I sent recently to another group addressing this issue. There were other emails in the correspondence thread that I didn't include, so they might appear somewhat disjointed.

The first email addresses an FCC directive allowing very high automotive radar exposures at all vehicle speeds, including idling. There used to be a requirement that the radar be powered down at vehicle idling, but the FCC directive (at Toyota's request) removed this requirement. So, as I point out, a small child walking across a crosswalk with rows of cars stopped for a light could theoretically be exposed to a million microwatts/square meter, or more, full body radiation, if the radars are operating at the FCC limit. I don't know how much today's automotive radars actually emit, since I have seen nothing on the Web about that and I don't have access to a meter that could make those measurements.

The other two emails amplify specific automotive radar issues further, including potential synergistic effects among automotive radar and Bluetooth and WiFi and ELF (which can occur in non-hybrid cars as well as hybrid), which can be operating simultaneously in a given vehicle.

These automotive radar frequencies are within the frequency range encompassed by 5G, so, in fact, we have already been implementing 5G-frequencies for the past decade. We've been focusing on the shell, and not the pea, or at least on one pea and not the other pea(s)!

Dr. Ronald N. Kostoff

APPENDICES

FIRST EMAIL

Per the automotive radar issue, I came across this interesting FCC directive from 2012.

<https://www.federalregister.gov/documents/2012/08/13/2012-19732/operation-of-radar-systems-in-the-76-77-ghz-band>

It appears that the FCC used to have a requirement that when cars were stopped, such as in a traffic jam, any onboard radars would have to reduce power to minimize longer-term exposure to humans. In 2009, Toyota applied to relax these rules, for reasons described in the linked document. Naturally, the FCC complied with the request.

What I find interesting is the emission limits they adopted.

“In lieu of separate emission limits for in-motion and not-in-motion, the Commission proposed to increase the average power density limit to 88 $\mu\text{W}/\text{cm}^2$ at 3 meters (average EIRP of 50 dBm) and to decrease the peak power density limit to 279 $\mu\text{W}/\text{cm}^2$ at 3 meters (peak EIRP of 55 dBm) for vehicular radar systems regardless of the direction of illumination.”

In units I use, the average power density limit would be 88×10^4 microwatts/square meter, or 880,000 microwatts/square meter, at three meters. So, in slow moving traffic on a superhighway, if there was nine meters separation between the bumper of the car behind and the driver of the car ahead (a conservative estimate in bumper-to-bumper traffic), there could be as much as 220,000 microwatts/square meter radiating the driver/passengers of the front vehicle. I don't know how much would be absorbed by the glass at these frequencies, but I have seen some documents to the effect that

some bands will penetrate the glass. There could also be side radar coming from cars other than the rear car.

If you're walking on a crosswalk in front of stopped traffic, you may even be closer than three meters to the bumper, and could be exposed directly full body to a million microwatts/square meter. And, there's no glass or metal to absorb or block the radiation. And, that's with the assumption that you're being radiated from one car only.

I don't know what the actual emissions are in today's cars. I would suspect they're quite high, but the actual numbers would be conclusive. Walking on today's streets in high traffic areas has become a dangerous pastime, and few people realize it!

SECOND EMAIL

What we really need to get are the codes the auto manufacturers use to compute actual radar exposures to car occupants and pedestrians. There are geometric and obstacle issues that need to be taken into account, which were not included in the prior rough estimates. We need to know where specifically all the radars are located, what are their powers and antenna characteristics, how much radiation is blocked by a target car's trunk, hood, doors, etc. Also, how much passes through the windows, is absorbed by the windows, and is reflected by the windows.

The estimates for pedestrians are far more accurate. If they are walking in front of an idling car, they are getting pretty much unimpeded exposure. If some of the radars are mounted on the front bumper, then small children walking a crosswalk would be the most vulnerable. I don't know what the beam spread in the vertical plane would look like on these actual radar systems, but it wouldn't have to be much to provide full body exposure to small children.

So, people in a car are exposed not only to their cell phones/tablets and those of their fellow occupants, but also to Bluetooth and WiFi, in addition to the radar coming from other vehicles. If they have a hybrid, there could also be substantial exposures to ELF magnetic fields as well (as I-and others-have measured). What are the synergistic effects of being exposed to these myriad (radar, cell phone, WiFi, ELF, etc) non-ionizing frequencies simultaneously?

On route 66 in Virginia (a heavily trafficked superhighway near me), there are always repairs being done. The road gangs work only a few feet from the streams of traffic. In addition to their cell phones/tablets, they are exposed to radiation from the many cell towers that can be seen from 66, as well as to the radars from the cars that are whizzing by in close proximity. These exposures are almost continuous for eight hours a day. Again, what is the synergistic effect of these exposures to different frequency radiation.

And, of course, in highly congested traffic areas, there is the added bonus of high levels of pollution from the cars' exhausts. So, we get 2-for-1: EMF pollution and air pollution. What do those synergies look like? The arrival of 5G in these areas will be the icing on the cake. Given that radars operate at either 24GHz or 77GHz, 5G-frequency operation has essentially arrived in these areas. It's not coming from short cell towers, but rather ultra-short cars!!!

THIRD EMAIL

Two other interesting points. In the FCC directive I sent yesterday, the radar exposure limits were based on radar emanating from one car. But, if there are multiple cars, with some emissions spreading to the side, then the cumulative exposures could be well above the FCC exposure limits at selected points.

Additionally, many people believe the driver should sit as high as possible, to be able to see the front of the hood and have a commanding view of the highway. This is something of a safety measure. However, now with potential radar exposures, sitting higher above the car beltline is akin to a soldier in the trenches exposing himself to potential sniper fire. To avoid radar through the windshield, or especially through open side windows, one should sit as low as possible. This increases safety hazards. Another unintended consequence, brought to you by your friendly wireless vendor and FCC Commissioner!

Ronald N. Kostoff- Ph. D. has published over 200 peer-reviewed articles, served as Guest Editor of four journal Special Issues since 1994, and obtained two text mining system patents. He has published on numerous medical topics in the peer-reviewed literature, including:

- potential treatments for Multiple Sclerosis, Parkinson's Disease, Raynaud's Phenomenon, Cataracts, SARS, Vitreous Restoration, and Chronic Kidney Disease;
- potential causes of Chronic Kidney Disease and Alzheimer's Disease;
- potential treatment protocol for prevention and reversal of Alzheimer's Disease;
- potential impact of toxin combinations on determining exposure limits;
- potential impacts of Electromagnetic Fields on health.

Dr. Kostoff is listed in: Who's Who in America, 60th Edition (2006); Who's Who in Science and Engineering, 9th Edition (2006); and 2000 Outstanding Intellectuals of the 21st Century, 4th Edition, (2006).

Kostoff RN, Lau CGY. [Modified Health Effects of Non-ionizing Electromagnetic Radiation Combined with Other Agents Reported in the Biomedical Literature.](#) in C.D. Geddes (ed.), Microwave Effects on DNA and Proteins. Chapter 4. 97-157. © Springer International Publishing AG 2017. DOI 10.1007/978-3-319-50289-2_4.

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