

SCIENTIFIC STUDIES 2020

THE EFFECT OF METAL OBJECTS ON THE SAR AND TEMPERATURE INCREASE IN THE HUMAN HEAD EXPOSED TO DIPOLE ANTENNA (NUMERICAL ANALYSIS)

Bhargava D, Rattanadecho P, Wessapan T. The effect of metal objects on the SAR and temperature increase in the human head exposed to dipole antenna (numerical analysis). Case Studies in Thermal Engineering. Volume 22, December 2020. doi: 10.1016/j.csite.2020.100789.

Abstract

Wearable metal objects with high electromagnetic reflection characteristics can cause interference with the incident waves during exposure to the electromagnetic (EM) radiation. Therefore, it is of interest to investigate the effect of metal objects capable of increasing the absorption of EM energy and temperature within the tissues when get exposed to EM radiation. A numerical analysis of increase in specific absorption rate (SAR) and temperature distribution in a human head model when metal objects are placed between the head and radiating source is performed. A realistic three-dimensional heterogeneous human head model, metal objects of different shapes and sizes, and spectacles with different lenses are used. A half-wavelength dipole antenna operating at 1800 MHz served as an EM radiation source. Results show that the presence of metal objects in proximity to the head alters SAR and temperature increase within the tissues. In most cases, metal objects redistribute the EM field incident upon them to a smaller region increasing power absorption, thereby increasing SAR and temperature in that region. The power absorption in head layers is found to be sensitive to metal object's size and shape, and distance of the antenna from the objects.

Conclusion

This study investigated the SAR and temperature increase inside a heterogeneous human head model when metal objects of various shape and sizes were present in the proximity. The results show different important features to be discussed in the paper. The metal objects definitely alter the absorption of EM radiation in the tissues. In most of the cases, presence of all shapes of metal objects increase the SAR and temperature in the head model for voice calling position. Among all the metal objects, pin metal (7.2 cm length) causes highest increase in energy absorption in the head layers. However, pin metal having a length of 8.2 cm also decrease the energy absorption in the head model compared to when there is no metal object at all. For video calling position, both types of spectacle lenses (glass and PVC) decrease the power absorption in the eyeball layers. There is no major difference in the power absorption for both types of lenses. The skin around the eyes, however, has increased value of SAR and temperature in presence of spectacle lenses. The distance between the dipole antenna and metal objects also affects the energy absorbed in the tissue layers. The power absorption in the tissue layers increases as the dipole antenna moves closer to the metal objects. However, for resonant sizes of pin and ring, the head layers had highest power absorption when dipole antenna is 2 cm away from the metal objects. Skin around the eye area also has higher power absorption when dipole antenna is 2 cm away from the spectacle lenses. It is observed that a specific distance between the antenna and metal objects is necessary to have strong current coupling. Moving the antenna far or closer to that specific position makes the coupling go out of phase which results in low energy absorption in the tissue layers. The size of metal objects affects the distribution of power absorbed in the

tissues of the head. In presence of metal objects, the energy gets concentrated to a smaller region on the head which increases the power absorption there, hence, increase in SAR and temperature. The SAR and temperature do not directly correlate with each other and highly depend on the dielectric and thermal properties of tissues. For voice calling position, the maximum value of SAR is found in the skin layer, whereas, bone had the maximum value of temperature increase. For video calling position, SAR is maximum in the vitreous layer of the eyeball, whereas, sclera and vitreous had the maximum value of temperature increase. The maximum SAR and temperature obtained in the voice calling position due to pin metal were 26.42 W/kg and 37.42 °C, respectively, in the skin layer. Here, the SAR exceed the ICNIRP/IEEE (2 W/kg) limit of general public exposure. For video calling position, the maximum SAR and temperature increase were 196.87 W/kg (glass lens in vitreous) and 43.66 °C (no spectacle in sclera and vitreous), respectively. Here, both SAR and temperature obtained were higher than the thresholds for the induction of cataract and opacification formation. This paper, hence, shows how important it is to study temperature distribution along with the SAR distribution to clearly understand the effect of EM radiation on the tissues. Results obtained from this study can help spread awareness among the people who often get exposed to EM radiation wearing some type of metal objects. If the metal objects have size and distance in the range of generating strong coupling interaction with the EM radiation source, this could cause a harmful effect on the health.

Open access paper: <https://www.sciencedirect.com/science/article/pii/S2214157X20305311>

EXPOSURE TO 2.45 GHZ RADIOFREQUENCY MODULATES CALCITONIN-DEPENDENT ACTIVITY AND HSP-90 PROTEIN IN PARAFOLLICULAR CELLS OF RAT THYROID GLAND

E López-Martín, F J Jorge-Barreiro, J L Relova-Quintero, A A Salas-Sánchez, F J Ares-Pena. Exposure to 2.45 GHz radiofrequency modulates calcitonin-dependent activity and HSP-90 protein in parafollicular cells of rat thyroid gland. *Tissue Cell*. 2020 Dec 26;68:101478. doi: 10.1016/j.tice.2020.101478.

Highlights

- Non-ionizing radiation could constitute a toxic environment, altering the morphology and functioning of parafollicular cells.
- EMFs activate stress stimuli in the thyroid gland, which is associated with C-cell hyperplasia.
- Non-ionizing radiation modulates expression of Heat Shock Protein 90 in calcitonin-positive cells.

Abstract

In this study we analyzed the response of parafollicular cells in rat thyroid gland after exposure to radiofrequency at 2.45 GHz using a subthermal experimental diathermy model. Forty-two Sprague Dawley rats, divided into two groups of 21 rats each, were individually exposed at 0 (control), 3 or 12 W in a Gigahertz Transverse Electro-Magnetic (GTEM) chamber for 30 min. After radiation, we used simple or fluorescence immunohistochemistry to measure calcitonin cells or cellular stress levels, indicated by the presence hyperplasia of parafollicular cells, heat shock protein (HSP) 90. Immunomarking of calcitonin-positive cells was statistically significant higher in the thyroid tissue of rats exposed to 2.45 GHz

radiofrequency and cell hyperplasia appeared 90 min after radiation at the SAR levels studied. At the same time, co-localized expression of HSP-90 and calcitonin in parafollicular cells was statistically significant attenuated 90 min after radiation and remained statistically significantly low 24 h after radiation, even though parafollicular cell levels normalized. These facts indicate that subthermal radiofrequency (RF) at 2.45 GHz constitutes a negative external stress stimulus that alters the activity and homeostasis of parafollicular cells in the rat thyroid gland. However, further research is needed to determine if there is toxic action in human C cells.

<https://pubmed.ncbi.nlm.nih.gov/33373917/>

NON-THERMAL EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Peter Wust, Benedikt Kortüm, Ulf Strauss, Jacek Nadobny, Sebastian Zschaek, Marcus Beck, Ulrike Stein, Pirus Ghadjar. Non-thermal effects of radiofrequency electromagnetic fields. Sci Rep. 2020 Aug 10;10(1):13488. doi: 10.1038/s41598-020-69561-3.

Abstract

We explored the non-thermal effects of radiofrequency (RF) electromagnetic fields and established a theoretical framework to elucidate their electrophysiological mechanisms. In experiments, we used a preclinical treatment device to treat the human colon cancer cell lines HT-29 and SW480 with either water bath heating (WB-HT) or 13.56 MHz RF hyperthermia (RF-HT) at 42 °C for 60 min and analyzed the proliferation and clonogenicity. We elaborated an electrical model for cell membranes and ion channels and estimated the resulting ion fluxes. The results showed that, for both cell lines, using RF-HT significantly reduced proliferation and clonogenicity compared to WB-HT. According to our model, the RF electric field component was rectified and smoothed in the direction of the channel, which resulted in a DC voltage of $\sim 1 \mu\text{V}$. This may induce ion fluxes that can potentially cause relevant disequilibrium of most ions. Therefore, RF-HT creates additional non-thermal effects in association with significant ion fluxes. Increasing the understanding of these effects can help improve cancer therapy.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7417565/>

THE EFFECT OF EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELD ON WEIGHT GAIN OF PRETERM BABIES

Chia-Ying Lee, Jing-Yau Tang, Pen-Jan Chen, Ling-Sheng Jang, Hsiao-Ling Chuang. The Effect of Extremely Low Frequency Electromagnetic Field on Weight Gain of Preterm Babies. 2020 IEEE International Conference on Consumer Electronics - Taiwan (ICCE-Taiwan). 28-30 Sept. 2020. doi: 10.1109/ICCE-Taiwan49838.2020.9258046.

Abstract

This is an interim report of one-year randomized controlled trial study to investigate the effect of extremely low frequency electromagnetic field (ELF-EMF) on weight gain of the preterm babies. The ELF-EMF device operated at 7.83 Hz, which is known as the Schumann Resonance. After exposing to ELF-EMF for a week, both of the average body-weight gain and weight gain

rate are improved. The results show that ELF-EMF has the potential to develop a new method for helping preterm babies.

<https://ieeexplore.ieee.org/document/9258046>

ELECTROMAGNETIC FIELD OF EXTREMELY LOW FREQUENCY HAS AN IMPACT ON SELECTED CHEMICAL COMPONENTS OF THE HONEYBEE

A Kozirowska, J Depciuch, J Białek, I Woś, K Koziół, S Sadło, B Piechowicz. Electromagnetic field of extremely low frequency has an impact on selected chemical components of the honeybee. *Pol J Vet Sci.* 2020 Dec;23(4):537-544. doi: 10.24425/pjvs.2020.134703.

Abstract

The electromagnetic field (EMF) is an environmental factor affecting living organisms. The aim of this study was to demonstrate the effect of an extremely low frequency electromagnetic field (ELF-EMF) on selected chemical components of the honeybee (*Apis mellifera* L.) using Fourier Transform Infrared (FTIR) spectroscopy. The FTIR method provides information on the chemical structure of compounds through identification and analysis of functional groups. The honeybees were treated with EMF at a frequency of 50 Hz and magnetic induction of 1.6 mT for 2, 6, 12, 24 and 48 hours. Analysis of FTIR spectra showed that EMF exposure longer than 2 hours induced changes in the structure of chemical compounds, especially in the IR region corresponding to DNA, RNA, phospholipids and protein vibrations, compared to control samples (bees not EMF treated). The results confirm the effect of EMF on bees depending on the duration of exposure.

<https://pubmed.ncbi.nlm.nih.gov/33480489/>

EMF FREQUENCY DEPENDENT DIFFERENTIATION OF RAT BONE MARROW MESENCHYMAL STEM CELLS TO ASTROCYTE CELLS

Nader Asadian, Majid Jadidi, Manouchehr Safari, Taha Jadidi, Mahbobeh Gholami. EMF frequency dependent differentiation of rat bone marrow mesenchymal stem cells to astrocyte cells. *Neurosci Lett.* 2020 Dec 26;744:135587. doi: 10.1016/j.neulet.2020.135587.

Highlights

- Stem cells viability and proliferation rate reduced in 400 μ T (25–75 Hz) EMF.
- BMMSC differentiation to neuron increased with 400 μ T (25–75 Hz) EMF.
- BMMSC differentiation to astrocyte cell was EMF frequency dependent.

Abstract

The numerous factors regulate the bone marrow mesenchymal stem cell (BMMSC) self-renewal and differentiation response. We aimed to analyze the influence of electromagnetic field (EMF) as an external inducing factor on rat BMMSC differentiation and proliferation to neuron and astrocyte cells. BMMSCs extracted from the rats femurs and tibias and incubated in a cell-cultured CO₂ incubator. After the third passages, the plates selected randomly and then divided into seven groups (Sham exposed, three groups of square, and three groups of

sinusoidal waveform EMF (25, 50, and 75 Hz, 400 μ T, 1 h/day). The BMMSCs exposed to EMF at the middle of a Helmholtz coil for 7 days. The viable cell counting and proliferation performed by the MTT test and BMMSC differentiation into the neuron and the astrocyte cell was studied by immunocytochemistry staining.

The results confirmed BMMSC viability and proliferation rate reduction in sinusoidal 25 Hz, square 50 Hz and sinusoidal 75 Hz EMF groups compare to sham. The maximum BMMSC differentiation to neuron was considered in sinusoidal 50 Hz and 75 Hz EMF groups. The increase of BMMSC differentiation to astrocyte cell was frequency dependent and the most differentiation was shown in square 75 Hz, and sinusoidal 75 Hz EMF groups. In conclusion, the results suggest that both square and sinusoidal EMF could affect BMMSC development and differentiation to neuron and astrocyte cells. Further studies for the consequence of EMF with wider flux density and frequency on BMMSC are recommended.

<https://pubmed.ncbi.nlm.nih.gov/33373676/>

5G WIRELESS: CAPABILITIES AND CHALLENGES FOR AN EVOLVING NETWORK

U.S. Government Accountability Office (GAO). 5G Wireless: Capabilities and Challenges for an Evolving Network. Nov. 2020, Report to Congressional Requesters GAO-21-26SP: 1-67. <https://www.gao.gov/assets/720/710861.pdf>.

No abstract.

Excerpts from the report: <https://www.saferemr.com/2020/11/GAO-5G-Report-2020.html>

HEALTH COUNCIL OF THE NETHERLANDS ADVISORY REPORT: 5G AND HEALTH

Committee of the Health Council of the Netherlands. Advisory report. 5G and health. Health Council of the Netherlands. 2020, Advisory report 2020/16e: 1-33.

Executive Summary

The latest standard for mobile telecommunications (5G) is faster and more reliable and can process more data at the same time. 5G was developed to cope with the increasing demand for mobile telecommunications and to make new applications possible such as self-driving cars and remote surgery. The advent of 5G networks is, however, resulting in societal concerns about the potential influence of 5G on health. That is why the House of Representatives of the Dutch parliament has asked the Health Council of the Netherlands to analyse what is known about this from a scientific perspective. The Council's Standing Committee on Electromagnetic Fields has looked into this issue.

Effects of 5G frequencies on health not yet fully examined

To a certain extent, 5G uses the same frequencies as previous generations of mobile telecommunication such as 3G and 4G. In addition, it will use new frequency bands. The rollout of 5G networks has only just begun. Therefore, there are no studies as yet into the health effects of (long-term) exposure to electromagnetic fields with the frequencies that are reserved for 5G. However, applications have been examined that use frequencies very close to the new 5G frequencies. These include 2G, 3G and 4G, as well as Wi-Fi and radar.

No actual health risks known

This report is a first step in the analysis of possible health effects of 5G frequencies. As yet, the committee is unable to answer the question of whether exposure to 5G frequencies actually poses risks to human health. There are two reasons for that. The first is that such a statement requires knowledge of the level of exposure that can cause health damage to humans. That requires a more detailed analysis of the scientific data than the committee was able to carry out. The World Health Organization (WHO) is currently performing such an analysis and it is anticipated that it will be completed in 2022. Secondly, it requires knowledge of what the actual exposure to radiofrequency electromagnetic fields will be after the introduction of 5G. That is not yet known, because the use of 5G, as stated earlier, has only partially started.

Relations between 5G frequencies and health damage not demonstrated but cannot be excluded for a number of conditions. Therefore, the committee has investigated whether there are indications that electromagnetic fields with the frequencies of 5G have the potential to harm health. It has reviewed whether relations are known between exposure to radiofrequency electromagnetic fields on the one hand and the occurrence of diseases and conditions on the other. According to the committee, it cannot be excluded that the incidence of cancer, reduced male fertility, poor pregnancy outcomes and birth defects could be associated with exposure to radiofrequency electromagnetic fields. However, the committee deems the relation between exposure and these and other diseases or conditions neither proven nor probable.

The committee has also examined the possible relation between exposure to radiofrequency electromagnetic fields and changes in biological processes. It is probable that changes in electrical activity in the brain are associated with exposure, but it is not known whether that is favourable or unfavourable in health terms. For the majority of other biological processes it has neither been demonstrated nor is it probable that changes in them are associated with exposure to radiofrequency electromagnetic fields, although this cannot be excluded. Only for changes in the immune system and hormone levels, no relation was found. There has been almost no research into the effects of exposure to frequencies around 26 GHz.

The committee's recommendations

The committee has made four recommendations to Parliament.

1. Because the lower frequency bands for 5G (up to 3.5 GHz) have already been used for telecommunications applications and Wi-Fi for years without resulting in any proven adverse health effects, the committee sees no reason to stop or restrict the use of these frequency bands. It does however recommend that the exposure should be monitored before, during and after the rollout of the 5G systems. This will show to what extent exposure to radiofrequency electromagnetic fields changes as a result of the introduction of 5G and any long-term health risks can then be estimated better. The WHO analysis can also be used in estimating the risks.

2. The committee recommends doing more research:

- epidemiological research into the relation between exposure to the 5G frequencies used and the incidence of cancer, reduced male fertility, poor pregnancy outcomes and birth defects. An ongoing international study into the use of mobile telephones, in which the Netherlands is participating, can play a role in this.
- experimental research into the health effects of exposure to electromagnetic fields in the 26 GHz frequency band.
- scenario studies to get a picture of the exposure of individuals as a result of wireless communications systems (3G, 4G and 5G).

3. The committee recommends not to use the 26 GHz frequency band for 5G for as long as the potential health risks have not been investigated.

4. Finally, the committee recommends using the latest guidelines from the International Commission on Non- Ionizing Radiation Protection (ICNIRP) as the basis for exposure policy in the Netherlands. Because it cannot be excluded that exposure under the latest ICNIRP standards also has the potential to affect health, the committee recommends to take a cautious approach and keep exposures as low as reasonably achievable.

<https://www.healthcouncil.nl/binaries/healthcouncil/documents/advisory-reports/2020/09/02/5g-and-health/Advisory-report-5G-and-health.pdf>

Note: One of the two Scientific Secretaries for the Health Council of the Netherlands is Eric van Rongen, former Chair and current Vice Chair of the ICNIRP.

ASSOCIATION BETWEEN MOBILE PHONE RADIATION EXPOSURE AND THE SECRETION OF MELATONIN AND CORTISOL, TWO MARKERS OF THE CIRCADIAN SYSTEM: A REVIEW

Brahim Selmaoui, Yvan Touitou. Association Between Mobile Phone Radiation Exposure and the Secretion of Melatonin and Cortisol, Two Markers of the Circadian System: A Review. Bioelectromagnetics. 2020 Nov 25. doi: 10.1002/bem.22310.

Abstract

The extremely important use of mobile phones in the world, at all ages of life, including children and adolescents, leads to significant exposure of these populations to electromagnetic waves of radiofrequency. The question, therefore, arises as to whether exposure to these radiofrequencies (RFs) could lead to deleterious effects on the body's biological systems and health. In the current article, we review the effects, in laboratory animals and humans, of exposure to RF on two hormones considered as endocrine markers: melatonin, a neurohormone produced by the pineal gland and cortisol, a glucocorticosteroid synthesized by the adrenal glands. These two hormones are also considered as markers of the circadian system. The literature search was performed using PubMed, Medline, Web of Sciences (ISI Web of Knowledge), Google Scholar, and EMF Portal.

From this review on RF effects on cortisol and melatonin, it appears that scientific papers in the literature are conflicting, showing effects, no effects, or inconclusive data. This implies

the need for additional research on higher numbers of subjects and with protocols perfectly controlled with follow-up studies to better determine whether the chronic effect of RF on the biological functioning and health of users exists (or not).

<https://pubmed.ncbi.nlm.nih.gov/33238059/>

ASSOCIATION BETWEEN ESTIMATED WHOLE-BRAIN RADIOFREQUENCY ELECTROMAGNETIC FIELDS DOSE AND COGNITIVE FUNCTION IN PREADOLESCENTS AND ADOLESCENTS

Alba Cabré-Riera, Luuk van Wel, Ilaria Liorni, Arno Thielens, Laura Ellen Birks, Livia Pierotti, Wout Joseph, Lúcia González-Safont, Jesús Ibarluzea, Amparo Ferrero, Anke Huss, Joe Wiart, Loreto Santa-Marina, Maties Torrent, Tanja Vrijkotte, Myles Capstick, Roel Vermeulen, Martine Vrijheid, Elisabeth Cardis, Martin Röösli, Mònica Guxens. Association between estimated whole-brain radiofrequency electromagnetic fields dose and cognitive function in preadolescents and adolescents. *Int J Hyg Environ Health*. 2020 Nov 19;231:113659. doi: 10.1016/j.ijheh.2020.113659.

Abstract

Objective: To investigate the association between estimated whole-brain radiofrequency electromagnetic fields (RF-EMF) dose, using an improved integrated RF-EMF exposure model, and cognitive function in preadolescents and adolescents.

Methods: Cross-sectional analysis in preadolescents aged 9-11 years and adolescents aged 17-18 years from the Dutch Amsterdam Born Children and their Development Study (n = 1664 preadolescents) and the Spanish INfancia y Medio Ambiente Project (n = 1288 preadolescents and n = 261 adolescents), two population-based birth cohort studies. Overall whole-brain RF-EMF doses (mJ/kg/day) were estimated for several RF-EMF sources together including mobile and Digital Enhanced Cordless Telecommunications phone calls (named phone calls), other mobile phone uses than calling, tablet use, laptop use (named screen activities), and far-field sources. We also estimated whole-brain RF-EMF doses in these three groups separately (i.e. phone calls, screen activities, and far-field) that lead to different patterns of RF-EMF exposure. We assessed non-verbal intelligence in the Dutch and Spanish preadolescents, information processing speed, attentional function, and cognitive flexibility in the Spanish preadolescents, and working memory and semantic fluency in the Spanish preadolescents and adolescents using validated neurocognitive tests.

Results: Estimated overall whole-brain RF-EMF dose was 90.1 mJ/kg/day (interquartile range (IQR) 42.7; 164.0) in the Dutch and Spanish preadolescents and 105.1 mJ/kg/day (IQR 51.0; 295.7) in the Spanish adolescents.

Higher overall estimated whole-brain RF-EMF doses from all RF-EMF sources together and from phone calls were associated with lower non-verbal intelligence score in the Dutch and Spanish preadolescents (-0.10 points, 95% CI -0.19; -0.02 per 100 mJ/kg/day increase in each exposure). However, none of the whole-brain RF-EMF doses was related to any other cognitive function outcome in the Spanish preadolescents or adolescents.

Conclusions: Our results suggest that higher brain exposure to RF-EMF is related to lower non-verbal intelligence but not to other cognitive function outcomes. Given the cross-

sectional nature of the study, the small effect sizes, and the unknown biological mechanisms, we cannot discard that our results are due to chance finding or reverse causality. Longitudinal studies on RF-EMF brain exposure and cognitive function are needed. <https://pubmed.ncbi.nlm.nih.gov/33221634/>

Conclusion - Adolescence is a cognitive demanding stage of life, and one of the most rapid phases of human development. Therefore, it is important to identify factors that could compromise brain development at this stage and permanently impair cognitive abilities. Our results suggest that overall estimated whole-brain RF-EMF dose and specific dose from phone calls were related to lower non-verbal intelligence in preadolescents. However, our findings also indicate that whole-brain RF-EMF doses were not related to information processing speed, attentional function, visual attention, and cognitive flexibility in preadolescents or to working memory and semantic fluency in both preadolescents and adolescents. Given the cross-sectional nature of the study, the small effect sizes, and the unknown biological mechanisms, we cannot discard that our results might be due to chance finding or reverse causality. Our findings open the field to future longitudinal studies to further investigate the association between brain exposure to RF-EMF and cognitive function.

RADIOFREQUENCY ELECTROMAGNETIC FIELDS FROM MOBILE COMMUNICATION: DESCRIPTION OF MODELED DOSE IN BRAIN REGIONS AND THE BODY IN EUROPEAN CHILDREN AND ADOLESCENTS

Laura Ellen Birks, Luuk Van Wel, Ilaria Liorni, Livia Pierotti, Mònica Guxens, Anke Huss, Milena Foerster, Myles Capstick, Marloes Eeftens, Hanan El Marroun, Marisa Estarlich, Mara Gallastegi, Llúcia González Safont, Wout Joseph, Loreto Santa-Marina, Arno Thielens, Maties Torrent, Tanja Vrijkotte, Joe Wiart, Martin Röögli, Elisabeth Cardis, Roel Vermeulen, Martine Vrijheid. Radiofrequency Electromagnetic Fields from Mobile Communication: Description of Modeled Dose in Brain Regions and the Body in European Children and Adolescents. Environ Res. 2020 Nov 24;110505. doi:10.1016/j.envres.2020.110505.

Highlights

- We modeled daily RF dose in the brain and body in European children and adolescents.
- Our modeling combined exposure to near-field and far-field RF sources.
- Adolescents (age 14-18) received more RF dose in the brain than children (age 8-12).
- Subjects received the highest RF dose in the temporal and frontal lobes of brain.
- Calling on 2G networks was the largest contributor to RF dose in the brain. Abstract

Background: Little is known about radiofrequency electromagnetic fields (RF) from mobile technology and resulting dose in young people. We describe modeled integrated RF dose in European children and adolescents combining own mobile device use and surrounding sources.

Methods: Using an integrated RF model, we estimated the daily RF dose in the brain (whole-brain, cerebellum, frontal lobe, midbrain, occipital lobe, parietal lobe, temporal lobes) and the whole-body in 8,358 children (ages 8-12) and adolescents (ages 14-18) from the Netherlands, Spain, and Switzerland during 2012-2016. The integrated model estimated RF dose from near-field sources (digital enhanced communication technology (DECT) phone,

mobile phone, tablet, and laptop) and far-field, surrounding, sources (mobile phone base stations via 3D-radiowave modeling or RF measurements).

Results: Adolescents were more frequent mobile phone users and experienced higher modeled RF doses in the whole-brain (median 330.4 mJ/kg/day) compared to children (median 81.8 mJ/kg/day). Children spent more time using tablets or laptops compared to adolescents, resulting in higher RF doses in the whole-body (median whole-body dose of 81.8 mJ/kg/day) compared to adolescents (41.9 mJ/kg/day). Among brain regions, temporal lobes received the highest RF dose (medians of 274.9 and 1,786.5 mJ/kg/day in children and adolescents, respectively) followed by the frontal lobe. In most children and adolescents, calling on 2G networks was the main contributor to RF dose in the whole-brain (medians of 31.1 and 273.7 mJ/kg/day, respectively).

Conclusion: This first large study of RF dose to the brain and body of children and adolescents, shows that mobile phone calls on 2G networks are the main determinants of brain dose, especially in temporal and frontal lobes, whereas whole-body doses were mostly determined by tablet and laptop use. The modeling of RF doses provides valuable input to epidemiological research and to potential risk management regarding RF exposure in young people.

<https://pubmed.ncbi.nlm.nih.gov/33245886>

EFFECTS OF DIFFERENT MOBILE PHONE UMTS SIGNALS ON DNA, APOPTOSIS AND OXIDATIVE STRESS IN HUMAN LYMPHOCYTES

Sachin Gulati, Pavol Kosik, Matus Durdik, Milan Skorvaga, Lukas Jakl, Eva Markova, Igor Belyaev. Effects of different mobile phone UMTS signals on DNA, apoptosis and oxidative stress in human lymphocytes. *Environ Pollut.* 2020 Dec;267:115632. doi: 10.1016/j.envpol.2020.115632.

Highlights

- Comparatively analyzed genotoxic effects of UMTS signals at different frequency.
- Significant role of UMTS carrier frequency (1977 MHz) in inducing DNA damage.
- No association of UMTS exposure with apoptosis, TP53 mutations and PFG induction.
- Prolonged exposure to microwave radiation may induce genotoxic effects. Abstract

Different scientific reports suggested a link between exposure to radiofrequency radiation (RF) from mobile communications and induction of reactive oxygen species (ROS) and DNA damage while other studies have not found such a link. However, the available studies are not directly comparable because they were performed at different parameters of exposure, including carrier frequency of RF signal, which was shown to be critical for appearance of the RF effects. For the first time, we comparatively analyzed genotoxic effects of UMTS signals at different frequency channels used by 3G mobile phones (1923, 1947.47, and 1977 MHz). Genotoxicity was examined in human lymphocytes exposed to RF for 1 h and 3 h using complimentary endpoints such as induction of ROS by imaging flow cytometry, DNA damage by alkaline comet assay, mutations in TP53 gene by RSM assay, preleukemic fusion genes (PFG) by RT-qPCR, and apoptosis by flow cytometry. No effects of RF exposure on ROS, apoptosis, PFG, and mutations in TP53 gene were revealed regardless of the UMTS frequency while inhibition of a bulk RNA expression was found. On the other hand, we found relatively

small but statistically significant induction of DNA damage in dependence on UMTS frequency channel with maximal effect at 1977.0 MHz. Our data support a notion that each specific signal used in mobile communication should be tested in specially designed experiments to rule out that prolonged exposure to RF from mobile communication would induce genotoxic effects and affect the health of the human population.

<https://pubmed.ncbi.nlm.nih.gov/33254645/>

COMPARING CHROMOSOME DAMAGE INDUCED BY MOBILE TELEPHONY RADIATION AND A HIGH CAFFEINE DOSE: EFFECT OF COMBINATION AND EXPOSURE DURATION

Dimitris J Panagopoulos. Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. *Gen Physiol Biophys*. 2020 Nov;39(6):531-544. doi: 10.4149/gpb_2020036.

Abstract

I recently reported induction of chromatid-type aberrations in human peripheral blood lymphocytes after a single 15 min exposure to universal mobile telecommunications system (UMTS) mobile telephony (MT) electromagnetic field (EMF) from a mobile phone. Lymphocytes from six healthy subjects were stimulated for mitosis, and exposed during the G2/M phase at 1 cm distance from the handset during an active phone call in "talk" mode. The same type of cells from the same subjects treated with a high caffeine dose (~ 290 times above the permissible single dose for an adult human) exhibited the same type of aberrations in a little smaller but comparable degree. The combination of this caffeine dose and the 15 min MT EMF exposure increased dramatically the number of aberrations in all subjects. The combined effect increased almost linearly with increasing duration of exposure to the MT EMF. Thus, MT EMF exposure ~ 136 times below the official limit (ICNIRP 2020) exerts a genotoxic action even greater than that of a caffeine dose ~ 290 times above the corresponding limit. Therefore, with a reasonable approximation, the limit for MT EMFs should be lowered by at least $\sim 4 \times 10^4$ times (136×290) for short-term exposures, and $\sim 4 \times 10^6$ times for long-term exposures. <https://pubmed.ncbi.nlm.nih.gov/33226362/>

EFFECT OF MOBILE PHONE USAGE ON COGNITIVE FUNCTIONS, SLEEP PATTERN, VISUOSPATIAL ABILITY IN PARKINSON'S PATIENTS; A POSSIBLE CORRELATION WITH ONSET OF CLINICAL SYMPTOMS

Dhruv Tuteja, Nayanatara Arun Kumar, D Shivananda Pai, K Kunal. Effect of mobile phone usage on cognitive functions, sleep pattern, visuospatial ability in Parkinson's patients; a possible correlation with onset of clinical symptoms. *J Basic Clin Physiol Pharmacol*. 2020 Nov 9;/j/jbcpp.ahead-of-print/jbcpp-2020-0190/jbcpp-2020- 0190.xml. doi: 10.1515/jbcpp-2020-0190.

Abstract

Objectives - The global increase in various neurological disorders is a serious problem to be concerned. This study mainly focused on the changes in cognitive impairment, sleep pattern, visuospatial ability in the Parkinson's disease (PD) and its possible association with the usage of smartphones durations.

Methods - Parkinson's patients (40-60 years) visiting neurology clinics were included in this study. Based on their age the grouping was designed as Group I (>60) and Group II (40-60 years). All the patients were evaluated for the various motor symptoms in the presence of a neurologist and graded accordingly. The non-motor symptoms included the analysis cognitive function and sleep patterns. The mobile phone usage time was also collected. The Hoehn and Yahr system was used as assessment tool for gradations of PD signs.

Results - Duration of mobile phone usage in the Parkinson's patients ranging from 45-60 year was more when compared to the patients aged more than 60 years. The usage of mobile phone did not show significant variation on severity of motor symptoms and cognitive functions. Increased incidence of sleep deprivation was observed in the PD patients aged 40-60 years. Increased usage of mobile phone has been inversely associated with the increased progression of the Parkinson's disease.

Conclusion - The present study pointed out the significant association of mobile phone usage with the early onset of Parkinsonism.

<https://pubmed.ncbi.nlm.nih.gov/33155995/>

THE ASSOCIATION OF SMART MOBILE PHONE USAGE WITH COGNITIVE FUNCTION IMPAIRMENT IN SAUDI ADULT POPULATION

Thamir M Al-Khlaiwi, Syed Shahid Habib, Sultan Ayoub Meo, Mohammed S Alqhtani, Abeer A Ogailan. The association of smart mobile phone usage with cognitive function impairment in Saudi adult population. Pak J Med Sci. Nov-Dec 2020;36(7):1628-1633. doi: 10.12669/pjms.36.7.2826.

Abstract

Background & Objectives: Excessive use of mobile phones has raised a great concern about adverse health effects on human health. The present study's aim was to investigate the association of the usage of smartphones with cognitive function impairment in the Saudi adult population.

Methods: The present cross-sectional study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Saudi Arabia during September 2019 to January 2020. A total of 251 Saudi adults who were using mobile phones were recruited, and knowledge, attitude and practices were assessed by interview using a predesigned proforma. The Montreal Cognitive Assessment (MOCA) tool was employed to assess the cognitive functions, comparison was made between daily mobile phone usage group and their correlated Montreal Cognitive Score (MOCA).

Results: The mean age for 251 Saudi adult participants was 32.43 ± 12.8 years. More than 80% of the participants used their mobile phone for more than two hours daily. About 61% of the participants were not aware of the side effect of the radiation generated from mobile phone. The participants showed a decrease in MOCA score with increased daily mobile phone usage (MOCA=26.8 for <1 hour daily usage, 26.1 for 1-2 hours, and 24.6 for >2 hours with $P <$

0.05). In addition, participants showed decreased MOCA score by keeping their mobile phone near their pillow while sleeping; MOCA=24.35 for near pillow groups and >25.5 for the groups that placed their mobile phone away from the pillow.

Conclusions: Excessive use of mobile phones can cause cognitive function impairment. Strict policies must be implemented to control the use of smartphones in order to minimize the effects on mobile phone radiation on cognition. The media has to be on the forefront in educating the public about the proper usage of mobile phones.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7674882/>

METABOLOMICS AND PSYCHOLOGICAL FEATURES IN FIBROMYALGIA AND ELECTROMAGNETIC SENSITIVITY

Cristina Piras, Stella Conte, Monica Pibiri, Giacomo Rao, Sandro Muntoni, Vera Piera Leoni, Gabriele Finco, Luigi Atzori. Metabolomics and psychological features in fibromyalgia and electromagnetic sensitivity. Sci Rep. 2020 Nov 24;10(1):20418. doi: 10.1038/s41598-020-76876-8.

Abstract

Fibromyalgia (FM) as Fibromyalgia and Electromagnetic Sensitivity (IEI-EMF) are a chronic and systemic syndrome. The main symptom is represented by strong and widespread pain in the musculoskeletal system. The exact causes that lead to the development of FM and IEI-EMF are still unknown. Interestingly, the proximity to electrical and electromagnetic devices seems to trigger and/or amplify the symptoms. We investigated the blood plasma metabolome in IEI-EMF and healthy subjects using ¹H NMR spectroscopy coupled with multivariate statistical analysis. All the individuals were subjected to tests for the evaluation of psychological and physical features. No significant differences between IEI-EMF and controls relative to personality aspects, Locus of Control, and anxiety were found. Multivariate statistical analysis on the metabolites identified by NMR analysis allowed the identification of a distinct metabolic profile between IEI-EMF and healthy subjects. IEI-EMF were characterized by higher levels of glycine and pyroglutamate, and lower levels of 2-hydroxyisocaproate, choline, glutamine, and isoleucine compared to healthy subjects. These metabolites are involved in several metabolic pathways mainly related to oxidative stress defense, pain mechanisms, and muscle metabolism. The results here obtained highlight possible physiopathological mechanisms in IEI-EMF patients to be better defined.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7686375/>

THE USE OF A BED WITH AN INSULATING SYSTEM OF ELECTROMAGNETIC FIELDS IMPROVES IMMUNE FUNCTION, REDOX AND INFLAMMATORY STATES, AND DECREASE THE RATE OF AGING

E Díaz-Del Cerro, C Vida, I Martínez de Toda, J Félix, M De la Fuente. The use of a bed with an insulating system of electromagnetic fields improves immune function, redox and inflammatory states, and decrease the rate of aging. *Environ Health*. 2020 Nov 23;19(1):118. doi: 10.1186/s12940-020-00674-y.

Abstract

Background: The immune system, as a homeostatic system, is an excellent marker of health and has also been proposed as an indicator of the rate of aging. The base of the age-related changes in the immune system, "immunosenescence", is oxidative-inflammatory stress. Studies have shown that long-term exposure to electromagnetic fields (EMFs) produced by technology causes inhibitory effects on the immune response and increases oxidation. The aim of the present study was to investigate the effects of resting on an EMF-insulated system on several immune functions, the oxidative-inflammatory state and subsequently the rate of aging (biological age).

Methods: Several immune functions, in peripheral blood neutrophils and mononuclear cells, of 31 volunteers were analyzed before and after 2 months of using a bed with the patented HOGO system, which insulated participants against EMFs. Several oxidative and inflammatory parameters, in whole blood cells, were also studied. The biological age was calculated using a mathematical formula, which was based on several immune function parameters. A placebo group of 11 people using beds without that property were used as a control.

Results: The results showed a significant improvement of immune functions and antioxidant and anti-inflammatory defenses after using the HOGO system for 2 months. In addition, a decrease in oxidants and pro-inflammatory compounds, a lowering of oxidative damage in lipids and in DNA as well as a reduction of calculated biological age was also observed. The placebo group did not show any changes.

Conclusions: In conclusion, 2 months of resting on a bed insulated from EMFs demonstrates improvement in immune function, oxidative-inflammatory state and biological age.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7685570/>

MODELLING OF TOTAL EXPOSURE IN HYPOTHETICAL 5G MOBILE NETWORKS FOR VARIED TOPOLOGIES AND USER SCENARIOS

Sven Kuehn, Serge Pfeifer, Beyhan Kochali, Niels Kuster. Modelling of Total Exposure in Hypothetical 5G Mobile Networks for Varied Topologies and User Scenarios. Final Report of Project CRR-816. A report on behalf of the Swiss Federal Office for the Environment (FOEN). IT'IS Foundation, Zurich. 24 June 2019.

Executive Summary

In January 2019, the Swiss Federal Office for the Environment (FOEN) mandated the IT'IS Foundation to evaluate the total human exposure in hypothetical 5G mobile networks for varied topologies and user scenarios to identify factors that would minimize the total exposure of the population. In this study, total exposure is defined as the combined exposure from network base stations, the user's own device, as well as bystanders' mobile devices.

The influence of various factors on total exposure in mobile communication networks (as defined above) was modeled and analyzed with the help of the Monte Carlo simulation technique. Total exposure is described as the local peak specific absorption rate (SAR) spatially averaged over any 10 g of tissue mass (psaSAR10g) averaged over a period of 6 minutes. The unit psaSAR10g was chosen because it defines the governing basic restriction for wireless exposure as the whole-body average SAR limits (wbaSAR) are intrinsically met if the limits of local exposure are satisfied. The averaging duration of 6 minutes constitutes the internationally accepted averaging time to prevent thermal hazards at frequencies below 6 GHz as instant values have little justification. However, it should be noted that some regulators define shorter averaging time periods, e.g., the US Federal Communications Commission (FCC) of 100 s.

In a first step, we analyzed the tissue-specific exposure as a function of frequency. The preliminary dosimetric study showed that exposure of the human brain to the 3.6 GHz band, that has been recently added to the Swiss mobile communication frequencies, is reduced by a factor of >6 for the tissue averaged SAR when compared to mobile network operation at <1 GHz. This reduction is due to the smaller penetration depth at higher frequencies. This conclusion, however, does not apply to exposed tissues close to the surface or skin (eyes, testicles, etc.) when the peak SAR in this tissue is evaluated. The peak SAR in the grey matter remains in approximately the same order of magnitude (3 dB) over all frequencies but the area of high exposure is reduced at 3.6 GHz.

In a second step, we used data measured in 4G systems and analyzed the latest mobile network standards to extrapolate the exposures for various 5G network scenarios. These measured data were also used to extrapolate the exposure to the future development of data usage in 5G networks.

Specifically, we analyzed the effect on the total exposure of (i) the network topology by varying the cell size and amount of indoor coverage in the network, as well as the usage of (ii) an individual's own device, and (iii) devices of close bystanders.

The results – based on simulations of more than 200 different exposure scenarios – reveal that, for all user types, except for non-users (including passive mobile phone users and users

dominantly using downlink data traffic, e.g., video streaming), total exposure is dominated by the person's own mobile device. Compared to non-users, the exposure is increased (i) for light users (with 100 MByte uplink data per day) by 6 – 10 dB (or a factor of 4 to 10), (ii) for moderate users (with 1 GByte uplink data per day) by 13 – 25 dB (or a factor of 20 to >300), and (iii) for heavy users by 15 – 40 dB (or a factor of 30 to >10000). Further, the results show that peak exposure of non-users is not defined by exposure to base stations but by exposure to mobile devices of close bystanders in urban areas resulting in 6 dB (or a factor of 4) higher exposure than from a nearby base station antenna. While a reduction of the mobile cell size leads to a reduction in total exposure by a factor of 2 to 10 for people actively using their mobile devices, this might also lead to a small increase by a factor of 1.6 in total exposure of non-users due to the generally increased incident signal levels from the surrounding base stations.

Similarly, the exposure of active users can be reduced by a factor of 4 to 600 by increasing the indoor network coverage. Yet, in line with the results for the mobile cell sizes, increased indoor coverage will also lead to increased exposure of non-users by a factor of 2 to 10. This increase, however, starts at a level 1000 times lower than the typical total exposure of active users.

The results of this study show that the personal mobile device is the dominant exposure source for active mobile network users. Besides a person's own usage behavior, total exposure is also closely linked to the network infrastructure. Generally speaking, a network with a lower path loss, i.e., smaller cells and additional indoor coverage, helps to reduce total exposure. The exposure per transmitted bit is reduced by a factor of <3 by the increased spectral efficiency of the 5G technology, and the reduced penetration depth associated with the new bands at 3.5 – 3.8 GHz.

The results presented above are limited due to the network data that has been used and the definition of total exposure as stated in this report. Furthermore, it only considers time-averaged (6 min) and not instant exposures. This study does not consider (i) the effect of upcoming massive MIMO systems in 5G networks, (ii) alternative data transmission links, for instance the use of Wireless Local Area Network (WLAN), and (iii) millimeter wave frequencies in 5G mobile networks.

Conclusions

The results of this study show that the absorption of energy by the human brain, resulting from exposure to the 3.6 GHz band newly added to the Swiss mobile communication frequencies, is reduced by a factor >6 for the tissue averaged SAR when compared to mobile networks operating at <1 GHz, and by a factor of >2 when compared to the frequency bands at 1.8 – 2GHz. For deep brain regions, the reduction is much larger.

The reduced exposure for these regions is due to lower penetration depths at higher frequencies. Close to the surface (eyes, testicles, etc.) the exposure can be higher. At the most exposed surface of the grey matter, the values remain approximately 3 dB over all frequencies whereas the area of high exposure is reduced.

More than 200 Monte Carlo simulated exposure scenarios have been analyzed to evaluate total human exposure in 5G Networks for different topologies and user scenarios. The results show that for all users (except non-users), the total exposure is dominated by a person's own mobile device. Compared to a non-user, the exposure is increased for a light user (with 100 MByte uplink data per day) by 6 – 10 dB (or by a factor 4 to 10), for a moderate user (with 1 GByte uplink data per day) by 13 – 25 dB (or by a factor of 20 to >300), and for a heavy user by 25 – 40 dB (or a factor of 300 to >10000). The peak exposure of non-users is further not defined by exposure to surrounding base stations but by mobile devices of close bystanders in urban areas, resulting in 6 dB (or a factor of 4) higher exposure than from a nearby base station antenna.

Reducing the diameter of the mobile cell leads to a decreased overall exposure by a factor of 2 to 10 for people who actively use their mobile devices. At the same time, the reduction in cell size might lead to a small increase by a factor <2 in exposure for non-users. The exposure of active users can be reduced by factors ranging from 4 to 600 by increasing indoor network coverage which, in turn, will be linked to increased exposure of non-users by a factor of 2 to 10. However, such an increase is by a factor 1000 lower than the typical exposure of active users. The results of this study are limited due to the network data that has been used and the definition of total exposure as stated earlier in this report. This study does not consider (i) the effect of upcoming massive MIMO and multi-user MIMO systems in 5G networks, (ii) alternative data transmission links – for instance the use of Wireless Local Area Network (WLAN) and (iii) millimeter wave frequencies in 5G mobile networks.

In summary, the results of this study show that the user's own mobile device is the dominant source of exposure for the population of active mobile network users. Besides personal usage patterns, total exposure is also closely linked to the network infrastructure. Generally speaking, a network that decreases the path loss by means of smaller cells and additional indoor coverage will help to reduce the total exposure of the population.

<https://www.bafu.admin.ch/dam/bafu/en/dokumente/elektrosmog/externe-studienberichte/modelling-of-total-exposure-in-hypothetical-5g-mobile-networks-for-varied-topologies-and-user-scenarios.pdf.download.pdf/Modelling%20of%20Total%20Exposure%20in%20Hypothetical%205G%20Networks%20-%20Schlussbericht.pdf>

RADIOFREQUENCY EXPOSURE OF PEOPLE LIVING NEAR MOBILE-PHONE BASE STATIONS IN FRANCE

Pascal De Giudici, Jean-Christian Genier, Sylvie Martin, Jean-François Doré, Pierre Ducimetière, Anne-Sophie Evrard, Thierry Letertre, Claire Ségala. Radiofrequency exposure of people living near mobile-phone base stations in France. Environmental Research. Available online 19 November 2020, 110500. <https://doi.org/10.1016/j.envres.2020.110500>.

Highlights

- Mobile-phone base stations antennas are the dominant source of exposure to electromagnetic fields in surrounding housing.
- Indoor exposure was influenced by the position of the windows with respect to the antenna and the floor of the building.
- Personal electric field measurements showed higher values during trips than at home.

- Personal electric field measurements were higher during the day but not different between working days and weekends.
- Exposure quantified by spot and personal measurements was strongly correlated.

Abstract

In response to the demand from a growing number of people concerned about the possible impact of RF-EMF on health, the French National Frequency Agency (ANFR) has published a standardized protocol for in-situ measurements of radiofrequency electromagnetic fields (RF-EMF). This protocol was based on the search for the point of highest field strength and the use of spot measurement.

In the framework of an epidemiological study, such spot measurements were implemented in the homes of 354 participants located in urban areas within 250 m of a mobile-phone base station (MPBS) and in the main beam direction of the antenna. Among the participants, more than half accepted to be enrolled in a longer-term study, among whom 152 were equipped with a personal exposure meter (PEM) for 48 h and 40 for seven continuous days. Both spot and PEM measurements quantified downlink field strengths, i.e. FM, TV3-4-5, TETRA I-II-III, 2 GHz–5GHz Wi-Fi, WiMax, GSM900, GSM1800, UMTS900, UMTS 2100, LTE800, LTE1800, and LTE2600.

Spot measurements showed a mean/median field strength of 0.58/0.44 V/m for total RF-EMF and 0.43/0.27 V/m from the MPBS. RF-EMF from the MPBS was the dominant source of exposure in 64% of households.

Exposure to RF-EMF was influenced by the position of the windows with respect to the MPBS, in particular line- of-site visibility, the distance of the antenna and the floor of the apartment. The PEM surveys showed the measured exposure to be higher during outings than at home and during the day than at night, but there was no difference between the weekends and working days. There was a strong correlation between exposure quantified by both spot and PEM measurements, although spot measures were approximately three times higher than those by PEMs.

This study is the first to assess exposure to RF-EMF of people living near a MPBS in urban areas in France. These preliminary results suggest the value of using spot measurements to estimate the impact of the evolution of the mobile-phone network and technology on the exposure of populations to RF-EMF. The low levels of RF-RMF expressed as mean values do not necessarily rule out possible health effects of this exposure.

Open access paper: <https://www.sciencedirect.com/science/article/pii/S0013935120313979>

ASSESSING THE COMPLIANCE OF ELECTROMAGNETIC FIELDS RADIATED BY BASE STATIONS AND WIFI ACCESS POINTS WITH INTERNATIONAL GUIDELINES ON UNIVERSITY CAMPUS

Sajedeh Keshmiri, Neda Gholampour, Vahid Mohtashami. Assessing The Compliance Of Electromagnetic Fields Radiated by Base Stations And wifi Access Points With International Guidelines On University Campus. *Radiat Prot Dosimetry*. 2020 Nov 24; ncaa183. doi: 10.1093/rpd/ncaa183.

Abstract

This paper presents a series of electromagnetic field measurements performed on the campus of Ferdowsi University of Mashhad in order to assess the compliance of radiation levels of cellular base stations and WiFi access points with international guidelines. A calibrated, broadband and isotropic probe is used and recommendations of International Telecommunication Union (ITU) are followed up throughout measurements. More than 300 outdoor and indoor locations have been systematically chosen for measurements. The recorded data are post-processed and compared with the guideline of International Commission on Non-Ionizing Radiation Protection (ICNIRP). Measured power densities of WiFi access points are low and do not exceed 1% of the level allowed by ICNIRP. For cellular base stations, measured power density is usually low outdoors, but reaches up to 16% of the allowed radiation level in publicly accessible indoor locations. Comprehensive exposure assessment, as recommended by ITU, has been performed to estimate the maximum possible radiation of one indoor base station. It is concluded that precautionary actions have to be taken by university authorities to limit the presence of students in close proximity to specific indoor antennas. Moreover, comprehensive exposure assessment is more likely necessary for indoor base stations whereas such assessment is not usually required outdoors.

<https://pubmed.ncbi.nlm.nih.gov/33230555/>

RADIOFREQUENCY FIELDS AND CALCIUM MOVEMENTS INTO AND OUT OF CELLS

Andrew Wood, Ken Karipidis. Radiofrequency Fields and Calcium Movements Into and Out of Cells. *Radiat Res*. 2020 Nov 18. doi: 10.1667/RADE-20-00101.1.

Abstract

The recent rollout of 5G telecommunications systems has spawned a renewed call to re-examine the possibility of so-called "non-thermal" harmful effects of radiofrequency (RF) radiation. The possibility of calcium being affected by low-level RF has been the subject of research for nearly 50 years and there have been recent suggestions that voltage-gated calcium channels (VGCCs) are "extraordinarily sensitive" to ambient RF fields.

This article examines the feasibility of particularly modulated RF coupling to gating mechanisms in VGCCs and also reviews studies from the literature from the last 50 years for consistency of outcome. We conclude that the currents induced by fields at the ICNIRP guideline limits are many orders of magnitude below those needed to affect gating, and there would need to be a biological mechanism for detection and rectification of the extremely-low-frequency (ELF) modulations, which has not been demonstrated. Overall, experimental studies have not validated that RF affects Ca²⁺ transport into or out of cells.

<https://pubmed.ncbi.nlm.nih.gov/33206197/>

POSSIBLE EFFECTS OF DIFFERENT DOSES OF 2.1 GHZ ELECTROMAGNETIC RADIATION ON LEARNING, AND HIPPOCAMPAL LEVELS OF CHOLINERGIC BIOMARKERS IN WISTAR RATS

Çiğdem Gökçek-Saraç, Güven Akçay, Serdar Karakurt, Kayhan Ateş, Şükrü Özen, Narin Derin. Possible effects of different doses of 2.1 GHz electromagnetic radiation on learning, and hippocampal levels of cholinergic biomarkers in Wistar rats. *Electromagn Biol Med.* 2020 Dec 1;1-12. doi: 10.1080/15368378.2020.1851251.

Abstract

The present study evaluated whether short-term exposure to different doses of 2.1 GHz radiofrequency electromagnetic radiation (RF-EMR) has different effects on rats' behaviour and hippocampal levels of central cholinergic biomarkers. Animals were divided into three equal groups namely; group 1 was sham-exposed group, group 2-3 were exposed to 45 V/m and 65 V/m doses of 2.1 GHz frequency for 1 week respectively.

Numerical dosimetry simulations were carried out. Object location and Y-maze were used as behavioural tasks. The protein and mRNA expression levels of AChE, ChAT, and VACHT, in the hippocampus were tested using Western Blotting and Real-Time PCR. The impairment performance of rats subjected to 65 V/m dose of 2.1 GHz RF-EMR in both object location and Y-maze tasks was observed. The hippocampal levels of AChE, ChAT, and VACHT, were significantly lower in rats exposed to 65 V/m dose of 2.1 GHz RF-EMR than others. The stronger effect of "65 V/m" dose on both rat's hippocampal-dependent behavioural performances and hippocampal levels of cholinergic biomarkers may be due to the stronger effect of "65 V/m" dose where rats' snouts were located at the nearest distance from the monopole antenna. Furthermore, the simulated SAR values were high for 65 V/m electric-field strengths. For the first time, we report the potential dose-dependent effects of short-term exposure to 2.1 GHz radiation on rat's behavioural performances as well as hippocampal levels of cholinergic biomarkers. Further studies are needed to understand the mechanisms by which RF-EMR influences the function of the central cholinergic system in the brain.

<https://pubmed.ncbi.nlm.nih.gov/33259237/>

MORPHOLOGICAL CHANGES IN THE VERTEBRAE AND CENTRAL CANAL OF RAT PUPS BORN AFTER EXPOSURE TO THE ELECTROMAGNETIC FIELD OF PREGNANT RATS

Ayşe İkinci Keleş. Morphological changes in the vertebrae and central canal of rat pups born after exposure to the electromagnetic field of pregnant rats. *Acta Histochem.* 2020 Nov 12;122(8):151652. doi: 10.1016/j.acthis.2020.151652.

Abstract

Several studies have investigated the effects of the electromagnetic field (EMF) on the central nervous system. However, we encountered no studies of the effects of EMF applied in the prenatal period on the offspring vertebrae. The aim of this study is to investigate the effect of a 900 megahertz (MHz) EMF applied to rat dams in the prenatal period on the vertebrae of rat pups. Female Sprague Dawley rats weighing 180-250 g were used in the experiment. Rats identified as pregnant were divided into two groups, control (n = 3) and EMF (n = 3). No EMF was applied to the control group pregnant rats. EMF was applied to the EMF group rats for 1 h daily on an equal and standard basis on prenatal days 13-21. All newborn rat pups were

divided into pup control (n = 6) (PC) and pup EMF (n = 6) (PEMF) groups, and no treatment was performed on either. All animals were decapitated on day 32, and the spinal cord in the upper thoracic region was harvested. Vertebral tissues were subjected to routine histological procedures. Histopathological examination revealed that PEMF group vertebral cartilage had been converted into bone tissue. Comparison of central canal diameter and area values between the PEMF group and the PC group revealed statistically significant increases in the PEMF group ($p = 0.000$ and $p = 0.001$, respectively). Statistical analysis revealed no significant difference in mean body weights between the two groups ($p > 0.530$). Based on these findings, we think that 900 MHz EMF applied in the prenatal period affects the development of the vertebrae. This effect causes pathological changes in the rat pup vertebrae. These findings now raise the question of whether EMF also has an impact on neurological and neurosurgical diseases involving the vertebrae.

<https://pubmed.ncbi.nlm.nih.gov/33190055/>

LONG-TERM 1800MHZ ELECTROMAGNETIC RADIATION DID NOT INDUCE BALB/C-3T3 CELLS MALIGNANT TRANSFORMATION

Zhen Ding, Xiaoyong Xiang, Jintao Li, Shuicai Wu. Long-term 1800MHz electromagnetic radiation did not induce Balb/c-3T3 cells malignant transformation. *Electromagn Biol Med*. 2020 Nov 19;1-10. doi: 10.1080/15368378.2020.1846194.

Abstract

There is an increased public concern about potential health hazards of exposure to electromagnetic radiation (EMR). To declare the carcinogenic effects of 1800 MHz EMR. In this study, Balb/c-3T3 cells were exposed to 1800 MHz EMR for 80 days. The cells were harvested for cell proliferation detection, cell cycle assay, plate clone, and soft agar formation assay, transwell assay, and mRNA microarray detection. 1800 MHz EMR promoted Balb/c-3T3 proliferation. No clones were observed in both plate clone and soft agar clone formation assay. The percentage of cells in S phase in Balb/c-3T3 cells of 80d Expo was obviously higher than the percentage in 80d Sham cells. 80d Expo Balb/c-3T3 cells had stronger migration ability than Sham cells. The mRNA microarray results indicated that cell cycle, cell division, and DNA replication were the main biological processes the significant genes enriched, with higher expression of RPs and Mcms. 1800 MHz EMR promoted Balb/c-3T3 cells proliferation and migration. The mRNA microarray results indicated that cell cycle, cell division, and DNA replication were the main biological processes the significant genes enriched.

<https://pubmed.ncbi.nlm.nih.gov/33211539/>

EFFECT OF INTERMITTENT ELF MF (EXTREMELY LOW FREQUENCY MAGNETIC FIELDS) ON UMBILICAL CORD BLOOD LYMPHOCYTES

Lucián Zastko, Leonardo Makinistian, Andrea Moravčíková, Ján Jakuš, Igor Belyaev. Effect of Intermittent ELF MFon Umbilical Cord Blood Lymphocytes. *Bioelectromagnetics*. 2020 Nov 15. doi: 10.1002/bem.22302.

No abstract

<https://pubmed.ncbi.nlm.nih.gov/33190314/>

EXPOSURE TO EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS IN LOW- AND MIDDLE-INCOME COUNTRIES: AN OVERVIEW

Dan Baaken, Daniel Wollschläger, Theodoros Samaras, Joachim Schüz , Isabelle Deltour. Exposure To Extremely Low-Frequency Magnetic Fields In Low- And Middle-Income Countries: An Overview. Pierdomenico, Mariateresa Mancuso, Carmela Marino, Barbara Benassi. Exposure of the SH-SY5Y Human Neuroblastoma Cells to 50-Hz Magnetic Field: Comparison Between Two-Dimensional (2D) and Three- Dimensional (3D) In Vitro Cultures. Mol Neurobiol. 2020 Nov 24. doi: 10.1007/s12035-020-02192-x.

Abstract

We here characterize the response to the extremely low-frequency (ELF) magnetic field (MF, 50 Hz, 1 mT) of SH- SY5Y human neuroblastoma cells, cultured in a three-dimensional (3D) Alvetex® scaffold compared to conventional two-dimensional (2D) monolayers. We proved that the growing phenotype of proliferating SH-SY5Y cells is not affected by the culturing conditions, as morphology, cell cycle distribution, proliferation/differentiation gene expression of 3D-cultures overlap what reported in 2D plates. In response to 72-h exposure to 50-Hz MF, we demonstrated that no proliferation change and apoptosis activation occur in both 2D and 3D cultures. Consistently, no modulation of Ki67, MYCN, CCDN1, and Nestin, of invasiveness and neo-angiogenesis-controlling genes (HIF-1 α , VEGF, and PDGF) and of microRNA epigenetic signature (miR-21-5p, miR-222-3p and miR-133b) is driven by ELF exposure. Conversely, intracellular glutathione content and SOD1 expression are exclusively impaired in 3D-culture cells in response to the MF, whereas no change of such redox modulators is observed in SH-SY5Y cells if grown on 2D monolayers. Moreover, ELF-MF synergizes with the differentiating agents to stimulate neuroblastoma differentiation into a dopaminergic (DA) phenotype in the 3D- scaffold culture only, as growth arrest and induction of p21, TH, DAT, and GAP43 are reported in ELF-exposed SH-SY5Y cells exclusively if grown on 3D scaffolds. As overall, our findings prove that 3D culture is a more reliable experimental model for studying SH-SY5Y response to ELF-MF if compared to 2D conventional monolayer, and put the bases for promoting 3D systems in future studies addressing the interaction between electromagnetic fields and biological systems.

<https://pubmed.ncbi.nlm.nih.gov/33230715/>

PHYSIOLOGICAL CA²⁺ TRANSIENTS VERSUS PATHOLOGICAL STEADY-STATE CA²⁺ ELEVATION, WHO FLIPS THE ROS COIN IN SKELETAL MUSCLE MITOCHONDRIA

Ang Li, Jianxun Yi, Xuejun Li, Jingsong Zhou. Physiological Ca²⁺ Transients Versus Pathological Steady-State Ca²⁺ Elevation, Who Flips the ROS Coin in Skeletal Muscle Mitochondria. Front Physiol. 2020 Oct 22;11:595800. doi: 10.3389/fphys.2020.595800.

Abstract

Mitochondria are both the primary provider of ATP and the pivotal regulator of cell death, which are essential for physiological muscle activities. Ca²⁺ plays a multifaceted role in mitochondrial function. During muscle contraction, Ca²⁺ influx into mitochondria activates multiple enzymes related to tricarboxylic acid (TCA) cycle and oxidative phosphorylation, resulting in increased ATP synthesis to meet the energy demand.

Pathophysiological conditions such as skeletal muscle denervation or unloading also lead to elevated Ca^{2+} levels inside mitochondria. However, the outcomes of this steady-state elevation of mitochondrial Ca^{2+} level include exacerbated reactive oxygen species (ROS) generation, sensitized opening of mitochondrial permeability transition pore (mPTP), induction of programmed cell death, and ultimately muscle atrophy. Previously, both acute and long-term endurance exercises have been reported to activate certain signaling pathways to counteract ROS production. Meanwhile, electrical stimulation is known to help prevent apoptosis and alleviate muscle atrophy in denervated animal models and patients with motor impairment. There are various mechanistic studies that focus on the excitation-transcription coupling framework to understand the beneficial role of exercise and electrical stimulation. Interestingly, a recent study has revealed an unexpected role of rapid mitochondrial Ca^{2+} transients in keeping mPTP at a closed state with reduced mitochondrial ROS production.

This discovery motivated us to contribute this review article to inspire further discussion about the potential mechanisms underlying differential outcomes of physiological mitochondrial Ca^{2+} transients and pathological mitochondrial Ca^{2+} elevation in skeletal muscle ROS production.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7642813>

CELLULAR PHONE USE AND RISK OF TUMORS: SYSTEMATIC REVIEW AND META-ANALYSIS

Yoon-Jung Choi⁺, Joel M. Moskowitz⁺, Seung-Kwon Myung, Yi-Ryoung Lee, Yun-Chul Hong. Cellular Phone Use and Risk of Tumors: Systematic Review and Meta-Analysis. International Journal of Environmental Research and Public Health. 2020, 17(21), 8079; <https://doi.org/10.3390/ijerph17218079>

Abstract

We investigated whether cellular phone use was associated with increased risk of tumors using a meta-analysis of case-control studies. PubMed and EMBASE were searched from inception to July 2018. The primary outcome was the risk of tumors by cellular phone use, which was measured by pooling each odds ratio (OR) and its 95% confidence interval (CI). In a meta-analysis of 46 case-control studies, compared with never or rarely having used a cellular phone, regular use was not associated with tumor risk in the random-effects meta-analysis. However, in the subgroup meta-analysis by research group, there was a statistically significant positive association (harmful effect) in the Hardell et al. studies (OR, 1.15—95% CI, 1.00 to 1.33— $n = 10$), a statistically significant negative association (beneficial effect) in the INTERPHONE-related studies (case-control studies from 13 countries coordinated by the International Agency for Research on Cancer (IARC); (OR, 0.81—95% CI, 0.75 to 0.89— $n = 9$), and no statistically significant association in other research groups' studies. Further, cellular phone use with cumulative call time more than 1000 hours statistically significantly increased the risk of tumors. This comprehensive meta-analysis of case-control studies found evidence that linked cellular phone use to increased tumor risk. ⁺Contributed equally to this study as the first author.

Excerpts

3.5. Exposure–Response Relationship Between Use of Cellular Phones and Risk of Tumors
Table 3 shows an exposure-response relationship between cellular phone use and tumor risk. In the subgroup meta-analysis by time since first use or latency, overall the risk of tumors by cellular phone use non-significantly increased from an OR of 0.97 to 1.29 as latency increased from less than 5 years to 10 or more years. This finding was observed in each subgroup meta-analysis by research group. Especially, statistically significant increased tumor risk was observed for latency of 10 or more years in the Hardell studies (OR, 1.62; 1.03 to 2.57; $n = 5$; $I^2 = 39.9\%$). Similarly, the use of cellular phones non-significantly increased the risk of tumors as the cumulative or lifetime use in years and the cumulative number of calls increased in all studies and in each study group. Remarkably, in the subgroup meta-analysis of all studies by cumulative call time, cellular phone use greater than 1000 hours statistically significantly increased the risk of tumors (OR, 1.60; 1.12 to 2.30; $n = 8$; $I^2 = 74.5\%$). Interestingly, the use of cellular phones overall and in the Hardell studies (OR, 3.65; 1.69 to 7.85; $n = 2$, especially in the Hardell studies) non significantly increased the risk of tumors with cumulative call time of 300– 1000 h and more than 1000 h, while it decreased the risk of tumors in most subgroup meta-analyses of the INTERPHONE studies.

Conclusions

In sum, the updated comprehensive meta-analysis of case-control studies found significant evidence linking cellular phone use to increased tumor risk, especially among cell phone users with cumulative cell phone use of 1000 or more hours in their lifetime (which corresponds to about 17 min per day over 10 years), and especially among studies that employed high quality methods. Further quality prospective studies providing higher level of evidence than case-control studies are warranted to confirm our findings.

Open access paper and supplemental material: <http://bit.ly/cellphonetumor>

CENTRAL NERVOUS SYSTEM LYMPHOMA AND RADIOFREQUENCY RADIATION – A CASE REPORT AND INCIDENCE DATA IN THE SWEDISH CANCER REGISTER ON NON-HODGKIN LYMPHOMA

Lennart Hardell, Michael Carlberg, Tarmo Koppel, Marie Nordström, Lena K.Hedendahl.
Central nervous system lymphoma and radiofrequency radiation – A case report and incidence data in the Swedish Cancer Register on non-Hodgkin lymphoma. Medical Hypotheses.

Volume 144, November 2020, 110052. <https://doi.org/10.1016/j.mehy.2020.110052>.

Abstract

Earlier animal studies have provided evidence that non-Hodgkin lymphoma (NHL) may be caused by exposure to radiofrequency (RF) radiation. This was recently confirmed by the U.S. National Toxicology (NTP) study that showed an increased incidence of malignant lymphoma in female mice exposed to the GSM modulated or the CDMA modulated cell phone RF radiation. Primary central nervous system lymphoma (PCNSL) is a rare malignancy in humans with poor prognosis. An increasing incidence has been reported in recent years. Based on a case-report we present the hypothesis that use of the hand-held mobile phone may be a risk factor for PCNSL. The increasing incidence of non-Hodgkin lymphoma in Sweden is discussed

in relation to etiologic factors.

Conclusions

No etiologic factor has clearly been defined to explain the increasing incidence of brain lymphoma. However, it has occurred during a time period when RF radiation to the brain from wireless phones has increased. Based on human epidemiology studies and laboratory studies there is evidence that malignant lymphoma may be related to exposure to RF radiation. This case-report stimulates the hypothesis that the increasing incidence of PCNSL may be caused by exposure to RF fields.

The effects from RF radiation through DNA damage and decreased DNA repair, by oxidative stress in the cells and increase in pro-inflammatory cytokines are some possible pathways that may influence the immune system and the lymphocytes. RF radiation from a mobile phone held near the right ear during 4 h per working day during 15 years may have had an impact on the development of the PCNSL in this female case report.

Open access paper: <https://www.sciencedirect.com/science/article/pii/S0306987720309567>

HUMAN ELECTROMAGNETIC FIELD EXPOSURE IN 5G AT 28 GHZ

Seungmo Kim; Imtiaz Nasim. Human Electromagnetic Field Exposure in 5G at 28 GHz. IEEE Consumer Electronics Magazine. 9(6):41-48. Nov. 1 2020. DOI: 10.1109/MCE.2019.2956223.

Abstract

The fifth-generation wireless (5G) has already started showing its capability to achieve extremely fast data transfer, which makes itself considered to be a promising mobile technology. However, concerns have been raised on adverse health impacts that human users can experience in a 5G system by being exposed to electromagnetic fields (EMFs). This article investigates the human EMF exposure in a 5G system and compares them with those measured in the previous-generation cellular systems. It suggests a minimum separation distance between a transmitter and a human user for keeping the EMF exposure below the safety regulation level, which provides consumers with a general understanding on the safe use of 5G communications.

<https://ieeexplore.ieee.org/document/9090831>

Excerpts

"First, we discuss the human EMF exposure in the downlink as well as the uplink. Most of the prior work studies the uplink only, while hardly paying attention to EMF emissions generated by BSs [base stations or cell towers] in a 5G network. Recall the aforementioned changes that the 5G adopts: 1) operation at higher carrier frequencies; 2) reduction of cell size (which leads to increase in number of BSs; and 3) concentration of higher EMF energy into an antenna beam. They all imply that in 5G, unlike the previous-generation wireless systems, the downlink can also be a threat to human health as well as the uplink.

Second, we suggest that both SAR [Specific Absorption Rate] and PD [power density] should be used to display human EMF exposure for a wireless system. The reason is that SAR captures an amount of EMF energy that is actually "absorbed" into human tissues, whereas PD is an

efficient metric only to present the EMF energy being introduced to a human user.

Third, we present an explicit comparison of human EMF exposure in 5G to those in the currently deployed wireless standards....

Fourth, we consider the maximum possible exposure that a human user can experience. "

"in a 5G network, a consumer is likely to be exposed to high EMF energy more consistently. Nevertheless, it is easier to apply a "compliance distance" [17] in a downlink than in an uplink. Thus, this article suggests 1) an overhaul of the compliance distances defined in different standards and 2) the consumers' discretion on being close to a BS. "

"the fact that a high-frequency EMF cannot penetrate deep into human skin does not mean that it is not dangerous. Specifically, although the penetration is limited only at the skin surface, the SAR (illustrated as a heat map in Figure 4) can be higher within the concentrated area, which can cause subsequent health problems such as skin heating."

Downlink vs. Uplink

"Figure 3(c) and (d) compare PD and SAR in uplink to the ICNIRP guidelines set at 10 W/m² and 2W/kg, respectively. PD and SAR are remarkably higher in uplink than those in downlink, shown via a comparison of the results for uplink to those for downlink shown in Figure 3(a) and (b). It is attributed to smaller separation distance between a transmitter and a human body. Imagine one talking on a voice call; it is a "direct" physical contact of the phone and the head!

Also, it is significant to notice that no regulation exists at 28 GHz where this article investigates for 5G. As such, we refer to the ICNIRP's guideline that is set to be 2 W/kg by ICNIRP[11] at a frequency "below 10 GHz." In Figure 3(d), it provides a "'inferred" understanding on SAR in an uplink. The zoom-in look shown in Figure 3(d) suggests that in 5G, use of a handheld device within the distance of 8 cm causes an EMF absorption exceeding 2 W/kg, which would have been prohibited if the carrier frequency was lower than 10 GHz. This implies the gravity of human EMF exposure in an uplink of 5G."

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"This article has discussed human EMF exposure in 5G operating at 28 GHz, while most of the prior work focuses only on the technological benefits that the technology brings. Considering the significance of wireless technologies in our daily life, the potential danger of using them should also be emphasized for sustainable advancement of the technologies. In this article, the first case study has demonstrated how much EMF exposure is caused in a 5G system compared to 4G and 3.9G. Then, the latter case study has suggested an adequate separation distance from a transmitter, in order to keep a human user from being exposed to EMF below a regulatory guideline. This article is expected to ignite continued interest in overarching research on the design of future wireless systems that achieve high performance while keeping consumer safety guaranteed.

However, considering the gravity of this issue, we suggest several directions to be achieved in our future research.

- Human EMF exposure mitigation strategy: We are particularly interested in exploiting the technical features in future wireless systems—i.e., a larger number of BSs within a unit area. Such a paradigm change will enable a holistic, network-based approach to mitigate the EMF exposure as an optimization problem with a set of constraints representing the PD, SAR, and skin-temperature elevation.
 - Further studies regarding exact human health impacts caused by EMF exposure: The particular focus will be put on 1) skin dielectric effect with respect to frequency and 2) the effect of radiation when the body is covered with clothing or garment materials."
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RADIATION ANALYSIS IN A GRADUAL 5G NETWORK DEPLOYMENT STRATEGY

El-Hajj AM, Naous T. Radiation Analysis in a Gradual 5G Network Deployment Strategy. 2020 IEEE 3rd 5G World Forum (5GWF), Bangalore, India IEEE, 2020: 448-453, ISBN 9781728173009 Abstract

In a world where many overlapping 2G, 3G, and 4G electromagnetic radiation sources already exist, concerns regarding the potential increase in these radiation levels following the roll-out of 5G networks are growing. The deployment of 5G is expected to increase power density levels drastically, given the limitations of mmWave communications that impose a notably higher number of base stations to cover a given area of interest. In this paper, we propose a gradual deployment strategy of a 5G network for a small area in downtown Austin, Texas, using the already existing 4G LTE sites of the area. The radiated power density of the proposed 5G network is then analyzed according to several electromagnetic field (EMF) exposure limits and compared to the radiation levels of the same area where only the LTE network is present. Simulation results for the selected area demonstrate the significant increase in radiation levels resulting from the addition of 5G cell towers.

<https://ieeexplore.ieee.org/document/9221314>

For the frequency range of 2 to 300 GHz, the IEEE C95.1-2019 standard [18] specifies a limit power density value of 10 W/m² in restricted environment and 50 W/m² in unrestricted environments. These correspond to an averaging time of 30 minutes. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2020 guidelines for limiting exposure to electromagnetic fields [19] specify the general public exposure limit at 10 W/m² for frequencies between 2 and 300 GHz with the averaging time being 30 minutes. Similar limits are specified by the Federal Communications Commission (FCC) in [20] where a restriction of 10 W/m² for the general public has been set. In contrast, the institute for building biology and sustainability (IBN) in Germany have specified the exposure limit to be less than 0.1 W/m² in their 2015 Standard of Building Biology Measurement Technique (SBM-2015) [21], which is a million-fold lower than what is specified by the aforementioned guidelines. This suggests that negative health effects can occur at levels much lower than 10 W/m². Finally, the Chinese ministry of health [22] have set the power density exposure limit to 0.1 W/m².

This paper presented an analysis of the radiation levels in a deployed 5G network in an urban outdoor environment. Under the constraints of exposure limits, several challenges face the design and planning of such radiation aware 5G networks. Cell ranges need to be reduced to comply with the maximum allowed radiated power, requiring the densification of small cells in small areas and making it more costly to deploy these radiation-aware 5G networks. Although in this work we considered the maximum allowed EIRP prior to network deployment, results showed power density levels that do not satisfy all the exposure limits set by several sources. In this regard, a positive impact can be imposed by radiation-aware 5G networks on several levels. On a governmental level, the exposure limits for the power density need to be revised using today's data and approaches to bridge the gap between the thresholds specified by the different institutes and commissions. On a technological and scientific level, the radiation exposure constraint can open the door for innovative 5G solutions targeted to limit the health risks and economic barriers associated with this problem. This work can be extended by developing an analytical framework to efficiently rank and rate different cell allocation alternatives to minimize the potential radiations given a carefully chosen list of key performance indicators.

DIFFERENCE OF ICNIRP GUIDELINES AND IEEE C95.1 STANDARD FOR HUMAN PROTECTION FROM RADIO-FREQUENCY EXPOSURES

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distributions of the electromagnetic environment become very important data. The aim of this paper is to investigate the radio-frequency electromagnetic environment in Beijing by measuring the electromagnetic field levels of three representative downtown areas from 10 MHz to 8.0 GHz. The spatial distributions of the electromagnetic field in measured areas are illustrated as two-dimensional maps through interpolation techniques. These results are analyzed with reference to the exposure level limits in China and the official annual report of the national radiation environment.

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Omer Dasdag, Nur Adalier, Suleyman Dasdag. Electromagnetic radiation and Alzheimer's disease. *Biotechnology & Biotechnological Equipment*. 34(1):1087-1094. Published online 14 Sep 2020. <https://doi.org/10.1080/13102818.2020.1820378>.

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WHICH SOURCES OF ELECTROMAGNETIC FIELD ARE OF THE HIGHEST CONCERN FOR ELECTROSENSITIVE INDIVIDUALS? - QUESTIONNAIRE STUDY WITH A LITERATURE REVIEW

Artur Kacprzyk, Gabriela Kanclerz, Eugeniusz Rokita , Grzegorz Tatoń. Which sources of electromagnetic field are of the highest concern for electrosensitive individuals? - Questionnaire study with a literature review. *Electromagn Biol Med*. 2020 Oct 24;1-8. doi: 10.1080/15368378.2020.1839489.

Abstract

The primary goal of the study was to identify sources of electromagnetic field (EMF) which are attributed to negative health outcomes by a general population of electrohypersensitive (EHS) individuals. Secondary goal was to investigate the differences in indicated sources in subgroups distinguished based on gender, sex, place of living, place of work and the distance between place of living and the nearest mobile phone base station (MPBS). The cross-sectional study aiming to describe and analyze the population of EHS subjects was performed using a web-based questionnaire. The full survey consisted of 32 questions and concerned participants' baseline characteristics and details on sensitivity to electronic devices. Participants were regarded as EHS if they answered "yes" to the question "Do the electric/electronic/telecommunication devices negatively affect your well-being?" and indicated at least one device which in their opinion had such an impact. We identified 408 EHS subjects, out of which 288 (70.73%) were females and 120 (29.27%) were males. Phones, especially mobile devices, were attributed to negative health outcomes by the highest number of subjects (309, 75.74% and 267, 65.44% for phones and mobile phones, respectively). Additional subgroup analysis indicated that older participants and participants

who live closer to MPBS more often complained of physical symptoms attributed to MPBS impact ($p = .02$ and $p < .01$, respectively). Phones, especially mobile devices, are the most important source of EMF influencing EHS subjects. People who self-reported living closer to MPBS and older individuals seem to be remarkably more concerned about MPBS health impact. <https://pubmed.ncbi.nlm.nih.gov/33100040/>

Conclusions

Phones, especially mobile devices, are the most important source of EMF negatively affecting electrosensitive subjects, followed by laptops, personal computers and Wi-Fi routers. People who self-reported living closer to MPBS and older individuals seem to be remarkably concerned about MPBS health impact. Nevertheless, analysis of available literature on the subject indicates significant discrepancy in sources of EMF adversely affecting well-being of EHS subjects, indicating heterogeneous nature of the condition.

THE EFFECT OF SHORT-TERM ELECTROMAGNETIC FIELDS CAUSED BY MOBILE PHONES ON THE ELECTRICAL ACTIVITY OF ALPHA AND BETA BRAIN WAVES

Mehmet Cihan Yavas. The effect of short-term electromagnetic fields caused by mobile phones on the electrical activity of alpha and beta brain waves. *Annals of Clinical and Analytical Medicine*. 11(5):474-478. Sep 2020. DOI: 10.4328/ACAM.20220.

Abstract

Aim: The widespread use of mobile phones by people is increasing in society. The effect of these areas on neurophysiological and EEG is intriguing. In this study, we aimed to investigate the effect of short-term cell phone-induced electromagnetic field on the electrical activity of the EEG alpha and beta bands in the human brain.

Materials and Methods: The study was carried on twenty males divided into four groups such as Group 1: eyes closed (10 sec), Group 2: eyes open (10 sec), Group 3: phone exposure (3 min) and Group 4: control group (no phone, 3 min).

Results: In our study, no significant change was observed in the EEG electrical activity of the alpha waves between mobile phone use and non-use ($p > 0.05$). As a result of the analysis made for the beta waves, in the comparison between the group exposed to the mobile phone and the non-exposed group, there was a significant difference between the FFT max F and PSD max power parameters ($p < 0.05$), and an insignificant difference between the FFT max value and PSD max F parameters was found ($p > 0.05$).

Discussion: The use of mobile phones can lead to some changes in the electrical activity of some bands of the brain.

https://www.researchgate.net/publication/342735635_The_effect_of_shortterm_electromagnetic_fields_caused_by_mobile_phones_on_the_electrical_activity_of_alpha_and_beta_brain_waves

EFFECTS OF 2.45 GHZ WI-FI EXPOSURE ON SLEEP-DEPENDENT MEMORY CONSOLIDATION

Ana Bueno-Lopez, Torsten Eggert, Hans Dorn, Gernot Schmid, Rene Hirtl, Heidi Danker-Hopfe. Effects of 2.45 GHz Wi-Fi exposure on sleep-dependent memory consolidation. *J Sleep Res*. 2020 Nov 9;e13224. doi: 10.1111/jsr.13224.

Abstract

Studies have reported that exposure to radiofrequency electromagnetic fields (RF-EMF) emitted by mobile telephony might affect specific sleep features. Possible effects of RF-EMF emitted by Wi-Fi networks on sleep-dependent memory consolidation processes have not been investigated so far. The present study explored the impact of an all-night Wi-Fi (2.45 GHz) exposure on sleep-dependent memory consolidation and its associated physiological correlates. Thirty young males (mean $\pm$ standard deviation [SD]: 24.1 $\pm$ 2.9 years) participated in this double-blind, randomized, sham-controlled crossover study. Participants spent five nights in the laboratory. The first night was an adaptation/screening night. The second and fourth nights were baseline nights, each followed consecutively by an experimental night with either Wi-Fi (maximum: psSAR_{10g} = <25 mW/kg; 6 min average: <6.4 mW/kg) or sham exposure. Declarative, emotional and procedural memory performances were measured using a word pair, a sequential finger tapping and a face recognition task, respectively. Furthermore, learning-associated brain activity parameters (power spectra for slow oscillations and in the spindle frequency range) were analysed. Although emotional and procedural memory were not affected by RF-EMF exposure, overnight improvement in the declarative task was significantly better in the Wi-Fi condition. However, none of the post-learning sleep-specific parameters was affected by exposure. Thus, the significant effect of Wi-Fi exposure on declarative memory observed at the behavioural level was not supported by results at the physiological level. Due to these inconsistencies, this result could also be a random finding. <https://pubmed.ncbi.nlm.nih.gov/33166026/>

Excerpts

This work was supported by the Swiss Research Foundation for Electricity and Mobile Communication, FSM—Forschungstiftung Strom und Mobilkommunikation (Project number A2016-01, 2017-2018). The authors declare no competing financial interests. The sponsor (FSM) did not have any influence on the study design, the data analysis or the manuscript. The manuscript reflects the opinions of the authors only.

THE RELATIONSHIP BETWEEN RISK PERCEPTION OF CELL PHONES AND OBJECTIVE KNOWLEDGE OF EMF IN KOREA

Myung-Soon Seo, Jae-Wook Choi, Kyung-Hee Kim, Hyung-Do Choi. The Relationship between Risk Perception of Cell Phones and Objective Knowledge of EMF in Korea. *Int J Environ Res Public Health*. 2020 Oct 1;17(19):E7207. doi: 10.3390/ijerph17197207.

Abstract

This study examines differences between the level of objective knowledge regarding radio-frequency electromagnetic fields (RF-EMF) and risk perception of cell phones in Korea. We also investigate the extent to which socio-demographic factors, perceived EMF exposure, objective knowledge regarding EMF, and psychological factors influence the risk perception of cell phones using hierarchical multiple regression. All 3393 study subjects completed a

survey measuring the degree of risk perception of EMF. They were sampled in accordance with representative proportions of sex, age group, and region of residence as shown in the 2019 Resident Registration Population Statistics reported by Korea. The variables that have the most influence on risk perception of cell phones can be induced from the beta values for each variable: The subjective factor, perceived level of exposure to EMF ($\beta = 0.253$), was more strongly related to risk perception of cell phones than level of knowledge regarding EMF, an objective factor in this study. Of the psychological factors, Dreadfulness ($\beta = 0.331$), Personal knowledge ($\beta = -0.174$), and Familiarity ($\beta = -0.089$) influenced risk perceptions of cell phones; Controllability did not. On the risk cognition map, people thought that it was easy to control risk related to Cell phone use in daily life, while risk related to High technology was uncontrollable.

Open access paper: <https://www.mdpi.com/1660-4601/17/19/7207>

SOMATOSENSORY ILLUSIONS ELICITED BY SHAM ELECTROMAGNETIC FIELD EXPOSURE: EXPERIMENTAL EVIDENCE FOR A PREDICTIVE PROCESSING ACCOUNT OF SOMATIC SYMPTOM PERCEPTION

Carolin Wolters, Jana Harzem, Michael Witthöft, Alexander L Gerlach, Anna Pohl. Somatosensory illusions elicited by sham electromagnetic field exposure: experimental evidence for a predictive processing account of somatic symptom perception. *Psychosom Med.* 2020 Nov 2. doi: 10.1097/PSY.0000000000000884.

Abstract

Objective: According to the predictive processing theory of somatic symptom generation, body sensations are determined by somatosensory input and central nervous predictions about this input. We examined how expectations shape predictions and consequently bodily perceptions in a task eliciting illusory sensations as laboratory analogue of medically unexplained symptoms.

Methods: Using the framework of signal detection theory, the influence of sham Wi-Fi on (i) response bias (c) and (ii) somatosensory sensitivity (d') for tactile stimuli was examined using the somatic signal detection task (SSDT). A healthy student sample ($n = 83$) completed the SSDT twice (sham Wi-Fi on/off) in a randomized order after watching a film that promoted adverse health effects of electromagnetic fields (EMF).

Results: When expecting a Wi-Fi signal to be present, participants showed a significantly more liberal response bias c ($p = .010$, $\eta p = .08$) for tactile stimuli in the SSDT as evidence of a higher propensity to experience somatosensory illusions. No significant alteration of somatosensory sensitivity d' ($p = .76$, $\eta p < .002$) was observed.

Conclusions: Negative expectations about the harmfulness of EMF may foster the occurrence of illusory symptom perceptions via alterations in the somatosensory decision criterion. The findings are in line with central tenets of the predictive processing account of somatic symptom generation. This account proposes a decoupling of percept and somatosensory input so that perception becomes increasingly dependent on predictions. This biased perception is regarded as a risk factor for somatic symptom disorders.

<https://pubmed.ncbi.nlm.nih.gov/33141791/>

INFLUENCES OF EXPOSURE TO 915-MHZ RADIOFREQUENCY IDENTIFICATION SIGNALS ON SEROTONIN METABOLITES IN RATS: A PILOT STUDY (OF RFID)

Hye Sun Kim, Man-Jeong Paik, Chan Seo, Hyung Do Choi, Jeong-Ki Pack, Nam Kim, Young Hwan Ahn. Influences of exposure to 915-MHz radiofrequency identification signals on serotonin metabolites in rats: A pilot study. *Int J Radiat Biol.* 2020 Nov 2;1-19. doi: 10.1080/09553002.2021.1844336.

Abstract

Purpose: The influences of radiofrequency electromagnetic exposure on animal health, particularly on serotonin metabolism, are not well-elucidated. In this in vivo study, we studied the influences of exposure to radiofrequency identification (RFID) signals on serotonin metabolism.

Materials and methods: Twenty-two male Sprague-Dawley rats were assigned to sham (n = 10) and RFID-exposed (n = 12) groups. Rats in the RFID-exposed group were exposed to RFID signals at an average whole-body specific absorption rate of 2 W/kg for 8 h/day, 5 days/week for 2 weeks. Before and after RFID exposure, 24-h urine was collected from each rat. Urinary tryptophan, 5-hydroxytryptophan, serotonin, 5-hydroxyindoleacetic acid, and 5-methoxyindole-3-acetic acid concentrations were examined using gas chromatography-mass spectrometry, and changes in the patterns of values were compared between the two groups.

Results: Urinary levels of serotonin decreased by 20% (p = 0.041, Student's t-test) and 40% (p = 0.024, Student's t-test) in both the sham and RFID-exposed groups, respectively. Level of 5-methoxyindole-3-acetic acid decreased by 30% in the RFID-exposed group (p = 0.039, Student's t-test).

Conclusion: Our results indicate that exposure to RFID signals at a specific absorption rate of 2 W/kg is sufficient to alter serotonin metabolism in rats regardless of whether the exposure level is considered biohazardous.

<https://pubmed.ncbi.nlm.nih.gov/33135949/>

THE PROTECTIVE EFFECT OF MELATONIN ON RADIOFREQUENCY ELECTROMAGNETIC FIELDS OF MOBILE PHONE-INDUCED TESTICULAR DAMAGE IN AN EXPERIMENTAL MOUSE MODEL

Mitra Shokri, Mohammad E Shamsaei, Abbasali K Malekshah, Fereshteh T Amiri. The protective effect of melatonin on radiofrequency electromagnetic fields of mobile phone-induced testicular damage in an experimental mouse model. *Andrologia.* 2020 Oct 11;e13834. doi: 10.1111/and.13834.

Abstract

Radiofrequency electromagnetic radiation (RF-EMR) from mobile devices has undesirable effects on the male reproductive organs. Melatonin with antioxidant potential can help to prevent these damages. Therefore, the aim of this study was to evaluate the protective effect of melatonin on testicular damage induced by RF-EMR of mobile phone. In this experimental study, 32 adult male BALB/c mice were divided randomly into four groups: control, melatonin (2 mg/kg, for 30 consecutive days, intraperitoneally), RF-EMR (900 MHz, 100 to 300 MT, 54 to 160 W/m) (4 hr per day, whole body) and melatonin + RF-EMR groups. One day after the

last prescription were evaluated oxidative stress parameters, testosterone level and histopathological assays of the testis. EMR of mobile phone led to the induction of oxidative stress, testicular tissue damage and decreased testosterone.

Treatment with melatonin improved oxidative stress parameters such as MDA and GSH, and testis injury score, increased the thickness of the germinal epithelial thickness and diameter of the seminiferous tubule, and decreased testosterone hormone in the EMR-exposed mice, and these differences were significant ($p < .05$). Data showed that melatonin with its antioxidant property can decrease oxidative damage induced by RF-EMR of mobile phones on testis tissue.

<https://pubmed.ncbi.nlm.nih.gov/33040351/>

EFFECT OF MOBILE PHONE SIGNAL RADIATION ON EPIGENETIC MODULATION IN THE HIPPOCAMPUS OF WISTAR RAT

Ranjeet Kumar, Pravin S Deshmukh, Sonal Sharma, Basu Dev Banerjee. Effect of mobile phone signal radiation on epigenetic modulation in the hippocampus of Wistar rat. Effect of mobile phone signal radiation on epigenetic modulation in the hippocampus of Wistar rat. Environ Res. 2020 Oct 6;110297. doi: 10.1016/j.envres.2020.110297.

Abstract

Exponential increase in mobile phone uses, given rise to public concern regarding the alleged deleterious health hazards as a consequence of prolonged exposure. In 2018, the U.S. National toxicology program reported, two year toxicological studies for potential health hazards from exposure to cell phone radiations. Epigenetic modulations play a critical regulatory role in many cellular functions and pathological conditions. In this study, we assessed the dose-dependent and frequency-dependent epigenetic modulation (DNA and Histone methylation) in the hippocampus of Wistar rats. A Total of 96 male Wistar rats were segregated into 12 groups exposed to 900 MHz, 1800 MHz and 2450 MHz RF-MW at a specific absorption rate (SAR) of 5.84×10^{-4} W/kg, 5.94×10^{-4} W/kg and 6.4×10^{-4} W/kg respectively for 2 hours per day for 1-month, 3-month and 6-month periods. At the end of the exposure duration, animals were sacrificed to collect the hippocampus. Global hippocampal DNA methylation and histone methylation were estimated by ELISA. However, DNA methylating enzymes, DNA methyltransferase1 (DNMT1) and histone methylating enzymes euchromatic histone methyltransferase1 (EHMT1) expression was evaluated by real-time PCR, as well as further validated with western blot. Alteration in epigenetic modulation was observed in the hippocampus. Global DNA methylation was decreased and histone methylation was increased in the hippocampus. We observed that microwave exposure led to significant epigenetic modulations in the hippocampus with increasing frequency and duration of exposure. Microwave exposure with increasing frequency and exposure duration brings significant ($p < 0.05$) epigenetic modulations which alters gene expression in the hippocampus.

<https://pubmed.ncbi.nlm.nih.gov/33035560/>

NO INCREASED DNA DAMAGE OBSERVED IN THE BRAIN, LIVER, AND LUNG OF FETAL MICE TREATED WITH ETHYLNITROSOUREA AND EXPOSED TO UMTS RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Alexander Lerchl, Melanie Klose, Karen Drees (née Grote). No Increased DNA Damage Observed in the Brain, Liver, and Lung of Fetal Mice Treated With Ethylnitrosourea and Exposed to UMTS Radiofrequency Electromagnetic Fields. *Bioelectromagnetics*. 2020 Oct 8. doi: 10.1002/bem.22301.

Abstract

The widespread use of mobile phones and Wi-Fi-based communication devices makes exposure to radiofrequency electromagnetic fields (RF-EMF) unavoidable. Previous experiments have revealed the tumor-promoting effects of non-ionizing RF-EMF in adult carcinogen-treated mice in utero. To extend these investigations, we tested whether these effects are due to the co-carcinogenicity of RF-EMF which would manifest as elevated DNA damage. Similar to previous experiments, pregnant mice were exposed to RF-EMF (Universal Mobile Telecommunication System [UMTS] standard, approximately 1,960 MHz) from day 7 post-conception (p.c.) at 0 (sham), 0.04, and 0.4 W/kg SAR. At day 14 p.c., the mice were injected with the carcinogen ethylnitrosourea (ENU, 40 mg/kg). At three time-points specifically 24, 36, and 72 h later, the pregnant females were sacrificed and the fetuses ($n = 24-57$) were removed. A dye (cy3) specific for adenyl adducts was used to detect DNA damage by fluorescence microscopy in the brain, liver, and lung of each fetus. Compared to control (0 W/kg SAR), exposure to RF-EMF had no effect on the formation of DNA adducts in the inspected tissues. We conclude that increased adenyl formation of DNA by RF-EMF exposure is not a valid explanation for the previously reported tumor-promoting effects of RF-EMF. Our findings may help to gain a deeper insight into the biological effects of RF-EMF exposure in the context of malignancy.

Conclusions

In summary, our data demonstrate that exposing the brain and other tissues of fetal mice to RF-EMF of relevant intensities does not cause any significant damage to DNA molecules when compared to the DNA damage caused by ENU alone. This is in agreement with the theoretical biophysical considerations as well as with the vast majority of epidemiological data that show no increase in brain tumors in humans even after extensive use of mobile phones. However, our study only measured the amount of adenyl adducts formed as an indicator of DNA damage. Further studies should focus on other markers that indicate DNA damage such as DNA strand breaks, micronucleus assay, and oxidative damage to provide a comprehensive picture of any potential biological damages caused by RF-EMF.

Open access paper: <https://onlinelibrary.wiley.com/doi/epdf/10.1002/bem.22301>

EVALUATION OF HEART RATE VARIABILITY, BLOOD PRESSURE AND LIPID PROFILE ALTERATIONS FROM DUAL TRANSCIVER MOBILE PHONE RADIATION EXPOSURE

Jamil Dauda Usman, Mikail Umar Isyaku, Adesoji Adedipe Fasanmade. Evaluation of heart rate variability, blood pressure and lipid profile alterations from dual transceiver mobile phone radiation exposure. J Basic Clin Physiol Pharmacol. 2020 Nov 4. doi: 10.1515/jbcpp-2020-0047.

Abstract

Objectives Electromagnetic fields have been reported to alter electrical activities in the brain and heart. However, there is paucity of information on the potential functional alterations that magnetic fields from mobile phone could cause to the heart. This study investigated heart rate variability (HRV), blood pressure (BP) and lipid profile in Wistar rats exposed to electromagnetic field radiation from a dual transceiver mobile phone (DTrMP).

Methods Twenty-one male albino Wistar rats (140-180 g) were randomly assigned to two major groups positioned 5 m apart as follows: control: no phone (n=7) and treatment group (n=14) continuously exposed to electromagnetic field from Tecno T312 DTrMP 900/1800 MHz set in silence mode. Experimental treatment consisted in 10 min calls/day, directed to this device for a period of six weeks. Seven animals from the treatment group were allowed to recover for a period of two weeks after exposure. HRV, systolic, diastolic and mean arterial BP were noninvasively investigated, while serum lipid profile and heart tissue nitric oxide (NO) activities were determined using standard procedures.

Results There was significant ($p<0.05$) increase in systolic, diastolic, mean arterial BP and a decrease in HRV. Serum high density lipoproteins decreased, while total cholesterol, atherogenic indices, and heart NO levels increased significantly in the radiation exposed animals. The alterations observed in exposed animals remained unchanged even after the recovery period.

Conclusions These results suggest that exposure to electromagnetic radiation from dual transceiver mobile phones could be a risk factor to increase in blood pressure.

<https://pubmed.ncbi.nlm.nih.gov/33146629/>

GENOTOXIC AND CYTOTOXIC EFFECTS OF MOBILE PHONE USE ON THE ORAL EPITHELIUM: A SYSTEMATIC REVIEW WITH META- ANALYSIS

Marcos Antônio Lima Dos Santos, Francielle Santos de Santana, Andréa Ferreira Soares, Sílvia Ferreira de Sousa, Liciane S Menezes, Wilton Mitsunari Takeshita. Genotoxic and cytotoxic effects of mobile phone use on the oral epithelium: a systematic review with meta-analysis. Gen Dent. Nov-Dec 2020;68(6):70-74. PMID: 33136050.

Abstract

The use of mobile phones is based on radiofrequency (RF) waves, and the devices act as transmitters and receivers of non-ionizing energy. The micronucleus test was developed to identify increases in the occurrence of mutations in cells exposed to various agents. This systematic review with meta-analysis adhered to the following protocol: defining the

objective, outlining the search method (PICO model), conducting the search, identifying literature, selecting articles, and extracting data. The study aimed to answer the following research question: Does non-ionizing radiation emitted by mobile phones have genotoxic and/or cytotoxic effects on the oral epithelium? The search for evidence published 2009-2019 was conducted in the MEDLINE, PubMed, Scopus, LILACS, Google Scholar, PROSPERO, and Cochrane Library databases. The following inclusion criteria were defined: investigations of effects on the oral mucosa related to RF; investigations of cytotoxic and/or genotoxic effects; investigations involving humans; and investigations using cells exfoliated from the oral epithelium. Investigations related to the parotid gland were excluded. The search strategy found 464 articles; after application of the eligibility criteria, 358 abstracts were analyzed and 351 abstracts excluded. After 7 full texts were reviewed, 1 study was excluded. The 6 included studies were classified as level 5 quality of evidence (observational studies). The meta-analysis included 2 studies that compared the frequency of micronuclei on the side exposed to RF electromagnetic fields (RF-EMFs) to that on the unexposed side. The studies evaluated presented a low degree of evidence, but the meta-analysis indicated that no genotoxic effects are associated with mobile phone use. However, observations of other nuclear abnormalities in some studies suggest the occurrence of cytotoxic effects caused by exposure to the RF-EMFs emitted by mobile phones. More studies are necessary to prove or refute this association.

<https://pubmed.ncbi.nlm.nih.gov/33136050/>

LONG-TERM EXPOSURE TO ELECTROMAGNETIC RADIATION FROM MOBILE PHONES CAN CAUSE CONSIDERABLE CHANGES IN THE BALANCE OF BAX/BCL2 MRNA EXPRESSION IN THE HIPPOCAMPUS OF MICE

Fatemeh-Zakieh Tohidi, Arianeh Sadr-Nabavi, Hossein Haghiri, Reza Fardid, Houshang Rafatpanah, Hosein Azimian, Mohammad-Hossein Bahreyni-Toossi. Long-term exposure to electromagnetic radiation from mobile phones can cause considerable changes in the balance of Bax/Bcl2 mRNA expression in the hippocampus of mice. *Electromagn Biol Med.* 2020 Oct 20;1-7. doi: 10.1080/15368378.2020.1830793.

Abstract

The aim of the present study was the investigation of the effects of mobile phones at different daily exposure times on the hippocampal expression of two apoptotic genes. Forty-eight male BALB/c mice were randomly divided into six groups with 8 animals in each group. Four experimental groups were respectively exposed to electromagnetic waves for 0.5, 1, 2 and 4 hours twice a day for 30 consecutive days. One experimental group was radiated for 4 hours once a day, while the control group did not receive any radiation during the experiment. The expression of both Bax and Bcl2 mRNAs was upregulated in the mice exposed for one and two hours. Whilst the highest expressions were observed in the two-hours radiation in the exposed group, the expression of both studied genes was downregulated in animals with longer exposure to radiation in a duration-dependent manner. The highest ratio of Bax/Bcl2 expression was observed in the mice that received radiation for four hours twice a day. These results revealed that mobile phone radiation can cause considerable changes in the balance of Bax/Bcl2 mRNA expression in laboratory mice hippocampus.

<https://pubmed.ncbi.nlm.nih.gov/33081559/>

EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS ON THERMAL SENSITIVITY IN THE RAT

Nihal S Ouadah, Kelly Blazy, Anne-Sophie Villégier. Effect of Radiofrequency Electromagnetic Fields on Thermal Sensitivity in the Rat. *Int J Environ Res Public Health*. 2020 Oct 18;17(20):E7563. doi: 10.3390/ijerph17207563.

Abstract

The World Health Organization and the French Health Safety Agency (ANSES) recognize that the expressed pain and suffering of electromagnetic field hypersensitivity syndrome (EHS) people are a lived reality requiring daily life adaptations to cope. Mechanisms involving glutamatergic N-methyl d-aspartate (NMDA) receptors were not explored yet, despite their possible role in hypersensitivity to chemicals. Here, we hypothesized that radiofrequency electromagnetic field (RF-EMF) exposures may affect pain perception under a modulatory role played by the NMDA receptor. The rats were exposed to RF-EMF for four weeks (five times a week, at 0 (sham), 1.5 or 6 W/kg in restraint) or were cage controls (CC). Once a week, they received an NMDA or saline injection before being scored for their preference between two plates in the two-temperatures choice test: 50 °C (thermal nociception) versus 28 °C. Results in the CC and the sham rats indicated that latency to escape from heat was significantly reduced by -45% after NMDA, compared to saline treatment. Heat avoidance was significantly increased by +40% in the 6 W/kg, compared to the sham exposed groups. RF-EMF effect was abolished after NMDA treatment. In conclusion, heat avoidance was higher after high brain-averaged specific absorption rate, affording further support for possible effect of RF-EMF on pain perception. Further studies need to be performed to confirm these data.

Open access paper: <https://www.mdpi.com/1660-4601/17/20/7563>

EFFECTS OF RADIOFREQUENCY FIELD EXPOSURE ON PROTEOTOXIC-INDUCED AND HEAT-INDUCED HSF1 RESPONSE IN LIVE CELLS USING THE BIOLUMINESCENCE RESONANCE ENERGY TRANSFER TECHNIQUE

Emmanuelle Poque, Hermanus J Ruigrok, Delia Arnaud-Cormos, Denis Habauzit, Yann Chappe et al. Effects of radiofrequency field exposure on proteotoxic-induced and heat-induced HSF1 response in live cells using the bioluminescence resonance energy transfer technique. *Cell Stress Chaperones*. 2020 Oct 16. doi: 10.1007/s12192-020-01172-3.

Abstract

As of today, only acute effects of RF fields have been confirmed to represent a potential health hazard and they are attributed to non-specific heating (≥ 1 °C) under high-level exposure. Yet, the possibility that environmental RF impact living matter in the absence of temperature elevation needs further investigation. Since HSF1 is both a thermosensor and the master regulator of heat-shock stress response in eukaryotes, it remains to assess HSF1 activation in live cells under exposure to low-level RF signals. We thus measured basal, temperature-induced, and chemically induced HSF1 trimerization, a mandatory step on the cascade of HSF1 activation, under RF exposure to continuous wave (CW), Global System for Mobile (GSM), and Wi-Fi-modulated 1800 MHz signals, using a bioluminescence resonance energy transfer technique (BRET) probe. Our results show that, as expected, HSF1 is heat-activated by acute exposure of transiently transfected HEK293T cells to a CW RF field at a specific absorption rate of 24 W/kg for 30 min. However, we found no evidence of HSF1

activation under the same RF exposure condition when the cell culture medium temperature was fixed. We also found no experimental evidence that, at a fixed temperature, chronic RF exposure for 24 h at a SAR of 1.5 and 6 W/kg altered the potency or the maximal capability of the proteasome inhibitor MG132 to activate HSF1, whatever signal used. We only found that RF exposure to CW signals (1.5 and 6 W/kg) and GSM signals (1.5 W/kg) for 24 h marginally decreased basal HSF1 activity. <https://pubmed.ncbi.nlm.nih.gov/33067759/>

RADIOFREQUENCY AT 2.45 GHZ INCREASES TOXICITY, PRO-INFLAMMATORY AND PRE-APOPTOTIC ACTIVITY CAUSED BY BLACK CARBON IN THE RAW 264.7 MACROPHAGE CELL LINE

Rosa Ana Sueiro-Benavides, Jose Manuel Leiro-Vidal, Aarón Ángel Salas-Sánchez, J Antonio Rodríguez-González, Francisco J Ares-Pena, M Elena López-Martín. Radiofrequency at 2.45 GHz increases toxicity, pro-inflammatory and pre-apoptotic activity caused by black carbon in the RAW 264.7 macrophage cell line. Sci Total Environ. 2020 Oct 4;142681. doi: 10.1016/j.scitotenv.2020.142681.

Abstract

Environmental factors such as air pollution by particles and/or electromagnetic fields (EMFs) are studied as harmful agents for human health. We analyzed whether the combined action of EMF with fine and coarse black carbon (BC) particles induced cell damage and inflammatory response in RAW 264.7 cell line macrophages exposed to 2.45 GHz in a gigahertz transverse electromagnetic (GTEM) chamber at sub-thermal specific absorption rate (SAR) levels. Radiofrequency (RF) dramatically increased BC-induced toxicity at high doses in the first 24 h and toxicity levels remained high 72 h later for all doses. The increase in macrophage phagocytosis induced after 24 h of RF and the high nitrite levels obtained by stimulation with lipopolysaccharide (LPS) endotoxin 24 and 72 h after radiation exposure suggests a prolongation of the innate and inflammatory immune response. The increase of proinflammatory cytokines tumor necrosis factor- α , after 24 h, and of interleukin-1 β and caspase-3, after 72 h, indicated activation of the pro-inflammatory response and the apoptosis pathways through the combined effect of radiation and BC. Our results indicate that the interaction of BC and RF modifies macrophage immune response, activates apoptosis, and accelerates cell toxicity, by which it can activate the induction of hypersensitivity reactions and autoimmune disorders. <https://pubmed.ncbi.nlm.nih.gov/33071139/>

IEC/IEEE INTERNATIONAL STANDARD - MEASUREMENT PROCEDURE FOR ASSESSMENT OF SPECIFIC ABSORPTION RATE OF HUMAN EXPOSURE TO RF FIELDS FROM HAND-HELD AND BODY-MOUNTED WIRELESS COMMUNICATION DEVICES

62209-1528-2020 - IEC/IEEE International Standard - Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz). IEEE. 19 Oct. 2020. DOI: 10.1109/IEEESTD.2020.9231298.

Abstract

This document specifies protocols and test procedures for the reproducible and repeatable measurement of the conservative exposure peak spatial average SAR (psSAR) induced inside

a simplified model of the head and the body by radio-frequency (RF) transmitting devices, with a defined measurement uncertainty. These protocols and procedures apply to a significant majority of the population, including children, during the use of hand-held and body-worn wireless communication devices. These devices include single or multiple transmitters or antennas, and are operated with their radiating structure(s) at distances up to 200 mm from a human head or body. This document is employed to evaluate SAR compliance of different types of wireless communication devices used next to the ear, in front of the face, mounted on the body, operating in conjunction with other RF- transmitting, non-transmitting devices or accessories (e.g. belt-clips), or embedded in garments. The applicable frequency range is from 4 MHz to 10 GHz. Devices operating in the applicable frequency range can be tested using the phantoms and other requirements defined in this document. The device categories covered include, but are not limited to, mobile telephones, cordless microphones, and radio transmitters in personal, desktop and laptop computers, for multi-band operations using single or multiple antennas, including push-to-talk devices. This document can also be applied for wireless power transfer devices operating above 4 MHz. This document does not apply to implanted medical devices.

<https://ieeexplore.ieee.org/servlet/opac?punumber=9231296>

STUDY OF THE EFFECTS OF 3.1 THz RADIATION ON THE EXPRESSION OF RECOMBINANT RED FLUORESCENT PROTEIN (RFP) IN E. COLI

Jiping Zhao, Erling Hu, Sen Shang, Dai Wu, Peng Li, Peng Zhang, Dan Tan, Xiaoyun Lu. Study of the effects of 3.1 THz radiation on the expression of recombinant red fluorescent protein (RFP) in E. coli. *Biomed Opt Express*. 2020 Jun 22;11(7):3890-3899. doi: 10.1364/BOE.392838.

Abstract

In recent years, many studies have been conducted to investigate the non-thermal effects of THz radiation on different organisms, but further studies are needed to fully elucidate the effects, especially on the molecular level. In this study, we explored the effects of at 3.1 THz radiation on protein expression in *Escherichia coli* (E. coli) using red fluorescent protein as a reporter molecule. After 8 hours of continuous THz irradiation of bacteria on LB (Luria-Bertani) solid plates at an average power of 33 mW/cm² and 10 Hz pulse repetition frequency, we found that the plasmid copy number, protein expression and fluorescence intensity of bacteria from the irradiated area were 3.8-, 2.7-, and 3.3 times higher than in bacteria from the un-irradiated area, respectively. These findings suggest that plasmid replication changed significantly in bacteria exposed to 3.1 THz radiation, resulting in increased protein expression as evidenced by increased fluorescence intensity of the RFP reporter.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7510898/>

STUDY ON THE EFFECTS OF TERAHERTZ RADIATION ON GENE NETWORKS OF ESCHERICHIA COLI BY MEANS OF FLUORESCENT BIOSENSORS

Danil S Serdyukov, Tatiana N Goryachkovskaya, Irina A Mescheryakova, Svetlana V Bannikova, Sergei A Kuznetsov, Olga P Cherkasova, Vasiliy M Popik, Sergey E Peltek. Study on the effects of terahertz radiation on gene networks of Escherichia coli by means of fluorescent biosensors. Biomed Opt Express. 2020 Aug 25;11(9):5258-5273. doi: 10.1364/BOE.400432.

Abstract

Three novel fluorescent biosensors sensitive to terahertz (THz) radiation were developed via transformation of Escherichia coli (E. coli) cells with plasmids, in which a promotor of genes *matA*, *safA*, or *chbB* controls the expression of a fluorescent protein. The biosensors were exposed to THz radiation from two sources: a high- intensity pulsed short-wave free electron laser and a low-intensity continuous long-wave IMPATT-diode-based device. The threshold and dynamics of fluorescence were found to depend on radiation parameters and exposure time. Heat shock or chemical stress yielded the absence of fluorescence induction. The biosensors are evaluated to be suitable for studying influence of THz radiation on the activity of gene networks related with considered gene promoters.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7510871/>

OCCUPATIONAL EXPOSURE TO ELECTRIC SHOCKS AND EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS AND MOTOR NEURONE DISEASE

Grace X Chen, Andrea't Mannelje, Jeroen Douwes, Leonard H Berg, Neil Pearce, Hans Kromhout, Bill Glass, Naomi Brewer, Dave J McLean. Occupational Exposure to Electric Shocks and Extremely Low-Frequency Magnetic Fields and Motor Neurone Disease. Am J Epidemiol. 2020 Oct 9;kwaa214. doi: 10.1093/aje/kwaa214.

Abstract

In a New Zealand population-based case-control study we assessed associations with occupational exposure to electric shocks, extremely low-frequency magnetic fields (ELF-MF) and motor neurone disease using job- exposure matrices to assess exposure. Participants were recruited between 2013 and 2016. Associations with ever/never, duration, and cumulative exposure were assessed using logistic regression adjusted for age, sex, ethnicity, socioeconomic status, education, smoking, alcohol consumption, sports, head or spine injury and solvents, and mutually adjusted for the other exposure. All analyses were repeated stratified by sex. An elevated risk was observed for having ever worked in a job with potential for electric shocks (odds ratio (OR)=1.35, 95% confidence interval (CI): 0.98, 1.86), with the strongest association for the highest level of exposure (OR=2.01, 95%CI: 1.31, 3.09). Analysis by duration suggested a non-linear association: risk was increased for both short-duration (<3 years) (OR= 4.69, 95%CI: 2.25, 9.77) and long-duration in a job with high level of electric shock exposure (>24 years; OR=1.88; 95%CI: 1.05, 3.36), with less pronounced associations for intermediate durations. No association with ELF-MF was found. Our findings provide support for an association between occupational exposure to electric shocks and motor neurone disease but did not show associations with exposure to work- related ELF-MF.

<https://pubmed.ncbi.nlm.nih.gov/33034341/>

ASSOCIATION OF PERSONAL EXPOSURE TO POWER-FREQUENCY MAGNETIC FIELDS WITH PREGNANCY OUTCOMES AMONG WOMEN SEEKING FERTILITY TREATMENT IN A LONGITUDINAL COHORT STUDY

Mary E Ingle, Lidia Mínguez-Alarcón, Ryan C Lewis, Paige L Williams, Jennifer B Ford, Ramace Dadd, Russ Hauser, John D Meeker, EARTH Study Team. Association of personal exposure to power-frequency magnetic fields with pregnancy outcomes among women seeking fertility treatment in a longitudinal cohort study. *Fertil Steril*. 2020 Oct 6;S0015-0282(20)30535-5. doi: 10.1016/j.fertnstert.2020.05.044.

Abstract

Objective: To assess for the first time the potential relationships of personal exposure to magnetic fields (MF) with pregnancy outcomes among a cohort of women from a fertility clinic, addressing, through study design, some of the primary limitations of previous studies on this topic.

Design: Longitudinal preconception prospective cohort. Setting: Fertility center.

Patient(s): Our analysis included 119 women recruited from 2012 to 2018, who underwent in vitro fertilization (IVF) (n = 163 cycles) and/or intrauterine insemination (IUI) (n = 123 cycles).

Intervention(s): Women wore personal exposure monitors continuously for up to three consecutive 24-hour time periods separated by several weeks.

Main outcome measure(s): Implantation, clinical pregnancy, live birth, and pregnancy loss.

Result(s): The median and maximum of the overall daily mean (daily peak) MF exposure levels were 1.10 mG (2.14 mG) and 15.54 mG (58.73 mG), respectively. MF exposure metrics were highest among women who changed environments four or more times per day. Overall, no statistically significant associations between MF exposure metrics and fertility treatment or pregnancy outcomes were observed in crude or adjusted models. Effect estimates, both positive and negative, varied by outcome and the exposure metric, including the way in which exposure was modeled.

Conclusion(s): Personal MF exposures were not associated with fertility treatment outcomes or pregnancy outcomes. Despite its limited size, strengths of the study include a longitudinal repeated-measures design, the collection of personal MF exposure data across multiple days, and carefully documented outcome and covariate information among a potentially susceptible study population.

<https://pubmed.ncbi.nlm.nih.gov/33036793/>

CHANGES IN THE HONEYBEE ANTIOXIDANT SYSTEM AFTER 12 H OF EXPOSURE TO ELECTROMAGNETIC FIELD FREQUENCY OF 50 HZ AND VARIABLE INTENSITY

Paweł Migdał, Agnieszka Murawska, Aneta Strachecka, Paweł Bieńkowski, Adam Roman. Changes in the Honeybee Antioxidant System after 12 h of Exposure to Electromagnetic Field Frequency of 50 Hz and Variable Intensity. *Insects*. 2020 Oct 18;11(10):E713. doi: 10.3390/insects11100713.

Abstract

In recent years, on a global scale, more and more reports of a phenomenon called CCD (Colony Collapse Disorder) have been reported. In addition to pesticides, diseases, and other environmental stressors, electromagnetic fields are also mentioned as one of the possible causes of CCD. One of the body's first lines of defense against harmful factors is the antioxidant system. We hypothesized that electromagnetic field upregulate the activity of SOD (superoxide dismutase), CAT (catalases), and changed FRAP (total antioxidant potential) in honeybee hemolymph. In our research, 12 h bee's exposure to E-field was analyzed to determine changes in the antioxidant system. The frequency of 50 Hz and various intensities were used: 5.0 kV/m, 11.5 kV/m, 23.0 kV/m, and 34.5 kV/m. Superoxide dismutase was characterized by four times higher activity in the study groups as compared to the control group. Catalase activity in all groups was characterized by statistically significantly different activity between the groups. The highest activity was recorded in the 34.5 kV/m group. The lowest activity was recorded in the 11.5 kV/m group. A relationship was found between different E-field intensities and changes in the antioxidant system.

Open access paper: <https://www.mdpi.com/2075-4450/11/10/713>

THE EFFECTS OF EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS EXPOSURE AT 1 MT ON HEMOGRAM AND BLOOD BIOCHEMISTRY IN RATS

Jin Wang, Shenglan Yang, Xingfa Liu, Yemao Zhang, Lijian Ding, Xiong Wu, Mengying He, Guoran Ruan, Jinsheng Lai, Chen Chen. The effects of extremely low frequency electromagnetic fields exposure at 1 mT on hemogram and blood biochemistry in rats. *Electromagn Biol Med*. 2020 Oct 27;1-12. doi: 10.1080/15368378.2020.1839490.

Abstract

The biological effects of extremely low-frequency electromagnetic fields (ELF-EMF) exposure are not fully clarified. We conducted this investigation to explore the effects of ELF-EMF on hematologic and biochemical indexes in adult rats. Thirty adult male Sprague-Dawley rats were exposed to ELF-EMF at 1 mT for 24 weeks, while another 30 SD rats were sham exposed. During the exposure, peripheral blood was collected every 4 weeks to analyze the hematologic parameters and biochemical indexes. The morphology of liver and kidney was detected by hematoxylin-eosin staining at the end of the experiment. Exposed to ELF-EMF at 1 mT did not exert any statistic difference on hematologic parameters including total white blood cell count, neutrophil ratio, lymphocyte ratio, red blood cells, hemoglobin concentration and platelets count, compared to the control group. Similarly, biochemical indexes, such as glucose, lipid profile, liver function and renal function, were not affected by ELF-EMF exposure. In addition, no morphological change was observed in the liver and kidney from the exposure group. The exposure to ELF-EMF at the intensity of 1 mT for 24 weeks did not affect hematologic and biochemical indexes in adult rats.

<https://pubmed.ncbi.nlm.nih.gov/33107341/>

SAFETY OF SMARTWATCHES AND THEIR CHARGERS IN PATIENTS WITH CARDIAC IMPLANTABLE ELECTRONIC DEVICES

Stylianos Tzeis, Dimitrios Asvestas, Nektarios Moraitis, Emmanuel P Vardas, Panagiotis Mililis, Konstantinos Letsas, Konstantinos Kouvelas, Konstantina S Nikita, Panos Vardas. Safety of smartwatches and their chargers in patients with cardiac implantable electronic devices. *Europace*. 2020 Oct 10;euaa220. doi: 10.1093/europace/euaa220.

Abstract

Aims: Cardiac implantable electronic devices (CIEDs) are susceptible to electromagnetic interference (EMI). Smartwatches and their chargers could be a possible source of EMI. We sought to assess whether the latest generation smartwatches and their chargers interfere with proper CIED function.

Methods and results: We included consecutive CIED recipients in two centres. We tested two latest generation smartwatches (Apple Watch and Samsung Galaxy Watch) and their charging cables for potential EMI. The testing was performed under continuous electrocardiogram recording and real-time device telemetry, with nominal and 'worst-case' settings. In vitro magnetic field measurements were performed to assess the emissions from the tested devices, initially in contact with the probe and then at a distance of 10 cm and 20 cm. In total, 171 patients with CIEDs (71.3% pacemakers-28.7% implantable cardioverter-defibrillators) from five manufacturers were enrolled (63.2% males, 74.8 ± 11.4 years), resulting in 684 EMI tests. No EMI was identified in any patient either under nominal or 'worst-case scenario' programming. The peak magnetic flux density emitted by the smartwatches was similar to the background noise level (0.81 μ T) even when in contact with the measuring probe. The respective values for the chargers were 4.696 μ T and 4.299 μ T for the Samsung and Apple chargers, respectively, which fell at the background noise level when placed at 20 cm and 10 cm, respectively.

Conclusion: Two latest generation smartwatches and their chargers resulted in no EMI in CIED recipients. The absence of EMI in conjunction with the extremely low intensity of magnetic fields emitted by these devices support the safety of their use by CIED patients.

<https://pubmed.ncbi.nlm.nih.gov/33038213/>

TUMOUR TREATING FIELDS THERAPY FOR GLIOBLASTOMA: CURRENT ADVANCES AND FUTURE DIRECTIONS

Ola Rominiyi, Aurelie Vanderlinden, Susan Jane Clenton, Caroline Bridgewater, Yahia Al-Tamimi, Spencer James Collis. Tumour treating fields therapy for glioblastoma: current advances and future directions. *Br J Cancer*. 2020 Nov 4. doi: 10.1038/s41416-020-01136-5.

Abstract

Glioblastoma multiforme (GBM) is the most common primary brain tumour in adults and continues to portend poor survival, despite multimodal treatment using surgery and chemoradiotherapy. The addition of tumour- treating fields (TTFields)-an approach in which alternating electrical fields exert biophysical force on charged and polarisable molecules known as dipoles-to standard therapy, has been shown to extend survival for patients with newly diagnosed GBM, recurrent GBM and mesothelioma, leading to the clinical approval of

this approach by the FDA. TTFields represent a non-invasive anticancer modality consisting of low-intensity (1-3 V/cm), intermediate-frequency (100-300 kHz), alternating electric fields delivered via cutaneous transducer arrays configured to provide optimal tumour-site coverage. Although TTFields were initially demonstrated to inhibit cancer cell proliferation by interfering with mitotic apparatus, it is becoming increasingly clear that TTFields show a broad mechanism of action by disrupting a multitude of biological processes, including DNA repair, cell permeability and immunological responses, to elicit therapeutic effects. This review describes advances in our current understanding of the mechanisms by which TTFields mediate anticancer effects. Additionally, we summarise the landscape of TTFields clinical trials across various cancers and consider how emerging preclinical data might inform future clinical applications for TTFields.

Open access paper: <https://www.nature.com/articles/s41416-020-01136-5>

A NEW LOOK AT THREE POTENTIAL MECHANISMS PROPOSED FOR THE CARCINOGENESIS OF 5G RADIATION

Bevelacqua JJ, Mehdizadeh AR, Mortazavi SMJ. A New Look at Three Potential Mechanisms Proposed for the Carcinogenesis of 5G Radiation. Editorial. J Biomed Phys Eng. Article in Press, Available online 27 September 2020.

Open access paper:

https://jbpe.sums.ac.ir/article_46931_90569196c2b806dfbd5ca574a4d6bee7.pdf

BENEFITS AND HAZARDS OF ELECTROMAGNETIC WAVES, TELECOMMUNICATION, PHYSICAL AND BIOMEDICAL: A REVIEW

S Batool, A Bibi, F Frezza, F Mangini. Benefits and hazards of electromagnetic waves, telecommunication, physical and biomedical: a review. Eur Rev Med Pharmacol Sci. 2019 Apr;23(7):3121-3128. doi: 10.26355/eurev_201904_17596.

Abstract

The aim of this paper is to review the current literature on electromagnetic radiation (EMR): physical, biophysical, and telecommunication. The widespread application of EMR in modern technologies requires telecommunication and healthcare professionals to possess some knowledge of its physical and biological properties. In this review article, we will discuss biophysical principles of EMR, its interactions with living organisms and its application in clinical practices. We will discuss here beneficial as well as hazardous effects of EMR. We will also discuss the safety guidelines.

Open access paper: <https://www.europeanreview.org/article/17596>

NON-IONIZING RADIATION AS POSSIBLE CARCINOGEN

Shiwangi Gupta, Radhey Shyam Sharma, Rajeev Singh. Non-ionizing radiation as possible carcinogen. *Int J Environ Health Res.* 2020 Sep 4;1-25. doi: 10.1080/09603123.2020.1806212.

Abstract

The advent of wireless technologies has revolutionized the way we communicate. The steady upsurge in the use of mobile phone all over the world in the last two decades, while triggered economic growth, has caused substantial damage to the environment, both directly and indirectly. The electromagnetic radiation generated from mobile phones, radio-based stations, and phone towers, high-voltage power lines have been reported which leads to the variety of health scares such as the risk of cancer in human beings and adverse effects in animals, birds, etc. Though the usage of such radiation emitting from mobile phones has risen steeply, there is a lack of proper knowledge about the associated risks. The review provides the latest research evidence based both on in vitro studies, in vivo studies, and possible gaps in our knowledge. Moreover, the present review also summarizes available literature in this subject, reports and studies which will help to form guidelines for its exposure limits to the public.

Excerpt

In conclusion, the results of the investigations were inconclusive, and in fact, indicated little or no association between the exposure to RFR with that of radiation and cancer. But NTP reported that RFR causes cancer in experimental animals. Nevertheless, it should also be pointed out in several epidemiological studies where weak association between carcinogenicity and RFR was observed. All the more reasons that the effects and the risk associated with the exposure to mobile phones were not consistent and didn't show any regular pattern. Studies on the exposure in children were also very limited. This discussion was intended to answer whether there's a health risk involved with the use of mobile phones, but at this stage, the review has not all the answers. The good thing is, several researchers are working on this field, and with more studies we'll surely get better clarity on the subject. Although there's little doubt of the risks involved with mobile phone usage, and therefore, this review indicates that precautions are needed while using mobile phones. Although, the available evidences do not provide a link between the exposure to RFR and microwave radiation and its effect on human health, at this moment, it's not possible to state otherwise as well. In the case of cancer, only the studies that were conducted for more extended period of time able to indicate any association between the use of mobile phone and cancer, especially brain cancer. The above studies suggested that GSM operated mobile phones have significant effect in comparison to CDMA operated mobile phones. As mobile phones have become an integral part of our everyday life, and so, it's even more critical today to study their effects on the human body. To conclude, it's time for government agencies and concerned bodies to understand the potentially harmful effects of RFR and to consider preventive actions like use of good phone brands keeping health and safety at priorities, use of Bluetooth (hands-free devices) and mobile phones having minimum SAR value. Animal studies for longer period of time are needed to execute for the probable health effects. There are no useful data available regarding RF; thus only data suggest a health risk associated with RF so far and the research is still shapeless, about both the amount and quality of available data. Thus, it's not possible to draw any conclusions yet and we must wait for future results.

<https://pubmed.ncbi.nlm.nih.gov/32885667/>

RF-EMF EXPOSURE EFFECTS ON SLEEP - AGE DOESN'T MATTER IN MEN!

Torsten Eggert, Hans Dorn, Cornelia Sauter, Gernot Schmid, Heidi Danker-Hopfe. RF-EMF exposure effects on sleep - Age doesn't matter in men! Environ Res. 2020 Sep 12;110173. doi: 10.1016/j.envres.2020.110173.

Abstract

Background: Although there are several human experimental studies on short-term effects of radiofrequency electromagnetic fields (RF-EMF) on sleep, the role of effect modification by sex or age in this context has not yet been considered. In an earlier study, we observed sex differences in RF-EMF effects in elderly subjects. The present study investigated possible RF-EMF effect modifications by age in men.

Methods: Data available for the present analysis come from three double-blind, randomized cross-over studies, in which effects of different RF-EMF exposure signals on sleep were investigated in young [sample 1: 25.3 (mean) $\pm$ 2.6 (SD) years; sample 2: 25.4 $\pm$ 2.6 years; n=30, respectively] and older (69.1 $\pm$ 5.5 years; n=30) healthy male volunteers. Studies comprised a screening/adaptation night followed by nine experimental nights at two-week intervals. RF-EMF exposure effect modifications by age were analysed for two different exposure signals (GSM900 at 2 W/kg, TETRA at 6 W/kg), each compared to a sham exposure. Polysomnography, during which the exposure signals were delivered by a head worn antenna, as well as sleep staging were performed according to the AASM standard. Four subjective and 30 objective sleep parameters were statistically analysed related to possible RF-EMF effects.

Results: Comparisons of sleep parameters observed under sham exposure revealed highly pronounced physiological differences between young and elderly men. A consistent exposure effect in both age groups was found for a shorter latency to persistent sleep under TETRA exposure reflecting a sleep-promoting effect. Exposure effect modifications by age were observed for two of the four self-reported sleep parameters following GSM900 exposure and for arousals during REM sleep under TETRA exposure.

Conclusions: As effects of a short-term all-night RF-EMF exposure on sleep occurred only sporadically in young and elderly men, it seems that age doesn't matter in this respect. However, as long as there are no corresponding data from young healthy women that would allow a comparison with the data from elderly women, this assumption cannot be conclusively verified. Nevertheless, the present results are not indicative of any adverse health effects.

<https://pubmed.ncbi.nlm.nih.gov/32931791/>

FUNCTIONAL AND NETWORK ANALYSES OF HUMAN EXPOSURE TO LONG-TERM EVOLUTION SIGNAL (4G STUDY)

Lei Yang, Chen Zhang, Zhiye Chen, Congsheng Li, Tongning Wu. Functional and network analyses of human exposure to long-term evolution signal. *Environ Sci Pollut Res Int*. 2020 Sep 25. doi: 10.1007/s11356-020-10728- w.

Abstract

Human exposure to the electromagnetic field emitted by wireless communication systems has raised public concerns. There were claims of the potential association of some neurophysiological disorders with the exposure, but the mechanism is yet to be established. The wireless networks, recently, experience a transition from the 4th generation (4G) to 5th generation (5G), while 4G long-term evolution (LTE) is still the frequently used signal in wireless communication. In the study, exposure experiments were conducted using the LTE signal. The subjects were divided into sham and real exposure groups. Before and after the exposure experiments, they underwent functional magnetic resonance imaging. Within-session and between-session comparisons have been executed for functional connectivity and network properties. Individual specific absorption rate (SAR) was also calculated. The results indicated that acute LTE exposure beneath the safety limits modulated both the functional connection and graph-based properties. To characterize the effect of functional activity, SAR averaged over a certain tissue mass was not an appropriate metric. The potential neurophysiological effect of 5G exposure has also been discussed in the study.

<https://pubmed.ncbi.nlm.nih.gov/32974829/>

Excerpts

Since 2019, the fifth-generation (5G) wireless network has been implemented. Two different frequency ranges available for 5G wireless technology include- frequency range 1 (FR1) and frequency range 2 (FR2). At present, the popular commercial frequency at FR1 was around 2.4 and 3.5 GHz, close to the current 3G and 4G frequencies. The emission power of 5G mobile phones is comparable to that of 3G and 4G terminals. Most of the existed literature, as well as our studies, narrated similar activated sites (frontal and temporal lobules) for different frequencies/modulations. It is, therefore, reasonable to expect that the exposure to new generation wireless signals would result in a similar effect.

Conclusion

Human brain modulation following LTE exposure was firstly evaluated by functional and network metrics. The topological changes have been reported, and their consistency with the previous analysis was highlighted. Integrating the results from the regional BOLD variation, intraregional similarity, and hypothesis-driven FC analysis, a comprehensive view for the brain activity by the exposure of LTE signal and the signal of next- generation can be obtained. Another novelty was that no correlation was found between the peak SAR values and the altered topological parameters. It demonstrated peak SAR averaged over a certain mass, which was used for assessing the thermal effect of human exposure, was incongruous to quantify the neurophysiological effect of EMF exposure. It may clarify the inconsistency in current human exposure studies.

RADIOFREQUENCY RADIATION: WAYS TO THE RISK ASSESSMENT

Sergei Jargin. Radiofrequency Radiation: Ways to the Risk Assessment. Dose Response. 2020 Sep 11;18(3):1559325820959557. doi: 10.1177/1559325820959557.

No abstract.

Open access letter: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7488907/>

ARE CONTEMPORARY SMARTWATCHES AND MOBILE PHONES SAFE FOR PATIENTS WITH CARDIOVASCULAR IMPLANTABLE ELECTRONIC DEVICES?

Philipp Lacour, Abdul Shokor Parwani, Franziska Schuessler, Felix Hohendanner, Frank R Heinzl, et al. Are Contemporary Smartwatches and Mobile Phones Safe for Patients With Cardiovascular Implantable Electronic Devices? CC Clin Electrophysiol. 2020 Sep;6(9):1158-1166. doi: 10.1016/j.jacep.2020.04.033.

Abstract

Objectives: Given the increasing prevalence of mobile phone and smartwatch use, this study tested patients with cardiovascular implantable electronic devices (CIEDs) for the incidence and consequence of contemporary mobile phone and smartwatch-produced electromagnetic interferences.

Background: Electromagnetic interferences can be hazardous for patients with CIEDs.

Methods: In total, 148 patients with CIEDs and leads from 4 different manufacturers were subjected to 1,352 tests. Analyzed CIEDs included 51 pacemakers, 5 cardiac resynchronization therapy pacemakers, 46 implantable cardioverter-defibrillators, 43 cardiac resynchronization therapy defibrillators, and 3 implantable loop recorders. To analyze a possible influence of certain distances between the mobile phone (iPhone 6) and the smartwatch (Apple Watch A1553) to the CIED, both were placed either directly above implanted devices or at the right wrist. All possible activations of the iPhone and the Apple Watch, including the standby, dialing, and connecting modes (telephone connection and Internet access) were tested. In addition, we studied incidence and characteristics of interferences with interrogation telemetry.

Results: In this study, only a single case of mobile phone-induced electromagnetic interference on a dual-chamber pacemaker was observed. Utilizing wand telemetry, iPhone induced interferences were found in 14% of the patients. However, none of the patients showed any interference with the Apple Watch.

Conclusions: The risk of electromagnetic interferences of the iPhone 6 and the Apple Watch with CIEDs is low. However, close proximity of the iPhone 6 to implanted devices can cause telemetry interferences.

<https://pubmed.ncbi.nlm.nih.gov/32972552/>

INVESTIGATION OF SPECIFIC ABSORPTION RATE (SAR) NEAR MODEL OF FETUS IN UTERUS

Zuzana Psenakova, Mariana Beňová, Timea Lauková. Investigation of Specific Absorption Rate (SAR) near model of fetus in uterus 2020. ELEKTRO, 25-28 May 2020, DOI: 10.1109/ELEKTRO49696.2020.9130308.

Abstract

This article deals with effects of electromagnetic fields (EMF) to different models that represent the model of a pregnant woman- AustinWoman, model in first trimester of pregnancy and model of fetus in uterus in 35 weeks of pregnancy. There are differences between specific absorption rate (SAR) near model of fetus in uterus and AustinWoman model in open area. In the presented approach, the investigation is focused on modelling of EMF proceeded on the finite integration method. The simulations were carried out for specific scenario where a person-pregnant woman was placed in the open space using a cellular phone. The results were evaluated in terms of the SAR values – the determination of electromagnetic (EM) energy absorption inside the human models. Two antennas- dipole antenna with a frequency of 2,4 GHz and planar monopole antenna were designed and work as radio frequency sources in our simulations. In the proposed matching method, two models of human body – Model of fetus in uterus and AustinWoman model - were chosen to simulate in different situations with different models of antennas. Both have the dielectric properties determined to the evaluated frequency of source. The numerical results have shown that the obtained maximal SAR values in AustiWoman model is higher than are maximum values determined according to maximum SAR in European standards limit.

Conclusions

In this paper, the study of the electromagnetic energy absorption changes caused to the two models by pregnancy by different antennas and frequencies were proposed. The near-field exposure results from have shown that the SAR values vary for the antenna type and pregnant model type, where is the antenna placed 10mm from models.

In some cases of our simulation scenarios, the SAR values results are not within the limits for public radio- frequency EMF field exposure by ICNRIP. However, it could be caused by setting the specific parameters of our simulations – such as dielectric parameters of materials, number of voxels, boundary conditions in each space and types of using models. On the other hand, the cases presented in this paper represent a risk for long-term exposure of human body, especially of fetus by pregnancy, to EMF.

In this article we want to show differences between two models of human body in pregnancy and differences by specific frequencies and antennas types. Our investigation shows, that higher SAR value is by higher resolution model -AustinWoman, model in first trimester of pregnancy, and by frequency 900MHz for monopole antenna. In first trimester of pregnancy is fetus the most sensitive for negative influences from environment and not enough safety is not recommended. Therefore, a woman at this stage of pregnancy should be particularly protected and the limits of SAR should be respected.

<https://ieeexplore.ieee.org/document/9130308>

EVALUATION OF SPECIFIC ABSORPTION RATE IN THE FAR-FIELD, NEAR-TO-FAR FIELD AND NEAR-FIELD REGIONS FOR INTEGRATIVE RADIOFREQUENCY EXPOSURE ASSESSMENT

Ilaria Liorni, Myles Capstick, Luuk van Wel, Joe Wiart, Wout Joseph, Elisabeth Cardis, Mònica Guxens, Roel Vermeulen, Arno Thielens. Evaluation of Specific Absorption Rate in the Far-Field, Near-to-Far Field and Near- Field Regions for Integrative Radiofrequency Exposure Assessment. Radiat Prot Dosimetry. 2020 Sep 28;ncaa127. doi: 10.1093/rpd/ncaa127.

Abstract

The specific absorption rate (SAR) induced by wireless radiofrequency (RF) systems depends on different parameters. Previously, SAR was mainly assessed under conditions of a single frequency and technology and for a limited number of localized RF sources. The current and emerging mobile systems involve a wider range of usage scenarios and are frequently used simultaneously, leading to combined exposures for which almost no exposure evaluation exists. The aim and novelty of this study is to close this gap of knowledge by developing new methods to rapidly evaluate the SAR induced by RF systems in such scenarios at frequencies from 50 MHz to 5.5 GHz. To this aim, analytical methods for SAR estimation in several usage scenarios were derived through a large-scale numerical study. These include subject-specific characteristics, properties of the RF systems and provide an estimation of the SAR in the whole body, tissues and organs, and different brain regions.

<https://pubmed.ncbi.nlm.nih.gov/32990753/>

Conclusions

In this study, an easy-to-use approach for fast estimation of RF-EMF exposure in terms of SAR within the human body resulting from simultaneously operated RF systems in different exposure scenarios is proposed. System- specific analytical approximation formulas for quantification of the absorbed power of several RF systems over a wide range of human subjects and frequencies, accounting for variations in system location, posture, age, sex and morphology were developed. To this aim, numerical simulations of advanced human anatomical phantoms exposed to several RF systems to simulate far-field, near-to-far field, and near-field exposure conditions were executed and analyzed. The approximation formulas permit to have an estimation of the absorbed power in the whole body, tissues and organs and different brain regions. Since the general population is normally exposed to numerous sources of RF exposure during the day, these approximation formulas represent a useful tool for epidemiology studies to predict the cumulative exposure for assessment of health impact. Indeed, the SAR levels can be combined with personal information about the conditions and duration of use of each RF source and scaled with respect to the actual output power of each device to obtain typical and personal integrated and cumulative RF doses

DOES THE SHORT-TERM EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELD ORIGINATING FROM MOBILE PHONE AFFECT AUDITORY FUNCTIONS AS MEASURED BY ACOUSTIC ADMITTANCE AND EVOKED OTOACOUSTIC EMISSION TESTS?

Artur Kacprzyk, Sebastian Kocoń, Jacek Składzień, Eugeniusz Rokita, Rafał Pawlak, Jakub Kwiecień, Grzegorz Tatoń. Does the short-term exposure to radiofrequency electromagnetic field originating from mobile phone affect auditory functions as measured by Acoustic Admittance and Evoked Otoacoustic Emission tests? *Electromagn Biol Med.* 2020 Sep 30;1-8. doi: 10.1080/15368378.2020.1826960.

Abstract

Background: Mobile phones constitute an important source of radiofrequency electromagnetic field (RF-EMF) for humans. Taking into account high sensitivity of sensory hair cells of the inner ear to endogenous and exogenous agents, the potential impact of mobile phone usage on auditory organs is of particular interest.

Aim: The aim of the study was to evaluate the impact of short-term exposure to RF-EMF generated by a mobile phone during 15-minute simulated phone call on human hearing as measured by Transient Evoked Otoacoustic Emission (TEOAE) and Acoustic Admittance Testing (AAT).

Material and methods: Within-subject study was performed on 23 healthy volunteers. All of the participants underwent TEOAE and AAT before and immediately after 15-minute simulated phone call with the use of a standard, modern smartphone. Analyzed parameters included: static compliance of tympanic membrane, middle ear pressure, ipsi- and contralateral acoustic reflex thresholds and percentage of signal reproducibility in TEOAE for exposed and non-exposed ear. Additionally, the results were compared in subgroups distinguished basing on self-reported sensitivity to RF-EMF originating from mobile phones.

Results: No statistically significant differences were identified between results of TEOAE and AAT before and after exposure, both in exposed and non-exposed ear. The results of EMF sensitive and non-sensitive subjects were comparable in all performed tests.

Conclusions: Short-term exposure to mobile phone electromagnetic field did not influence auditory functions as measured by Evoked Otoacoustic Emission test and Acoustic Admittance Testing.

<https://pubmed.ncbi.nlm.nih.gov/32993394/>

Limitations

Study sample was relatively small and consisted only of males. Such a sample may not be representative for the entire population, thus the conclusions drawn from the research cannot be simply generalized. Furthermore, only single signal frequency band (2100 MHz) was used in our study protocol. Keeping in mind that new generations of cellular telecommunication are currently being implemented it is important to conduct further studies to assess their potential hazards.

EVALUATION OF INFLAMMATION BY CYTOKINE PRODUCTION FOLLOWING COMBINED EXPOSURE TO ULTRAVIOLET AND RADIOFREQUENCY RADIATION OF MOBILE PHONES ON 3D RECONSTRUCTED HUMAN SKIN IN VITRO

Zsófia Szilágyi, Zsuzsanna Németh, József Bakos, Péter Pál Necz, Anna Sáfár, et al. Evaluation of Inflammation by Cytokine Production Following Combined Exposure to Ultraviolet and Radiofrequency Radiation of Mobile Phones on 3D Reconstructed Human Skin In Vitro. *Int J Environ Res Public Health*. 2020 Jun 19;17(12):4401. doi: 10.3390/ijerph17124401.

Abstract

The absorption of exposure to radiofrequency (RF) emitted by wireless devices leads to a high specific absorption rate in the skin. Ultraviolet (UV) radiation can induce several damages to the skin. The aim of this study was to examine whether combined, consecutive exposure to solar UV radiation and 1950 MHz RF exposure of third generation (3G) mobile system have any effect on inflammation processes in the skin. Under in vitro experiments, the inflammation process was examined by cytokines (IL-1 α , IL-6, and IL-8) and MMP-1 enzyme secretion on 3D full thickness human skin model. The RF exposure was applied before or after UV irradiation, in order to study either the possible cooperative or protective effects of exposure to RF and UV. We did not find changes in cytokines due to exposure to RF alone. The RF exposure did not enhance the effects of UV radiation. There was a statistically not-significant decrease in cytokines when the skin tissues were pre-exposed to RF before being exposed to 4 standard erythemal dose (SED) UV compared to UV exposure alone. We found that RF exposure reduced the previously UV-treated MMP-1 enzyme concentration. This study might support the evaluation of the effects on the skin exposed to microwave radiation of 5G mobile technology.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7344923/>

EFFECTS OF PULSE-MODULATED RADIOFREQUENCY MAGNETIC FIELD (RF-EMF) EXPOSURE ON APOPTOSIS, AUTOPHAGY, OXIDATIVE STRESS AND ELECTRON CHAIN TRANSPORT FUNCTION IN HUMAN NEUROBLASTOMA AND MURINE MICROGLIAL CELLS

Jana Zielinski, Angélique D. Ducray, Anja M. Moeller, Manuel Murbach, Niels Kuster, Meike Mevissen. Effects of pulse-modulated radiofrequency magnetic field (RF-EMF) exposure on apoptosis, autophagy, oxidative stress and electron chain transport function in human neuroblastoma and murine microglial cells. *Toxicology in Vitro*. Vol. 68, October 2020, 104963. <https://doi.org/10.1016/j.tiv.2020>.

Highlights

- RF-EMF exposure (935 MHz, 4 W/kg) did not cause apoptosis in SH-SY5Y and microglial cells.
- The time-dependent increase in autophagy markers is related to the cell type.
- A transient increase in oxidative stress was seen at SAR levels above the standards.

Abstract

The use of body-worn wireless devices with different communication protocols and rapidly changing exposure scenarios is still multiplying and the need to identify possible health effects of radiofrequency electromagnetic field (RF-EMF) exposure with extremely low-frequency

(ELF) modulation envelopes. In this study, effects of ELF- modulated 935 MHz RF-EMF on apoptosis, autophagy, oxidative stress and electron exchange in N9 microglial and SH-SY5Y neuroblastoma cells were investigated.

Cells were exposed at 4 W/kg or sham-exposed for 2 and 24 h. RF-EMF exposure of both cell types did not alter apoptosis, the number of living cells nor the apoptosis-inducing factor (AIF), irrespective of the exposure duration. RF-EMF exposure for 24, but not for 2 h, increased protein levels of the autophagy marker ATG5, whereas LC3B-I and II and pERK were not altered in both cell types and exposure times investigated. A transient increase in glutathione (GSH), but not hydrogen peroxide and cytochrome c oxidase was found only in SH-SY5Y cells, indicating that short-time RF-EMF at SAR levels accepted by today's safety guidelines might cause autophagy and oxidative stress with the effect being dependent on cell type and exposure duration. Further studies are needed to evaluate possible underlying mechanisms involved in pulse-modulated RF-EMF exposure.

<https://www.sciencedirect.com/science/article/abs/pii/S0887233320305130>

EFFECT OF LUTEOLIN ON BIOCHEMICAL, IMMUNOHISTOCHEMICAL, AND MORPHOMETRICAL CHANGES IN RAT SPINAL CORD FOLLOWING EXPOSURE TO A 900 MHZ ELECTROMAGNETIC FIELD

Ahmad Yahyazadeh, Berrin Zuhail Altunkaynak. Effect of Luteolin on Biochemical, Immunohistochemical, and Morphometrical Changes in Rat Spinal Cord following Exposure to a 900 MHz Electromagnetic Field. Biomed Environ Sci. 2020 Aug 20;33(8):593-602. doi: 10.3967/bes2020.078.

Abstract

Objective: This study aimed to investigate the effect of exposure to a 900 MHz electromagnetic field (EMF) on the cervical spinal cord (CSC) of rats and the possible protective effect of luteolin (LUT) against CSC tissue damage.

Methods: Quantitative data were obtained via stereological, biochemical, immunohistochemical, and histopathological techniques. We investigated morphometric value, superoxide dismutase (SOD) level, and the expression of high-mobility group box 1 protein molecules, as well as histological changes.

Results: The total number of motor neurons in the EMF group significantly decreased in comparison with that in the control group ($P < 0.05$). In the EMF + LUT group, we found a significant increase in the total number of motor neurons compared with that in the EMF group ($P < 0.05$). SOD enzyme activity in the EMF group significantly increased in comparison with that in the control group ($P < 0.05$). By contrast, the EMF+LUT group exhibited a decrease in SOD level compared with the EMF group ($P < 0.05$).

Conclusion: Our results suggested that exposure to EMF could be deleterious to CSC tissues. Furthermore, the protective efficacy of LUT against SC damage might have resulted from the alleviation of oxidative stress caused by EMF.

Open access paper: <http://www.besjournal.com/en/article/doi/10.3967/bes2020.078>

RADIOFREQUENCY ELECTROMAGNETIC FIELD AFFECTS HEART RATE VARIABILITY IN RABBITS

Jakub Misek, Marcel Veternik, Ingrid Tonhajzerova, et al. Radiofrequency Electromagnetic Field Affects Heart Rate Variability in Rabbits. *Physiological Research*. 69(4):633-643. Aug 2020.

Summary

The aim of this study was to assess the effects of radiofrequency electromagnetic field (RF EMF) on heart rate variability (HRV) in rabbits with intensity slightly exceeding the limits for occupations. Totally 21 New Zealand white rabbits divided into two groups were used in this double-blind study. The first group of animals without general anesthesia was subjected to HRV examination under exposure to a device generated RF EMF source (frequency 1788 MHz, intensity 160 V/m, lasting 150 min.). The second group (premedications + α chloralose mg/kg) underwent the same protocol under the exposure to the real RF EMF signal from the base stations of mobile providers (frequency range 1805 – 1870 MHz -corresponding to the downlink signal of Slovak mobile providers, 160 V/m, 150 min., respectively). Individual 5-min records were used to analyze the HRV parameters: heart rate and root Mean Square of the Successive Differences (rMSSD) for time domain analysis and spectral powers in the low (LF-VFS) and high frequency (HF-VFS) bands for frequency domain analysis. Our study revealed the increased in HRV parameters (HF-HRV, rMSSD) associated with lower heart rate indicating increased cardiac vagal control under the exposure to RF EMF in experimental methods.

Open access paper: https://www.biomed.cas.cz/physiolres/pdf/2020/69_633.pdf

RADIOFREQUENCY ELECTROMAGNETIC RADIATION FROM WI-FI AND ITS EFFECTS ON HUMAN HEALTH, IN PARTICULAR CHILDREN AND ADOLESCENTS. REVIEW

Andrzej Magiera, Jolanta Solecka. Radiofrequency electromagnetic radiation from Wi-fi and its effects on human health, in particular children and adolescents. Review. *Rocz Panstw Zakl Hig*. 2020;71(3):251-259. doi: 10.32394/rpzh.2020.0125.

Abstract

Radiofrequency electromagnetic radiation emitted from Wi-Fi devices is nonionizing radiation. The frequencies used in wireless technology are similar to those applied in mobile telephony. Due to the much lower output power of devices using Wi-Fi compared to mobile phones, the degree of exposure to radiation is also lower.

Most of the research on Wi-Fi has been carried out in less favorable or adverse conditions, involving higher power values of devices (peak values instead of average values) and smaller distances of working devices from measuring points. None of the studies conducted so far have indicated that there were the exceedances of the permissible values of radiofrequency electromagnetic radiation contained in the Polish and global legal regulations. Similar to the research related to the impact of mobile telephony on human health, the studies conducted until now focusing on exposure to Wi-Fi are considered ambiguous as they do not give a definitive answer on the possible negative (including carcinogenic) effects on human health. Because of the continuous development of wireless networks, there is a need for further research on this topic. Moreover, due to the high popularity of devices using Wi-Fi among children and adolescents, whose period of exposure to electromagnetic radiation is longer compared to adults, it is necessary to continuously observe these populations and subject

them to careful analysis.

<https://pubmed.ncbi.nlm.nih.gov/32938167/>

HUMAN FIBROBLASTS IN VITRO EXPOSED TO 2.45 GHZ CONTINUOUS AND PULSED WAVE SIGNALS: EVALUATION OF BIOLOGICAL EFFECTS WITH A MULTIMETHODOLOGICAL APPROACH

Elisa Regalbuto, Anna Anselmo, Stefania De Sanctis, Valeria Franchini, Florigio Lista, Monica Benvenuto, Roberto Bei, Laura Masuelli, Guglielmo D'Inzeo, Alessandra Paffi, Eugenio Trodella, Antonella Sgura. Human Fibroblasts In Vitro Exposed to 2.45 GHz Continuous and Pulsed Wave Signals: Evaluation of Biological Effects with a Multimethodological Approach. *Int J Mol Sci.* 2020 Sep 25;21(19):E7069. doi: 10.3390/ijms21197069.

Abstract

The increasing exposure to radiofrequency electromagnetic fields (RF-EMF), especially from wireless communication devices, raises questions about their possible adverse health effects. So far, several in vitro studies evaluating RF-EMF genotoxic and cytotoxic non-thermal effects have reported contradictory results that could be mainly due to inadequate experimental design and lack of well-characterized exposure systems and conditions. Moreover, a topic poorly investigated is related to signal modulation induced by electromagnetic fields. The aim of this study was to perform an analysis of the potential non-thermal biological effects induced by 2.45 GHz exposures through a characterized exposure system and a multimethodological approach. Human fibroblasts were exposed to continuous (CW) and pulsed (PW) signals for 2 h in a wire patch cell-based exposure system at the specific absorption rate (SAR) of 0.7 W/kg. The evaluation of the potential biological effects was carried out through a multimethodological approach, including classical biological markers (genotoxic, cell cycle, and ultrastructural) and the evaluation of gene expression profile through the powerful high-throughput next generation sequencing (NGS) RNA sequencing (RNA-seq) approach. Our results suggest that 2.45 GHz radiofrequency fields did not induce significant biological effects at a cellular or molecular level for the evaluated exposure parameters and conditions.

<https://www.mdpi.com/1422-0067/21/19/7069>

EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS AND THE RISK OF CHILDHOOD B-LINEAGE ACUTE LYMPHOBLASTIC LEUKEMIA IN A CITY WITH HIGH INCIDENCE OF LEUKEMIA AND ELEVATED EXPOSURE TO ELF MAGNETIC FIELDS

Juan C Núñez-Enríquez, Víctor Correa-Correa, Janet Flores-Lujano, María L Pérez-Saldivar, Elva Jiménez- Hernández, et al. Extremely Low-Frequency Magnetic Fields and the Risk of Childhood B-Lineage Acute Lymphoblastic Leukemia in a City With High Incidence of Leukemia and Elevated Exposure to ELF Magnetic Fields. *Bioelectromagnetics.* 2020 Sep 23. doi: 10.1002/bem.22295.

Abstract

It is important to study the relationship between extremely low-frequency magnetic fields (ELF-MFs) and childhood leukemia, particularly in locations with a high incidence of this neoplasm in children and an elevated exposure to ELF-MF, such as Mexico City. The aim was to investigate the association between ELF-MF exposure and the risk of B-lineage acute

lymphoblastic leukemia (B-ALL). A case-control study was conducted in Mexico City during the period from 2010 to 2011. Residential 24-h ELF-MF measurements were obtained for 290 incident B-ALL patients and 407 controls, aged less than 16 years. Controls were frequency-matched by sex, age (± 18 months), and health institution. The adjusted odds ratios (aOR) and 95% confidence intervals (CIs) were calculated. ELF-MF exposure at $<0.2 \mu\text{T}$ was used to define the reference group. ELF-MF exposure at $\geq 0.3 \mu\text{T}$ was observed in 11.3% of the controls. Different ELF-MF intensity cutoff values were used to define the highest exposure category; the highest exposure category for each cutoff value was associated with an increased risk of B-ALL compared with the corresponding lower exposure categories. The aORs were as follows: $\geq 0.2 \mu\text{T} = 1.26$ (95% CI: 0.84-1.89); $\geq 0.3 \mu\text{T} = 1.53$ (95% CI: 0.95-2.48); $\geq 0.4 \mu\text{T} = 1.87$ (95% CI: 1.04-3.35); $\geq 0.5 \mu\text{T} = 1.80$ (95% CI: 0.95-3.44); $\geq 0.6 \mu\text{T} = 2.32$ (95% CI: 1.10-4.93). ELF-MF exposure as a continuous variable (per $0.2 \mu\text{T}$ intervals) was associated with B-ALL risk (aOR = 1.06; 95% CI: 1.01-1.12). In the present study, the proportion of children exposed to $\geq 0.3 \mu\text{T}$ is among the highest reported worldwide. Additionally, an ELF-MF exposure $\geq 0.4 \mu\text{T}$ may be associated with the risk of B-ALL.

<https://pubmed.ncbi.nlm.nih.gov/32965755/>

AMYOTROPHIC LATERAL SCLEROSIS, OCCUPATIONAL EXPOSURE TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS AND ELECTRIC SHOCKS: A SYSTEMATIC REVIEW AND META-ANALYSIS

Hamed Jalilian, Kamran Najafi, Yahya Khosravi, Martin Rösli. Amyotrophic lateral sclerosis, occupational exposure to extremely low frequency magnetic fields and electric shocks: a systematic review and meta-analysis. *Rev Environ Health*. 2020 Sep 18;/j/reveh.ahead-of-print/reveh-2020-0041/reveh-2020-0041.xml. doi: 10.1515/reveh-2020-0041.

Abstract

Exposure to extremely low frequency magnetic fields (ELF-MF) and electric shocks occurs in many workplaces and occupations but it is unclear whether any of these exposures cause Amyotrophic lateral sclerosis (ALS). The aim of this systematic review and meta-analysis is to explore whether occupational exposure to ELF-MF and/or electric shocks are risk factor for ALS. We searched PubMed, Embase, and Web of Science databases up to the end of 2019. Pooled risk estimates were calculated using random-effects meta-analysis including exploration of the sources of heterogeneity between studies and publication bias. Twenty-seven publications fulfilled the inclusion criteria. We found a weak, significant, association between occupational exposure to ELF-MF and the risk of ALS (RRPooled estimate: 1.20; 95%CI: 1.05, 1.38) with moderate to high heterogeneity ($I^2=66.3\%$) and indication of publication bias (PEgger's test=0.03). No association was observed between occupational exposure to electric shocks and risk of ALS (RRPooled estimate: 0.97; 95%CI: 0.80, 1.17) with high heterogeneity ($I^2=80.5\%$), and little indication for publication bias (PEgger's test=0.24). The findings indicate that occupational exposure to ELF-MF, but not electric shocks, might be a risk factor for ALS. However, given the moderate to high heterogeneity and potential publication bias, the results should be interpreted with caution.

<https://pubmed.ncbi.nlm.nih.gov/32946420/>

ASSOCIATION OF OCCUPATIONAL FACTORS AND DEMENTIA OR COGNITIVE IMPAIRMENT: A SYSTEMATIC REVIEW AND META- ANALYSIS

Liang-Yu Huang, He-Ying Hu, Zuo-Teng Wang, Ya-Hui Ma, Qiang Dong, Lan Tan, Jin-Tai Yu. Association of Occupational Factors and Dementia or Cognitive Impairment: A Systematic Review and Meta-Analysis. J Alzheimers Dis. 2020 Sep 19. doi: 10.3233/JAD-200605.

Abstract

Background: Several existing studies have reported that occupational factors might play an important part in cognitive function with aging.

Objective: We aim to explore the associations between modifiable occupational factors and risk of dementia or mild cognitive impairment (MCI).

Methods: Adopting random-effect models, this study conducted primary analyses for all occupational factors and subgroup analyses for the effect of occupation type based on prospective cohort and case-control studies searched from PubMed and EMBASE databases up to March 2020.

Results: Among the 38,111 identified literatures, 9 studies on occupation type, 4 studies on work complexity, and 30 studies on occupational exposure were included. In terms of occupation type, mental work conferred a 44% reduced risk (95% CI = 0.34-0.94, $I^2 = 85.00\%$, $p < 0.01$) for MCI. In terms of work complexity, higher work complexity conferred a 5% reduced risk (95% CI = 0.91-1.00, $I^2 = 57.00\%$, $p < 0.01$) for dementia. In terms of occupational exposure, high strain and passive job in the longest-held job conferred a 1.21- and 1.15-fold excess risk (95% CI = 1.05-1.39 $I^2 = 62.00\%$, $p < 0.05$; 95% CI = 1.05-1.26 $I^2 = 31.00\%$, $p = 0.23$; respectively) of cognitive decline. Besides, magnetic field exposure conferred a 1.26-fold excess risk (95% CI = 1.01-1.57, $I^2 = 69.00\%$, $p < 0.01$) for dementia.

Conclusion: Novel prevention strategies based on occupational factors may hold promise against dementia and MCI.

<https://pubmed.ncbi.nlm.nih.gov/32986670/>

RISK OF CONGENITAL HEART DISEASE DUE TO EXPOSURE TO COMMON ELECTRICAL APPLIANCES DURING EARLY PREGNANCY: A CASE-CONTROL STUDY

Doudou Zhao, Leqian Guo, Ruozhang, Qixia Zhu, Hongli Wang, Rong Liu, Hong Yan, Shaonong Dang. Risk of congenital heart disease due to exposure to common electrical appliances during early pregnancy: a case- control study. Environ Sci Pollut Res Int. 2020 Sep 19. doi: 10.1007/s11356-020-10852-7.

Abstract

To examine the association between exposure to common electrical appliances in early pregnancy and congenital heart disease (CHD). A case-control study of 2339 participants was conducted in six hospitals in Xi'an, Shaanxi Province, Northwest China from 2014 to 2016. All infants with CHD were diagnosed according to ICD-10 classification. Selected controls consisted of newborns from the same hospital, without any birth defects, and 1:3 matched by birthdate. We conducted personal interviews with the mothers to gather information on any exposure to electrical appliances during pregnancy. Multivariate logistic regression was

used to estimate the effects of exposure to common electrical appliances on CHD. We observed that the mothers exposed to computers (OR: 1.33, 95% CI: 1.03, 1.71), induction cookers (OR: 2.79, 95% CI: 2.19, 3.55), and microwave ovens (OR: 1.53, 95% CI: 1.01, 2.31) during early pregnancy were more likely to give birth to infants with CHD. Mothers who wore radiation protection suits (OR: 0.67, 95% CI: 0.52, 0.87) during early pregnancy decreased the risk of CHD in their neonate. There was an interaction for induction cooker exposure with wore radiation protection suits on CHD (RERI: - 1.44, 95% CI: - 2.48, - 0.39; S: 0.37, 95% CI: 0.16, 0.84; AP: - 0.79, 95% CI: - 1.53, - 0.05). Our study confirmed that exposure to some electrical appliances was associated with a higher risk of CHD, and wearing a radiation protection suit was associated with a lower risk of CHD. Women should therefore reduce the usage of electrical appliances before and during pregnancy.

<https://pubmed.ncbi.nlm.nih.gov/32949363/>

OXIDATIVE STRESS ASSOCIATED WITH LONG TERM OCCUPATIONAL EXPOSURE TO EXTREMELY LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS

Majid Bagheri Hosseinabadi, Narges Khanjani, Pirasteh Norouzi, Seyed Reza Mirbadie, Mozghan Fazli, Mehdi Mirzaei. Oxidative stress associated with long term occupational exposure to extremely low frequency electric and magnetic fields. Work. 2020 Sep 6. doi: 10.3233/WOR-203244.

Abstract

Background: Occupational exposure to extremely low frequency electromagnetic fields (ELF-EMFs) may have harmful effects on biologic systems and has raised many concerns in the last decades.

Objective: The aim of this study was to determine the effects of exposure to extremely low frequency electric and magnetic fields on lipid peroxidation and antioxidant enzyme activities.

Methods: This study was conducted on 115 power plant workers as the exposed group and 145 office workers as the non-exposed group. The levels of Malondialdehyde (MDA), Superoxide Dismutase (SOD), Catalase (Cat), and Total Antioxidant Capacity (TAC) were measured in the serum of all subjects. Exposure to ELF-EMFs was measured based on spot measurements and the IEEE Std C95.3.1 standard.

Results: The levels of MDA, SOD, and Cat in the exposed group were significantly higher than in the non-exposed group. However, the level of TAC was not significantly different between the exposed (2.45 ± 1.02) and non-exposed (2.21 ± 1.07) groups. The levels of MDA and SOD were higher among workers with higher exposure to electric fields than workers with low exposure. All oxidative stress indicators increased with increased exposure to magnetic fields, except TAC.

Conclusions: The antioxidant system imbalance among power plant workers may be related to long term occupational exposure to electromagnetic fields.

<https://pubmed.ncbi.nlm.nih.gov/32925155/>

EFFECTS OF ANTIOXIDANT VITAMINS ON PROINFLAMMATORY CYTOKINES AND BIOCHEMICAL PARAMETERS OF POWER PLANT WORKERS: DOUBLE-BLIND RANDOMIZED CONTROLLED CLINICAL TRIAL

Majid Bagheri Hosseinabadi, Narges Khanjani, Pirasteh Norouzi, Ali Faghihi-Zarandi, Davood Darban-Sarokhalil, Seyed Sajjad Khoramrooz, Seyed Reza Mirbadie, Mehdi Mirzaii. The Effects of Antioxidant Vitamins on Proinflammatory Cytokines and Some Biochemical Parameters of Power Plant Workers: A Double-Blind Randomized Controlled Clinical Trial. Bioelectromagnetics. 2020 Sep 15. doi: 10.1002/bem.22294.

Abstract

Some epidemiological studies have suggested that exposure to extremely low-frequency magnetic fields (ELF- MFs) can affect the immune system. This study aimed to investigate the effects of antioxidant vitamin consumption on proinflammatory cytokines and biochemical parameters changes. In this randomized, controlled double-blinded trial study, power plant workers exposed to ELF-MFs were enrolled based on inclusion criteria. Ninety-one eligible subjects were randomly divided into four groups: the first group (400 units of vitamin E/day), second group (1,000 mg of vitamin C/day), third group (400 units of vitamin E and 1,000 mg of vitamin C/day), and control group. The intervention was conducted for 3 months. Proinflammatory cytokines interleukin-1 β (IL-1 β), IL-6, and tumor necrosis factor- α (TNF- α), and biochemical parameters (fasting blood sugar, total cholesterol, triglyceride, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol [HDL-c], total protein, and albumin) were measured among the participants' serums, before and after the intervention. The mean level of IL-6 in all vitamin-receiving groups, the mean level of IL-1 β in vitamin C and E&C groups, and the mean level of TNF- α in the vitamin C group, decreased significantly after intervention. The arithmetic means of the effect sizes for IL-1 β , IL-6, and TNF- α were 0.71, 0.57, and 0.2, respectively. The level of HDL-c in the vitamin E and vitamin E&C groups and the level of triglyceride in the vitamin C group significantly increased after the intervention. Taking antioxidant vitamins can prevent an increase of proinflammatory cytokines induced by prolonged exposure to ELF-MFs.

<https://pubmed.ncbi.nlm.nih.gov/32931612/>

EFFECT OF LOW-FREQUENCY ELECTRIC FIELD SCREENING ON MOTILITY OF HUMAN SPERM

Romuald Górski, Malgorzata Kotwicka, Izabela Skibińska, Magdalena Jendraszak, Stanisław Wosiński. Effect of low-frequency electric field screening on motility of human sperm. Ann Agric Environ Med. 2020 Sep 11;27(3):427-434. doi: 10.26444/aaem/116019.

Abstract

Introduction: The human body is constantly exposed to an extremely low electromagnetic field (ELF-EMF), in particular at 50 Hz, emitted by power lines, domestic distribution lines, electrical appliances, etc. It is assumed that the increase in electromagnetic exposure may cause adverse effects upon human health, as well as raising concerns regarding the impact on human fertility.

Objective: The aim of this in vitro study was to investigate the influence of ELF-EMF with a frequency of 50 Hz on the motility of human sperm. At the same time, the effectiveness of the dielectric screen constructed by ADR Technology® in absorbing the emitted radiation was examined.

Material and methods: Semen samples of 20 patients were exposed to the influence of an extremely low electromagnetic field. After 5, 15 and 30 min., spermatozoa motility was analysed using a computer-assisted spermatozoa motility analysis system. The following sperm motility parameters were examined: 1) velocity straight linear motility; 2) cross-beat frequency; 3) lateral head displacement; 4) homogeneity of progressive motility velocity.

Results: It was found that the ELF-EMF presented a negative effect on the motility of human spermatozoa. A significant decrease in spermatozoa motility speed and a significant increase in lateral head deviation values were observed under the influence of the electromagnetic field. ELF-EMF did not show an effect on either lateral head displacement or homogeneity of progressive motility velocity.

Conclusions: A positive effect of the dielectric screen ADR Technology® was found. This effect compensated spermatozoa motility changes induced with ELF-EMF.

Open access paper: <http://www.aaem.pl/Effect-of-Low-Frequency-Electric-Field-Screening-on-the-Motility-of-Human-Sperm,116019,0,2.html>

RELATIONSHIP BETWEEN THE EXPOSURE TO MAGNETIC FIELDS DURING PREGNANCY AND RISK OF ABORTION: A REVIEW ARTICLE

Aghdas Ebadi, Hedieh Pournorouz, Seyedeh Samaneh Aghajanzpour Mir ; Mohammad Raisan et al. Relationship between the Exposure to Magnetic Fields during Pregnancy and Risk of Abortion: A Review Article. Intl J Pediatrics-MASHHAD. 8:11813-11818. Aug 2020. DOI: 10.22038/ijp.2020.50416.4013.

Abstract

Background: Exposure to electro-magnetic fields is a risk factor for abortion. We aimed to review the relationship between exposure to magnetic fields during pregnancy and the risk of abortion.

Materials and Methods: Two independent researchers screened the articles with related keywords including: "Radiofrequency", "RF", "RF-EMFs", "Phone", "Mobile phone", "Cell phone", "Electromagnetic field", "Electromagnetic waves", "EMF", "EMW", "Magnetic Field", "Abortion, and "Miscarriage". Following electronic databases: Scopus, EMBASE, Cochrane, Web of Science and Medline were searched without time and language restrictions from inception up to March, 2020.

Results: In the first study, there was a significant difference in the magnitude of Extremely Low-Frequency Electro-Magnetic Fields (ELF-EMF) between the two groups in the participants' houses. In the second study, the relationship between the miscarriage risks with high Magnetic Field exposure was evaluated among pregnant women by eliminating various confounding factors. In the third study, there was a relationship between miscarriage risk and prenatal exposure to the highest magnetic field, about 16 mG (95% CI: 1.2-2.7). In the fourth study, the research units exposed to higher MF levels were 2.72 times more at risk of miscarriage compared to the women exposed to lower MF levels. In the fifth study, a significant difference was observed between the two groups regarding the magnitude of ELF-

EMF in the participants' houses. A significant likelihood of miscarriage in women who exposed to a significant level of the electromagnetic wave was observed; however, this relationship was not confirmed by the Wald test.

Conclusion: The effect of exposure on the risk of abortion depends on the distance from the source of radiation and the intensity of the frequency of the waves.

Open access paper:

http://ijp.mums.ac.ir/article_16183_a8930748a6f2ca22f53be9079e7ccb86.pdf

REACTIVE OXYGEN SPECIES: POTENTIAL REGULATORY MOLECULES IN RESPONSE TO HYPOMAGNETIC FIELD EXPOSURE

Bingfang Zhang, Lanxiang Tian. Reactive Oxygen Species: Potential Regulatory Molecules in Response to Hypomagnetic Field Exposure. Bioelectromagnetics. 2020 Sep 30. doi: 10.1002/bem.22299.

Abstract

Organisms, including humans, could be exposed to hypomagnetic fields (HMFs, intensity <5 μ T), e.g. in some artificially shielded magnetic environments and during deep-space flights. Previous studies have demonstrated that HMF exposure could have negative effects on the central nervous system and embryonic development in many animals. However, the underlying mechanisms remain unknown. Studies have revealed that HMFs affect cellular reactive oxygen species (ROS) levels and thereby alter physiological and biological processes in organisms. ROS, the major component of highly active free radicals, which are ubiquitous in biological systems, were hypothesized to be the candidate signaling molecules that regulate diverse physiological processes in response to changes in magnetic fields. Here, we summarize the recent advances in the study of HMF-induced negative effects on the central nervous system and early embryonic development in animals, focusing on cellular ROS and their role in response to HMFs. Furthermore, we discuss the potential mechanism through which HMFs regulate ROS levels in cells.

<https://pubmed.ncbi.nlm.nih.gov/32997824/>

BIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS ON INSECTS (REVIEW PAPER IN GERMAN)

Alain Thill. Biologische Wirkungen elektromagnetischer Felder auf Insekten. umwelt - medizin - gesellschaft. Sonderbeilage in Ausgabe 3-2020 / ISSN 1437-2606 / 33. Jahrgang.

Summary (Google translation from English)

All over the world, insects are declining at an alarming rate. It is known that here, among other causes, in particular the use of pesticides and modern agricultural practice play a major role. The cumulative effects of multiple low dose toxins and the spread of toxins in nature are not yet methodically researched or only just beginning.

Existing research suggests another factor of anthropogenic origin that could have subtle harmful effects: the increasingly frequent use of engineered electromagnetic fields (EMF) such as high voltage, cellular communications and WiFi. The infrastructure of the next

generation of cellular technologies (5G) will currently be built up without having previously been tested for possible toxic effects. With the pursuit of humanity With the ubiquity of technology, even modest effects of electromagnetic fields on organisms could eventually reach a level of saturation that can no longer be ignored.

This systematic review evaluates the study situation on the toxic effects of electromagnetic fields (EMF) on insects. Also included is a general overview of reported effects and mechanisms of exposure to EMF, which addresses new findings in cell biology. 72 of the 83 studies analyzed found an effect. The following negative effects have been described in studies: restrictions of the sense of direction, reduced reproductive capacity and fertility, lethargy, changes in flight dynamics, failure to search for food, reduced reaction speeds, escape behavior, disruption of the circadian rhythm, blockage of the respiratory chain and damage to the mitochondria, Incorrect activation of the immune system, increased number of DNA strand breaks.

Some mechanisms of action that lead to this damage are identified. EMFs affect the metabolism, u. a. do they act on voltage gated calcium channels, e.g. in the neuronal impulse transmission and in the muscle tissue, which can lead to an over-activation of the signal transduction and respiratory chain with the production of free oxygen radicals and consequently to oxidative cell stress.

The results show that EMF could have a serious impact on the vitality of insect populations. In some experiments it was found that despite the low levels of pollution from transmitter systems, harmful effects occurred after several months. Field strengths 100 times below the ICNIRP limit values could already have effects. Against the background of the rapid decline in insects and the further expansion of high-frequency electromagnetic field sources, there is not only further, urgent need for research, in particular also for the interactions with other harmful noxae such as pesticides. When planning the expansion of mobile communications, the habitats of insects must already be protected from EMF exposure.

<http://bit.ly/RFinsectreview2020>

STATIC MAGNETIC FIELD ON BEHAVIOR, HEMATOLOGICAL PARAMETERS AND ORGAN DAMAGE IN SPONTANEOUSLY HYPERTENSIVE RATS

Tatjana Tasić, Maja Lozić, Sofija Glumac, Marija Stanković, Ivan Milovanovich, Drago M Djordjevich, Alexander M Trbovich, Nina Japundžić-Žigon, Silvio R De Luka. Static magnetic field on behavior, hematological parameters and organ damage in spontaneously hypertensive rats. *Ecotoxicol Environ Saf.* 2020 Sep 5;207:111085. doi: 10.1016/j.ecoenv.2020.111085.

Abstract

Previous studies showed contradictory results of static magnetic field (SMF) influence on behavior, hematological parameters and organ damage. The aim of this study was to investigate influence of subchronic continuous exposure to upward and downward oriented SMF of moderate intensity on behavior, hematological characteristics, heart and kidney tissue of spontaneously hypertensive rats. SH rats exposed to downward oriented SMF demonstrated lack of anxious-like behavior. SMF of either orientation caused decrease in the

number of platelets in peripheral blood, granulocytes in the spleen and bone marrow and increase in the number of erythrocytes in the spleen, in both exposed groups. We also demonstrated that spontaneously

hypertensive rats exposed to upward oriented SMF exhibited decreased lymphocytes count in blood, decreased bone marrow erythrocytes count and rats exposed to downward oriented SMF had increased lymphocytes count in bone marrow. The results showed adverse effect of differently oriented SMF on hematological parameters of spontaneously hypertensive rats. Also, exposure to different oriented SMF didn't affect their heart and kidney morphological characteristics.

<https://pubmed.ncbi.nlm.nih.gov/32898814/>

SODIUM ION TRANSPORT ACROSS THE ENDOTHELIAL GLYCOCALYX LAYER UNDER ELECTRIC FIELD CONDITIONS: A MOLECULAR DYNAMICS STUDY

Xi Zhuo Jiang, Lumeng Yang, Yiannis Ventikos, Kai H Luo. Sodium ion transport across the endothelial glycocalyx layer under electric field conditions: A molecular dynamics study. J Chem Phys. 2020 Sep 14;153(10):105102. doi: 10.1063/5.0014177.

Abstract

In the present research, the sodium ion transport across the endothelial glycocalyx layer (EGL) under an imposed electric field is investigated, for the first time, using a series of molecular dynamics simulations. The electric field is perpendicularly imposed on the EGL with varying strengths. The sodium ion molarity difference between the inner and outer layers of EGL, Δc , is used to quantify the sodium transport in the presence of the negatively charged glycocalyx sugar chains. Results suggest that a weak electric field increases Δc , regardless of whether the electric field is imposed perpendicularly inward or outward. By contrast, a strong electric field drives sodium ions to travel in the same orientation as the electric field. Scrutiny of the charge distribution of the glycocalyx sugar chains suggests that the electric field modifies the spatial layouts of glycocalyx atoms as it drives the transport of sodium ions. The modification in glycocalyx layouts further changes the inter-molecular interactions between glycocalyx sugar chains and sodium ions, thereby limiting the electric field control of ion transport. The sodium ions, in turn, alter the apparent bending stiffness of glycocalyx. Moreover, the negative charges of the glycocalyx sugar chains play an important role in maintaining structural stability of endothelial glycocalyx. Based on the findings, a hypothesis is proposed regarding the existence of a strength threshold of the electric field in controlling charged particles in the endothelium, which offers an alternative explanation for contrasting results in previous experimental observations.

<https://pubmed.ncbi.nlm.nih.gov/32933268/>

ANIMAL NAVIGATION: A NOISY MAGNETIC SENSE?

Sönke Johnsen, Kenneth J Lohmann, Eric J Warrant. Animal navigation: a noisy magnetic sense? *Journal of Experimental Biology* 2020 223: jeb164921 doi: 10.1242/jeb.164921
Published 23 September 2020.

Abstract

Diverse organisms use Earth's magnetic field as a cue in orientation and navigation. Nevertheless, eliciting magnetic orientation responses reliably, either in laboratory or natural settings, is often difficult. Many species appear to preferentially exploit non-magnetic cues if they are available, suggesting that the magnetic sense often serves as a redundant or 'backup' source of information. This raises an interesting paradox: Earth's magnetic field appears to be more pervasive and reliable than almost any other navigational cue. Why then do animals not rely almost exclusively on the geomagnetic field, while ignoring or downplaying other cues? Here, we explore a possible explanation: that the magnetic sense of animals is 'noisy', in that the magnetic signal is small relative to thermal and receptor noise. Magnetic receptors are thus unable to instantaneously acquire magnetic information that is highly precise or accurate. We speculate that extensive time-averaging and/or other higher-order neural processing of magnetic information is required, rendering the magnetic sense inefficient relative to alternative cues that can be detected faster and with less effort. This interpretation is consistent with experimental results suggesting a long time course for magnetic compass and map responses in some animals. Despite possible limitations, magnetoreception may be maintained by natural selection because the geomagnetic field is sometimes the only source of directional and/or positional information available.

<https://pubmed.ncbi.nlm.nih.gov/32967977/>

5G WIRELESS DEPLOYMENT AND HEALTH RISKS: TIME FOR A MEDICAL DISCUSSION

Priyanka Bandara, Tracy Chandler, Robin Kelly, Julie McCredden, Murray May, Steve Weller, Don Maisch, Susan Pockett, Victor Leach, Richard Cullen, Damian Wojcik. 5G Wireless Deployment and Health Risks: Time for a Medical Discussion in Australia and New Zealand. *ACNEM Journal*. 39(1). July 2020.

Excerpts

"There is an urgent need for clinicians and medical scientists in the Australia-New Zealand region to engage in an objective discussion around the potential health impacts of the fifth generation (5G) wireless technology currently being deployed. The statements of assurance by the industry and government parties that dominate the media in our region are at odds with the warnings of hundreds of scientists actively engaged in research on biological/health effects of anthropogenic electromagnetic radiation/fields (EMR/EMF). (1) There have been worldwide public protests as well as appeals by professionals and the general public (2) that have compelled many cities in Europe to declare moratoria on 5G deployment and to begin investigations. In contrast, there is no medically-oriented professional discussion on this public health topic in Australia and New Zealand, where 5G deployment is being expedited. 5G is untested for safety on humans and other species and the limited existing evidence raises major concerns that need to be addressed. The vast body of research literature on biological/health effects of 'wireless radiation' (radiofrequency EMR) (3,4) indicates a range of health-related issues associated with different types of wireless technologies (1G-4G, WiFi,

Bluetooth, Radar, radio/TV transmission, scanning and surveillance systems). These are used in a wide range of personal devices in common use (mobile/cordless phones, computers, baby monitors, games consoles etc) without users being aware of the health risks. Furthermore, serious safety concerns arise from the extra complexity of 5G as follows:

- 5G carrier waves use a much broader part of the microwave spectrum including waves with wavelengths in the millimetre range (hence called 'millimetre waves') which will be used in the second phase of 5G). Until now, millimetre waves have had limited applications such as radar, point-to-point communications links and non-lethal military weapons. (5)
- Extremely complex modulation patterns involving numerous frequencies form novel exposures.
- Beam formation characteristics can produce hotspots of high unknown intensities.
- A vast number of antenna arrays will add millions of microwave transmitters globally in addition to the existing RF transmitters thereby greatly increasing human exposure. This includes 5G small cell antennas to be erected every 200-250 metres on street fixtures, such as power poles and bus shelters, many of which will be only metres from homes with the homeowners having absolutely no say in where the antennas will be located.

This massive leap in human exposure to RF-EMR from 5G is occurring in a setting where the existing scientific evidence overwhelmingly indicates biological interference, (3,4) therefore suggesting the need to urgently reduce exposure"

"As for the new 5G technology, it is concerning that leading experts in the technical field (6) have reported the possibility of damaging thermal spikes under the current exposure guidelines (from beam forming 5G millimetre waves that transfer data with short bursts of high energy) and some animals and children may be at an increased risk due to smaller body size. Even working within the entirely thermally-based current regulatory process, they pointed out 5G millimetre waves "may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines". (6) Microwave experts from the US Air Force have reported on 'Brillouin Precursors' created by sharp transients at the leading and trailing edges of pulses of mm waves, when beam forming fast millimetre waves create moving charges in the body which penetrate deeper than explained in the conventional models, and have the potential to cause tissue damage. (7) In fact, concerns about moving charges affecting deep tissue are associated with other forms of pulsed RF radiation currently used for wireless communications. This may be one factor explaining why the pulsed radiation used in wireless communication technologies is more biologically active than continuous RF radiation. (8) Such effects of high energy 5G mm waves could have potentially devastating consequences for species with small body size and also creatures that have innate sensitivity to EMF, which include birds and bees that use nature's EMFs for navigation. (9) Unfortunately, non-thermal effects and chronic exposure effects are not addressed in the current guidelines. (10)"

"Our investigation into the scientific literature has found RF-EMR to be a potent inducer of oxidative stress even at so-called "low-intensity" exposures (which are in fact billions of times higher than in nature (26)) such as those from commonly used wireless devices. An analysis (22) of 242 publications (experimental studies) which had investigated endpoints related to

oxidative stress - biomarkers of oxidative damage such as 8-oxo-2'- deoxyguanosine (indicating oxidative DNA damage) and/or altered antioxidant levels - revealed that 216 studies (89%) had reported such findings (Fig. 1). This evidence base on RF-associated oxidative stress from 26 countries (only one study from Australia and none from New Zealand) is relatively new and mostly post 2010, i.e. after the WHO's International Agency for Research on Cancer (IARC) classified RF-EMR as a Group 2B possible carcinogen. Moreover, 180 studies out of the 242 (74.7%) were in vivo studies (including several human studies) which presents strong evidence.

"Proponents of 5G often dismiss concerns about health risks claiming that 5G microwaves will minimally penetrate the skin and therefore any effects are limited to minor skin heating (and they acknowledge that there is some uncertainty around heating effects on the eyes). The medical community understands that skin is the largest organ of the human body and a key part of the neuro-immune and neuro-endocrine systems. Natural UVA and UVB (also so-called non-ionizing radiation) that penetrate the skin less than 5G millimetre waves have profound effects on health and wellbeing of humans. Therefore, artificial 5G waves must be subjected to rigorous safety testing."

"Unfortunately, the questionable conduct of regulatory agencies such as ARPANSA and WHO's international EMF Project (43) with conflicts of interest due to funding links to the wireless industry (44) remains to be investigated. More open questioning and protests are appearing in Europe and North America where there is some level of engagement on the part of government bodies in response to warnings of adverse health effects of anthropogenic EMF/EMR by expert medical bodies such as EUROPAEM and AAEM (31,32) (despite industry opposition)."

5G COMMUNICATION TECHNOLOGY AND CORONAVIRUS DISEASE [HEALTH MATTERS]

James C. Lin. 5G Communication Technology and Coronavirus Disease [Health Matters]. IEEE Microwave Magazine, 21(9):16-19. Sep 2020.

Excerpts

"The fact is that there is no link between the COVID-19 virus and 5G cell phone technology or 5G base-station communication towers. These are totally different constructs; they are not even close. None of the conspiracy theories that try to link 5G and the coronavirus make any sense scientifically."

"For biological matters, it is not obvious whether the biological responses to high-band 5G radiation will be akin to earlier generations or low-band 5G radiations, given the distinctive characteristics of mm-wave [millimeter wave] and its interaction with the complex structure and composition of pertinent biological tissues."

"It is important to note that the recent NTP and Ramazzini RF exposure studies presented similar findings in terms of heart schwannomas and brain gliomas. Thus, two relatively well-conducted RF exposure studies employing the same strain of rats showed consistent results in significantly increased cancer risks. More recently, an advisory group for the IARC has recommended including reevaluation of the carcinogenicity of human exposure to RF radiation, with high priority, in their monograph series [7]."

"... the 5G frequency domain is divided into low, mid, and high bands. The operating frequencies at low and mid bands can overlap with the current 4G band at 6 GHz or below. Thus, the biological effects of RF radiation at these lower frequency bands are likely to be comparable to 2, 3, or 4G. However, the scenarios of high-band 5G—especially for 24–60 GHz in the mm-wave region for high-capacity, short-range wireless data communications—are relatively recent arrivals and pose considerable challenge to health risk assessment. There is a paucity of data on permittivity and coupling, such as reflection, transmission, and induced energy deposition, in biological tissues in the mm-wave frequency band."

"Induced energy deposition increases with mm-wave frequency. However, at the highest frequencies, the energy deposition in the deeper regions inside the skin is lower because of the reduced penetration depth at these frequencies [11]."

"A recently published review [13] included 45 in vivo studies conducted using laboratory animals and other biological preparations and 53 in vitro studies involving primary cells and cultured cell lines. This industry-supported review noted that, aside from the wide frequency ranges, the studies were diverse both in subjects and in the end points investigated. Biological effects were observed to occur both in vivo and in vitro for different biological endpoints studied. Indeed, the percentage of positive responses at nonthermal levels in most frequency groups was as high as 70%."

"While many of these investigations with mm-wave exposures reported biological responses, there is inconsistency in the dependence of biological effects and mm-wave intensity used for exposure. Also, the reported in vitro and in vivo laboratory investigations are modest in number and diverse in subject matter, considering the wide 5G/mmwave frequency domain. The jury on the biological effect or health impact is still out on 5G. Moreover, there is a lack of ongoing controlled laboratory investigations. Simply put, the existing scientific data are too limited for any reliable assessment or conclusion with certainty."

<https://ieeexplore-ieee-org/document/9154657>

PHYSIOLOGICAL EFFECTS OF MILLIMETER-WAVES ON SKIN AND SKIN CELLS: AN OVERVIEW OF THE TO-DATE PUBLISHED STUDIES

Dariusz Leszczynski. Physiological effects of millimeter-waves on skin and skin cells: an overview of the to-date published studies. Reviews on Environmental Health. DOI: <https://doi.org/10.1515/reveh-2020-0056>. Published online: 24 Aug 2020.

Abstract

The currently ongoing deployment of the fifth generation of the wireless communication technology, the 5G technology, has reignited the health debate around the new kind of radiation that will be used/emitted by the 5G devices and networks – the millimeter-waves. The new aspect of the 5G technology, that is of concern to some of the future users, is that both, antennas and devices will be continuously in a very close proximity of the users' bodies. Skin is the only organ of the human body, besides the eyes, that will be directly exposed to the mm-waves of the 5G technology. However, the whole scientific evidence on the possible effects of millimeter-waves on skin and skin cells, currently consists of only some 99 studies.

This clearly indicates that the scientific evidence concerning the possible effects of millimeter-waves on humans is insufficient to devise science-based exposure limits and to develop science-based human health policies. The sufficient research has not been done and, therefore, precautionary measures should be considered for the deployment of the 5G, before the sufficient number of quality research studies will be executed and health risk, or lack of it, scientifically established.

<https://www.degruyter.com/view/journals/reveh/ahead-of-print/article-10.1515-reveh-2020-0056/article-10.1515-reveh-2020-0056.xml>

IMPLICATIONS OF INCIDENT POWER DENSITY LIMITS ON POWER AND EIRP LEVELS OF 5G MILLIMETER-WAVE USER EQUIPMENT

Wang He, Bo Xu, Yuanqing Yao, Davide Colombi, Zhinong Ying, Sailing He. Implications of Incident Power Density Limits on Power and EIRP Levels of 5G Millimeter-Wave User Equipment IEEE Access. 10 Aug 2020. DOI: 10.1109/ACCESS.2020.3015231.

Abstract

User equipment (UE) is required to comply with the relevant radio frequency (RF) electromagnetic field (EMF) exposure limits, which are of relevance to establish the maximum permissible transmitted power and the maximum equivalent isotropically radiated power (EIRP). Recently, international RF EMF exposure guidelines, such as those published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) as well as by the IEEE, have been updated. In this paper, the implications of the revised incident power density limits are investigated in terms of maximum permissible transmitted power and the maximum EIRP for devices operating in close proximity of the user. A similar analysis is conducted according to the US Federal Communications Commission (FCC) regulation on RF exposure. EMF compliance of UE is studied by means of numerical modelling of patch antenna arrays of different array sizes taking into consideration possible beam-steering operations, at frequencies ranging from 10 GHz to 100 GHz. The results are compared with the 3rd Generation Partnership Project (3GPP) requirements on the total radiated power (TRP) and EIRP levels. The present implications of the incident power density limits for 5G millimeter-wave UE will give valuable insights to mobile equipment manufacturers, network operators, and standardization bodies.

Open access paper: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9163106>
<https://www.emf-portal.org/en/article/43123>

FACTORS AFFECTING RISK PERCEPTION OF ELECTROMAGNETIC WAVES FROM 5G NETWORK BASE STATIONS

Tae Hwan Koh, Jae Wook Choi, Myungsoon Seo, Hyung-Do Choi, KyungHee Kim. Factors Affecting Risk Perception of Electromagnetic Waves From 5G Network Base Stations. Bioelectromagnetics. 31 August 2020. <https://doi.org/10.1002/bem.22290>. Grant sponsor: ICT R&D program of MSIT/IITP (A Study on Public Health and Safety in a Complex EMF Environment); grant number: 2019-0-00102.

Abstract

The coverage of the fifth-generation network has increased steadily since the network was introduced in 2019. However, public protests around the globe against the construction of 5G network base stations have continued to occur for fear that electromagnetic (EM) waves emitted from the stations would cause adverse health effects. To identify factors that have contributed to such increased risk perception, we conducted a cross-sectional study using data obtained from a survey that assessed Korean adults' risk perception of EM wave-related objects. We found that female gender, high level of perceived exposure to EM waves, evaluation of public policies as ineffective, and high level of objective knowledge on EM waves were associated with increased risk perception. Furthermore, we found that higher ratings on a few risk characteristics such as "personal knowledge," "seriousness of the risk to future generations," "dreadfulness," and "severity of consequences" were also associated with increased risk perception as well.

Open access paper: <https://onlinelibrary.wiley.com/doi/10.1002/bem.22290>

PROSPECTIVE STUDY OF NOCEBO EFFECTS RELATED TO SYMPTOMS OF IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS (IEI-EMF)

Anne-Kathrin Bräscher, Stefan M Schulz, Omer Van den Bergh, Michael Witthöft. Prospective study of nocebo effects related to symptoms of idiopathic environmental intolerance attributed to electromagnetic fields (IEI- EMF). Environ Res. 2020 Aug 7;110019. doi: 10.1016/j.envres.2020.110019.

Highlights

- The etiology of idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) is unknown.
- Negative information on health effects of sham WiFi radiation induced nocebo effects.
- During sham WiFi exposure somatosensation and electrodermal activity were increased
- Interoceptive accuracy moderated the nocebo effect, depending on stimulus intensity.
- The nocebo effect was still detectable one week after its induction.

Abstract

The exact causes of Idiopathic Environmental Intolerance Attributed to Electromagnetic Fields (IEI-EMF, i.e., experience of somatic symptoms attributed to low-level electromagnetic fields) are still unknown. Psychological causation such as nocebo effects seem plausible. This study

aimed to experimentally induce a placebo effect for somatic symptom perception and examined whether it was reproducible after one week. We also examined whether these effects were associated with increased sympathetic activity and whether interoceptive accuracy (IAcc) moderated these relationships. Participants were recruited from the general population and instructed that electromagnetic exposure can enhance somatosensory perception. They participated twice in a cued exposure experiment with tactile stimulation and sham WiFi exposure in 50% of trials. The two sessions were scheduled one week apart (session 1: N = 65, session 2: N = 63). Before session 1, participants watched either a 6-minute film on adverse health effects of EMF or a neutral film on trade of mobile phones. IAcc was assessed with the heartbeat detection paradigm. Electrodermal activity served as a measure of sympathetic activation.

Evidence for a placebo effect (i.e., increased self-reported intensity and aversiveness and electrodermal activity) during sham WiFi exposure was observed in both sessions. IAcc moderated the placebo effect, depending on stimulus intensity. Contrary to previous findings, no difference emerged between the health-related EMF and the neutral films. Based on negative instructions, somatic perception and physiological responding can be altered. This is consistent with the assumption that IEI-EMF could be due to placebo effects, suggesting an important role for psychological interventions. <https://pubmed.ncbi.nlm.nih.gov/32777274/>

HEART RATE VARIABILITY IN HEALTHY YOUNG ADULTS EXPOSED TO GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM) 900- MHZ RADIOFREQUENCY SIGNAL FROM MOBILE PHONES

Jasmina Wallace, Soafara Andrianome, Rania Ghosn, Erwan Stephan Blanchard, Frederic Telliez, Brahim Selmaoui. Heart rate variability in healthy young adults exposed to global system for mobile communication (GSM) 900-MHz radiofrequency signal from mobile phones. *Environ Res.* 2020 Aug 23;191:110097. doi: 10.1016/j.envres.2020.110097.

Abstract

Given the large number of mobile phone users and the increasing exposure to radiofrequency electromagnetic field (RF-EMF) worldwide, we aimed to study the effect of RF-EMF related to mobile phones on heart rate variability (HRV). Twenty-six healthy young adults participated in two experimental sessions with a double-blind, randomized and counter-balanced crossover design. During each session, participants were exposed for 26 min to a sham or real 900 MHz RF-EMF, generated by a commercial dual-band Global System for Mobile technology (GSM) mobile phone. We recorded an electrocardiogram at rest during the exposure. We evaluated HRV by time- and frequency-domain analysis. Evaluation of time-domain HRV parameters revealed a statistically significant increase of the standard deviation of interbeat intervals (SDNN) during the real exposure. Other time- domain parameters were not affected. Analysis in the frequency-domain demonstrated that total spectral power and low-frequency band (LF) absolute power were significantly increased during exposure ($p = .046$ and $p = .043$, respectively). However, other parameters were not affected. In conclusion, it seems that most HRV parameters were not affected by GSM signal exposure in our study. The weak effect observed on HRV frequency-domain is likely to represent a random occurrence rather than a real effect.

<https://pubmed.ncbi.nlm.nih.gov/32846174/>

EFFECTS OF MOBILE PHONE RADIATION ON BUCCAL MUCOSAL CELLS: A SYSTEMATIC REVIEW

M. P Revanth, S Aparna, Parangimalai Diwakar Madankumar. Effects of mobile phone radiation on buccal mucosal cells: A systematic review. Electromagn Biol Med. 2020 Jul 24;1-9. doi: 10.1080/15368378.2020.1793168.

Abstract

The worldwide increased use of mobile phone in recent years has raised many questions on whether their use is safe to user who is exposed to electromagnetic radiation. The aim of the review is to find out the effect of mobile phone emitted radiations on buccal mucosal cells. To identify suitable literature, an electronic search was performed using PubMed, Trip database, Cochrane, Google Scholar and EBSCO host database. The search was focused on the effect of mobile phone radiation on buccal cells. Among the literature available in English, the screening of the related titles and abstracts was done, and only those articles were selected for full-text reading that fulfilled the inclusion and exclusion criteria. The initial literature search resulted in 23 articles out of which only 7 articles fulfilled the criteria were included in this systematic review. The studies showed that mobile phone-emitted radiations have adverse effects on buccal mucosal cells such as the formation of micronuclei and broken egg which was considered as bio-markers of genotoxicity.

<https://www.tandfonline.com/doi/full/10.1080/15368378.2020.1793168>

EFFECTS OF RADIOFREQUENCY RADIATION ON GENE EXPRESSION: A STUDY OF GENE EXPRESSIONS OF HUMAN KERATINOCYTES FROM DIFFERENT ORIGINS

Catherine Martin, Frederic Percevault, Kate Ryder, Etiam Sani, Jean-Christophe Le Cun, Maxim Zhadobov , Ronan Sauleau, Yves Le Dréan, Denis Habauzit. Effects of Radiofrequency Radiation on Gene Expression: A Study of Gene Expressions of Human Keratinocytes From Different Origins. Bioelectromagnetics. 2020 Aug 19. doi: 10.1002/bem.22287.

No abstract <https://pubmed.ncbi.nlm.nih.gov/32813280/>

DELAYED-ONSET MULTIPHASIC DEMYELINATING LESIONS AFTER HIGH DOSE RADIOFREQUENCY ELECTROMAGNETIC FIELD EXPOSURE: A MULTIPLE SCLEROSIS (MS) MIMIC

Sophia M Raefsky, Amit Chaudhari, Michael Y Sy. Delayed-Onset multiphasic demyelinating lesions after high dose radiofrequency electromagnetic field exposure: A multiple sclerosis (MS) micmic. Mult Scler Relat Disord. 2020 Jun 20;45:102318. doi: 10.1016/j.msard.2020.102318.

Excerpts

"Our patient is a 46-year-old Caucasian engineer with no significant past medical history. In 2011, he was exposed to prolonged high levels of radiofrequency electromagnetic field (RF-EMF) radiation during a technical malfunction at a cell phone tower. Unfortunately, a radiation monitor was not worn during the incident but company guidelines suggested that only 6 min of exposure was safe. In contrast, the patient remained directly in front of 15 active transmitters for at least 2 h. Immediately post exposure, he suffered cutaneous burns to his face, neck, and back, and developed eye, joint, muscle and stomach pain....

In summary, this case illustrates that high levels RF-EMF exposure can either increase risk for development of MS or induce a condition that mimics the presentation of multiple sclerosis both clinically and radiologically. Thus extreme RF-EMF radiation should be kept in the differential diagnosis when taking a thorough neurological history."

<https://pubmed.ncbi.nlm.nih.gov/32622299/>

BRAIN EM EXPOSURE FOR VOICE CALLS OF MOBILE PHONES IN WIRELESS COMMUNICATION ENVIRONMENT OF SEOUL, KOREA

Ae-Kyoung Lee ; Hyung-Do Choi. Brain EM Exposure for Voice Calls of Mobile Phones in Wireless Communication Environment of Seoul, Korea. IEEE Access. DOI:10.1109/ACCESS.2020.3020831.01 September 2020.

Abstract

The aim of this paper is to present the measurement results of the transmitted (Tx) power levels of mobile phones in currently operating wireless communication networks in Seoul in 2015 and 2017 and the calculation results of the specific absorption rate (SAR) in the brain for voice calls while holding a mobile phone against the user's ear when operating at the measured mean power level. The Tx power levels of mobile phones using Code Division Multiple Access (CDMA) 2000, Wide CDMA (WCDMA), and Long-Term Evolution (LTE) networks were compared for the three main mobile network operators in South Korea. The actual mean Tx power level was less than 0.5% of the maximum power for the CDMA2000 and WCDMA networks. In the LTE networks, however, an extremely wide gap in Tx power was observed between the operators; two of the operators showed a mean power of less than 0.1% of the maximum, whereas the other showed mean powers of the three bands within the range of 0.8%–20% of the maximum power. The measurement results suggest that the SAR in the user's brain is strongly dependent on the year the phone was used, the user-subscribed mobile operator, and the proportion of time connected to the network/technology. The maximum 1-g peak spatial-average SAR (psSAR) level at the mean Tx power in an LTE network was 4.8 mW/kg (for a child head model). A maximum gap of 25 dB in the psSAR was observed between all networks considered.

Open access paper: <https://ieeexplore.ieee.org/document/9184008>

REVIEW OF SAFETY AND EXPOSURE LIMITS OF ELECTROMAGNETIC FIELDS (EMF) IN WIRELESS ELECTRIC VEHICLE CHARGING (WEVC) APPLICATIONS

Erdem Asa, Mostak Mohammad, Omer C. Onar, Jason Pries, Veda Galigekere, Gui-Jia Su. Review of Safety and Exposure Limits of Electromagnetic Fields (EMF) in Wireless Electric Vehicle Charging (WEVC) Applications. 2020 IEEE Transportation Electrification Conference & Expo (ITEC). 23-26 June 2020. doi: 10.1109/ITEC48692.2020.9161597.

Abstract

This study reviews the exposure limits and safety of intermediate frequency (IF) electromagnetic field (EMF) emissions for wireless electric vehicle charging (WEVC) applications. A review of the electromagnetic field exposure limits identified in international guidelines are presented. An overview of the electromagnetic field shielding technologies is provided including recommended geometries, materials, and performances of the methods

available in the literature. Available laboratory results of EMF emissions are summarized considering several wireless power transfer studies in different power levels. Possible EMF reduction techniques are discussed with shielding practices and ORNL case studies. Also, living object detection (LOD) and foreign object detection (FOD) methods are reviewed from a safety aspect.

Conclusions

This study reviews and compiles the EMF emission limitations identified in international guidelines and standards including IEEE, ICNIRP, ACGIH, and SAE. EMF emissions can be substantial particularly at high-power transfer levels and misaligned conditions and should be reduced below the limits identified in the ICNIRP 2010 guidelines which are more conservative and thought to be safer. This study also provides a review of the shielding methods and presents two case studies from ORNL (Oak Ridge National Laboratory) experiences and practices on EMF shielding. EMF exposure levels and shielding methodologies for high-power and dynamic wireless power transfer applications should be analyzed in future studies with possible standards development activities.

<https://ieeexplore.ieee.org/document/9161597>

FRAMING EFFECTS IN RISK COMMUNICATION MESSAGES - HAZARD IDENTIFICATION VS. RISK ASSESSMENT

F Freudenstein, R J Croft, P M Wiedemann, A Verrender, C Böhmert, S P Loughran. Framing Effects in Risk Communication Messages - Hazard Identification vs. Risk Assessment. Environ Res. 2020 Aug 2;109934. doi: 10.1016/j.envres.2020.109934.

Abstract

The way in which risk communication messages are framed can influence recipients' risk perceptions. Despite this, there is a limited understanding of how framing is responsible for influencing risk perception. One particularly important element may be whether a risk communication message is framed as a completed 'risk assessment' (specifying a magnitude of risk to the public as a function of the exposure level), or as a 'hazard identification' (a statement regarding whether an environmental agent could in principle cause detrimental health effects in humans, without addressing whether such effects may occur in practice). The current study aimed to investigate for the first time whether framing a risk communication message regarding 'mobile phones and health' as a hazard identification or as a risk assessment affects the reader's risk perception. Using an online survey, participants were separated into three groups and shown either an original press release from the International Agency for Research on Cancer regarding mobile phones and cancer (Group 1), or the press release with additional text modules intended to frame the press release as either a risk assessment (Group 2) or a hazard identification (Group 3). The experimental manipulation was successful in that framing the message as a hazard identification reduced the number of people that believed the press release was a risk assessment, whereas framing it as a risk assessment was not able to increase the number of people who thought that it was a risk assessment. However, no differences in risk perception were found between the groups. In an attempt to ascertain the reason for this lack of framing effect on the radiofrequency electromagnetic fields risk perception measures, it was found that pre-existing interpretations of risk and hazard strongly predicted risk perception, regardless of

experimental group. Participants who believed that the International Agency for Research on Cancer conducted a hazard identification perceived lower risks and were less convinced that radiofrequency electromagnetic field exposure from mobile phones increases cancer risks. The results of the study demonstrate the importance of understanding the distinction between a hazard identification and a risk assessment, and suggest that radiofrequency electromagnetic field risk communication needs to develop means for empowering the public to differentiate between hazards and risks.

<https://pubmed.ncbi.nlm.nih.gov/32755556/>

EXPOSURE TO ELECTROMAGNETIC FIELD DURING GESTATION ADVERSELY AFFECTS THE ELECTROPHYSIOLOGICAL PROPERTIES OF PURKINJE CELLS IN RAT OFFSPRING

Haghani M, Pouladvand V , Mortazavi S M J, Razavinasab M, Bayat M, Shabani M. Exposure to Electromagnetic Field during Gestation Adversely Affects the Electrophysiological Properties of Purkinje Cells in Rat Offspring. J Biomed Phys Eng. 2020 Aug 1;10(4):433-440. doi: 10.31661/jbpe.v0i0.560.

Abstract

Background: Prenatal adverse effects of radiofrequency electromagnetic fields (RF-EMF) exposure on nervous system are an issue of major concern.

Objective: Thus, in this study we evaluated the membrane current flow properties of Purkinje neurons after maternal exposure to 900 MHz pulsed RF-EMF.

Material and methods: In this experimental study, during all days of pregnancy, rats in the EMF-exposed group were exposed to 900 MHz pulsed-EMF radiation for 6 h per day. The effects of RF-EMF exposure on the electrophysiological properties of the Purkinje cerebellum neurons from male pups were evaluated by whole- cell patch clamp recordings in current and voltage clamp modes. In voltage-clamp experiments, the holding potential was -60mV, and a depolarizing voltage step (1000 ms duration) was applied from -60 to +50 mV in 10 mV increments at 2s intervals.

Results: The exposure group demonstrated reduced spontaneous firing associated with upward and rightward shift in I/V curve compared to the control rats. Moreover, the peak amplitude of the current for the exposure pups also revealed a significant decrement. The reversal potential was +40 mV and +20 mV for the control and RF-EMF groups, respectively and showed significant differences between the two groups.

Conclusion: The decrease in ion's conductance could be attributed to the observed decrease in the voltage onset of the inward current, peak amplitude and voltage shift.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7416100/>

HEPATIC INJURY INDUCED BY RADIO FREQUENCY WAVES EMITTED FROM CONVENTIONAL WI-FI DEVICES IN WISTAR RATS

H M Fahmy, F F Mohammed. Hepatic injury induced by radio frequency waves emitted from conventional Wi-Fi devices in Wistar rats. *Hum Exp Toxicol*. 2020 Aug 7;960327120946470. doi: 10.1177/0960327120946470.

Abstract

In this study, the impact of standard 2.45 GHz radio frequency source (averaged whole-body specific absorption rate 0.01 W kg⁻¹ 24 h⁻¹ daily for 40 consecutive days) on the liver of Wistar female rats was investigated. The rats were randomly divided into control and Wi-Fi-exposed groups. At the end of the exposure, liver samples were dissected from rats. Rats' livers were inspected through the evaluation of some oxidative stress parameters and the evaluation of glutamic oxaloacetic transaminase and glutamic-pyruvic transaminase levels as well as through the molecular investigation using Fourier transform infrared spectroscopy. Histopathological examination in addition to ultrastructure examination was also performed. The present data revealed that Wi-Fi exposure leads to severe oxidative stress in the rat liver. Furthermore, Wi-Fi exposure resulted in deleterious effects in the liver function and alters its molecular structure. Moreover, severe histological and ultrastructural alterations are reported in the hepatic tissues points to hepatotoxic effects induced by Wi-Fi exposure. In conclusion, care must be taken when using Wi-Fi emitting devices due to their severe impact on the liver. Public awareness of the need to decrease exposure time and increase the distance from Wi-Fi exposure sources must be raised wherever possible.

<https://pubmed.ncbi.nlm.nih.gov/32762465/>

BEHAVIORAL CHANGES AND GENE PROFILE ALTERATIONS AFTER CHRONIC 1,950-MHZ RADIOFREQUENCY EXPOSURE: AN OBSERVATION IN C57BL/6 MICE

Ye Ji Jeong, Yeonghoon Son, Hyung-Do Choi, Nam Kim, Yun-Sil Lee, Young-Gyu Ko, Hae-June Lee. Behavioral changes and gene profile alterations after chronic 1,950-MHz radiofrequency exposure: An observation in C57BL/6 mice. *Brain Behav*. 2020 Aug 28;e01815. doi: 10.1002/brb3.1815.

Abstract

Introduction: Due to public concerns about deleterious biological consequences of radiofrequency electromagnetic fields (RF-EMF), the potential effects of RF-EMF on the central nervous system have received wide consideration.

Methods: Here, two groups of C57BL/6 mice, aged 2 and 12 months, were exposed to 1,950-MHz RF-EMF at a specific absorption rate of 5.0 W/kg for chronic periods (2 hr/day and 5 days/week for 8 months). Behavioral changes were then assessed in the mice at 10 months (sham- or RF-10M) and 20 months (sham- or RF-20M), on the open-field test, the Y-maze test, and an object recognition memory task, while biological effects were analyzed via microarray gene profiling of the hippocampus.

Results: Open-field test results showed a decrease in the time duration spent at the center while there was a decrease in enhanced memory shown by the Y-maze test and the novel object recognition test in the RF-20M mice, compared to sham-exposed mice, but no significant changes in the RF-10M group. Based on a 2-fold change cutoff, the microarray data

revealed that 15 genes, which are listed as being involved in neurogenesis on Gene Ontology, were altered in both groups. Quantitative real-time PCR for validation showed increased expression of Epha8 and Wnt6 in the hippocampi of RF-20M group mice, although 13 additional genes showed no significant changes following RF-EMF exposure.

Conclusion: Therefore, cognitive enhancement following chronic exposure for 8 months to RF-EMF from middle age may be associated with increases in neurogenesis-related signals in the hippocampus of C57BL/6 mice.

Open access paper: <https://onlinelibrary.wiley.com/doi/full/10.1002/brb3.1815>

INVESTIGATING HUMAN EXPOSURE TO A PRACTICAL WIRELESS POWER TRANSFER SYSTEM USING AND THE EFFECT ABOUT KEY PARAMETERS OF DOSIMETRY

SangWook Park. Investigating human exposure to a practical wireless power transfer system using and the effect about key parameters of dosimetry. PLoS One. 2020 Aug 14;15(8):e0236929. doi: 10.1371/journal.pone.0236929.

Abstract

Accurate dosimetry for a real wireless power transfer system (WPT) using electromagnetic resonance and electromagnetic induction requires an accurate description of the field formed by the system. In particular, the electromagnetic field depends on factors such as the construction of the transmitting and receiving coils, the circuit configuration, the input source of the front end of the transmitting coil, and the input impedance of the rear end of receiving coil. However, both circuit and electromagnetic simulations need to be performed to analyze the entire system, which is a difficult task. In order to overcome this difficulty, a method using an equivalent circuit model is proposed and verified through experiments. Moreover, the worst exposure condition to a magnetic field was examined by considering three variables: the charging mode, the state of charge, and the alignment and misalignment between the transmitting and receiving coils. Accordingly, the strongest magnetic field was created in the constant current mode in the fully charged state with misalignment. For example, the magnetic field strength in the case of 80% state of charge and misalignment was 1.397 times greater than in the case of 20% state of charge and alignment at a point 10 mm from the transmission pad.

Finally, the induced electric fields and induced current densities were calculated by using a Japanese adult male whole-body voxel human model, and the results were compared with the values recommended by international guidelines to ascertain their compliance.

<https://pubmed.ncbi.nlm.nih.gov/32797050/>

AN INVESTIGATION INTO THE EFFECTS OF LONG-TERM 50-HZ POWER-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE ON HEMATOGRAM, BLOOD CHEMISTRY, FIBROSIS, AND OXIDANT STRESS STATUS IN THE LIVER AND THE KIDNEY FROM SPRAGUE- DAWLEY RATS

Yemao Zhang, Jin Wang, Xingfa Liu, Lijian Ding, Xiong Wu, Mengying He, Huiying Hou, Guoran Ruan, Jinsheng Lai, Chen Chen. An Investigation Into the Effects of Long-Term 50-Hz Power-Frequency Electromagnetic Field Exposure on Hematogram, Blood Chemistry, Fibrosis, and Oxidant Stress Status in the Liver and the Kidney From Sprague-Dawley Rats. Bioelectromagnetics. 2020 Aug 25. doi: 10.1002/bem.22291.

Abstract

Power-frequency electromagnetic fields (PF-EMFs) at 50 Hz are potential health risk factors. This study aimed to explore the effects of long-term exposure to 50-Hz PF-EMFs on general physiological conditions in Sprague- Dawley (SD) rats. During a 24-week exposure period, the body mass and water and food intake of the animals were recorded regularly. The hematologic parameters were detected every 12 weeks, and blood chemistry analyses were performed every 4 weeks. After sacrifice, morphology was identified by hematoxylin-eosin, Masson, and immunohistochemical staining. Fibrosis-related gene expression and oxidative stress status were also detected. Compared with the control group, exposure to 30, 100, or 500 μ T PF-EMF did not exert any effect on body mass, food intake, or water intake. Similarly, no significant differences were found in hematologic parameters or blood chemistry analyses among these groups. Furthermore, morphological assays showed that exposure to PF-EMFs had no influence on the structure of the liver or kidney. Finally, fibrosis-related gene expression and oxidative stress status were unaltered by PF-EMF exposure. The present study indicates that 24 weeks of exposure to PF-EMFs at intensities of 30, 100, or 500 μ T might not affect hemograms, blood chemistry, fibrosis, or oxidative stress in the liver or kidney in SD rats.

<https://pubmed.ncbi.nlm.nih.gov/32841426/>

INDICATION OF ELECTROMAGNETIC FIELD EXPOSURE VIA RBF-SVM USING TIME-SERIES FEATURES OF ZEBRAFISH LOCOMOTION

Yaqing He, Kim Fung Tsang, Richard Yuen-Chong Kong, Yuk-Tak Chow. Indication of Electromagnetic Field Exposure via RBF-SVM Using Time-Series Features of Zebrafish Locomotion. Sensors (Basel). 2020 Aug 26;20(17):E4818. doi: 10.3390/s20174818.

Abstract

This paper introduces a novel model based on support vector machine with radial basis function kernel (RBF- SVM) using time-series features of zebrafish (*Danio rerio*) locomotion exposed to different electromagnetic fields (EMFs) to indicate the corresponding EMF exposure. A group of 14 adult zebrafish was randomly divided into two groups, 7 in each group; the fish of each group have the novel tank test under a sham or real magnetic exposure of 6.78 MHz and about 1 A/m. Their locomotion in the tests was videotaped to convert into the x, y coordinate time-series of the trajectories for reforming time-series matrices according to different time-series lengths. The time-series features of zebrafish locomotion were calculated by the comparative time-series analyzing framework highly comparative time-series analysis (HCTSA), and a limited number of the time-series features that were most relevant to the EMF exposure conditions were selected using the minimum redundancy

maximum relevance (mRMR) algorithm for RBF-SVM classification training. Before this, ambient environmental parameters (AEPs) had little effect on the locomotion performance of zebrafish processed by the empirical method, which had been quantitatively verified by regression using another group of 14 adult zebrafish. The results have demonstrated that the purposed model is capable of accurately indicating different EMF exposures. All classification accuracies can be 100%, and the classification precision of several classifiers based on specific parameters and feature sets with specific dimensions can reach higher than 95%. The speculative reason for this result is that the specified EMF has affected the zebrafish neural aspect, which is then reflected in their behaviors. The outcomes of this study have provided a new indication model for EMF exposures and provided a reference for the investigation of the impact of EMF exposure.

Open access paper: <https://www.mdpi.com/1424-8220/20/17/4818>

SECURITY MILLIMETRE WAVE BODY SCANNER SAFE FOR PATIENTS WITH LEADLESS PACEMAKERS OR SUBCUTANEOUS IMPLANTABLE CARDIOVERTER-DEFIBRILLATORS

Patrick Blažek, Matthew J O'Connor, Severin Weigand, Christian Grebmer, Sebastian Reif, et al. Security millimetre wave body scanner safe for patients with leadless pacemakers or subcutaneous implantable cardioverter-defibrillators. J Interv Card Electrophysiol. 2020 Aug 29. doi: 10.1007/s10840-020-00830-x.

Abstract

Purpose: This study was designed to evaluate the electromagnetic interference (EMI) effects and safety of the new security screening millimetre wave body scanners (MWBSs) for patients with rare cardiac implantable electronic devices (CIEDs).

Methods: We identified 73 patients with either entirely subcutaneous implantable cardioverter-defibrillators (S- ICD) or leadless pacemakers (LPM) attending routine device follow-up. CIED programming was optimised for the detection of EMI occurrence, and high-voltage therapy was disabled. Patients then underwent millimetre wave body scans under continuous ECG monitoring. Scanning was performed at the recommended distance as well as in close proximity to the scanner emulating accidental exposure. CIED function was observed for EMI effects.

Results: There were no episodes of inhibition of pacing in the leadless pacemaker subgroup, no oversensing in the S-ICD subgroup and no spontaneous device reprogramming in any group. There was no change in pacing or sensing thresholds, and S-ICD vector eligibility remained unchanged after scanning with the MWBS. No CIEDs were identified by the MWBS during the study.

Conclusion: No EMI events were detected during the use of MWBSs by patients with either S-ICDs or LPMs. This data should be reassuring for patients suggesting that they can undergo security body scans without worries or disclosure of their CIED status.

<https://pubmed.ncbi.nlm.nih.gov/32860605/>

HEALTH RISKS FROM RADIOFREQUENCY RADIATION, INCLUDING 5G, SHOULD BE ASSESSED BY EXPERTS WITH NO CONFLICTS OF INTEREST

Lennart Hardell, Michael Carlberg. Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest. *Oncology Letters*. 20:15. Published online July 15, 2020. <https://doi.org/10.3892/ol.2020.11876>.

Abstract

The fifth generation, 5G, of radiofrequency (RF) radiation is about to be implemented globally without investigating the risks to human health and the environment. This has created debate among concerned individuals in numerous countries. In an appeal to the European Union (EU) in September 2017, currently endorsed by >390 scientists and medical doctors, a moratorium on 5G deployment was requested until proper scientific evaluation of potential negative consequences has been conducted. This request has not been acknowledged by the EU. The evaluation of RF radiation health risks from 5G technology is ignored in a report by a government expert group in Switzerland and a recent publication from The International Commission on Non- Ionizing Radiation Protection. Conflicts of interest and ties to the industry seem to have contributed to the biased reports. The lack of proper unbiased risk evaluation of the 5G technology places populations at risk.

Furthermore, there seems to be a cartel of individuals monopolizing evaluation committees, thus reinforcing the no-risk paradigm. We believe that this activity should qualify as scientific misconduct.

Open access paper:

<https://www.spandidos-publications.com/10.3892/ol.2020.11876/download>

EXPERIMENTAL PROCEDURE FOR FIFTH GENERATION (5G) ELECTROMAGNETIC FIELD (EMF) MEASUREMENT AND MAXIMUM POWER EXTRAPOLATION FOR HUMAN EXPOSURE ASSESSMENT

Daniele Franci, Stefano Coltellacci, Enrico Grillo, Settimio Pavoncello, Tommaso Aureli, Rossana Cintoli, Marco Donald Migliore. Experimental Procedure for Fifth Generation (5G) Electromagnetic Field (EMF) Measurement and Maximum Power Extrapolation for Human Exposure Assessment. *Environments* 2020, 7(3), 22; <https://doi.org/10.3390/environments7030022>.

Abstract

The fifth generation (5G) technology has been conceived to cover multiple usage scenarios from enhanced mobile broadband to ultra-reliable low-latency communications (URLLC) to massive machine type communications. However, the implementation of this new technology is causing increasing concern over the possible impact on health and safety arising from exposure to electromagnetic field radiated by 5G systems, making imperative the development of accurate electromagnetic field (EMF) measurement techniques and protocols. Measurement techniques used to assess the compliance with EMF exposure limits are object to international regulation. The basic principle of the assessment is to measure the power received from a constant radio frequency source, typically a pilot signal, and to apply a proper extrapolation factor. This kind of approach is standardized for 2G, 3G, and 4G technologies, but is still under investigation for 5G technology. Indeed, the use of flexible numerologies and advanced Time Division Duplexing (TDD) and spatial multiplexing

techniques, such as beam sweeping and Massive Multiple Input Multiple Output (MIMO), requires the definition of new procedures and protocols for EMF measurement of 5G signals. In this paper a procedure for an accurate estimation of the instant maximum power received from a 5G source is proposed. The extrapolation technique is based on the introduction of proper factors that take into account the effect of the TDD and of the sweep beam in the measured value of the 5G signal level. Preliminary experimental investigation, based on code domain measurement of appropriate broadcast channels, and carried out in a controlled environment are reported, confirming the effectiveness of the proposed approach.

Open access paper: <https://www.mdpi.com/2076-3298/7/3/22/htm>

NON-RESONANT FREQUENCIES IN MOBILE WIRELESS 5G COMMUNICATION NETWORKS

Emanuele Calabrò, Salvatore Magazù. Non-resonant Frequencies in Mobile Wireless 5G Communication Networks. Wireless Personal Communications. 06 July 2020

Abstract

New emerging technology 5G will require higher speed, power and capacity in data transmission than previous generation, in order to obtain a complete world-wireless communication without limitation. In this scenario, given that the achievement of 5G technology will lead to a drastic increase of effects of exposure to microwave radiation, a strategy to reduce the effects of exposure to electromagnetic fields is needed. In this regard, given that cellular functions of human beings depend closely on ions flux across cellular membrane, whose mechanism should have its natural resonant frequencies, we can hypothesize to plan new emerging wireless technology 5G at frequencies far from these resonant frequencies in order to minimize the effects of exposure to extremely high frequency electromagnetic fields, inducing a significant decreasing of harmful effects on human health. We have named these frequencies “non-resonant frequencies”.

Conclusions

Progress developments will lead to increasingly sophisticated communication and automation in which wireless communication network 5G will have to be even faster and more efficient than previous generation, creating a world in which we will continually be inundated with high frequency electromagnetic waves. The price to pay for such technological advances will be a drastic increasing of exposure of living beings to high-frequency electromagnetic fields and of their effects whose damage to biological systems have been largely demonstrated up to now. In this scenario, the design of a technology which can reduce effects of exposure to electromagnetic fields as much as possible is needed. To this aim, we can apply resonance theory to search nonresonant frequencies in the mechanism of ions flux across cellular membrane channels, that minimize harmful effects of high-frequency electromagnetic radiation, by using spectroscopic and biochemical techniques. The design of wireless technology 5G without taking into account the result of this research may expose human beings to the risk that this technology will be planned at a natural resonant frequency, amplifying harmful effects of exposure to high-frequency electromagnetic fields. Instead, the development of new emerging technology 5G at non- resonant frequency should induce a decreasing of harmful effects on human health, without giving up advantages of this advanced technology.

<https://link.springer.com/article/10.1007/s11277-020-07633-3>

HEALTH EFFECTS OF ELECTROMAGNETIC FIELDS ON CHILDREN

Jin-Hwa Moon. Health effects of electromagnetic fields on children. Clin Exp Pediatr. 2020 May 26. doi: 10.3345/cep.2019.01494.

Abstract

In today's world, most children are exposed to various man made electromagnetic fields (EMFs). EMFs are electromagnetic waves less than 300 GHz. A developing child's brain is vulnerable to electromagnetic radiation; thus, their caregivers' concerns about the health effects of EMFs are increasing. EMF exposure is divided into two categories: extremely low frequencies (ELFs; 3-3,000 Hz), involving high-voltage transmission lines and in- house wiring; and radio frequencies (RFs; 30 kHz to 300 GHz), involving mobile phones, smart devices, base stations, WiFi, and 5G technologies. The biological effects of EMFs on humans include stimulation, thermal, and nonthermal, the latter of which is the least known. Among the various health issues related to EMFs, the most important issue is human carcinogenicity. According to the International Agency for Research on Cancer's (IARC's) evaluation of carcinogenic risks to humans, ELFs and RFs were evaluated as possible human carcinogens (Group 2B). However, the World Health Organization's (WHO's) view of EMFs remains undetermined. This article reviews the current knowledge of EMF exposure on humans, specifically children. EMF exposure sources, biological effects, current WHO and IARC opinions on carcinogenicity, and effects of EMF exposures on children will be discussed. As well-controlled EMF experiments in children are nearly impossible, scientific knowledge should be interpreted objectively. Precautionary approaches are recommended for children until the potential health effects of EMF are confirmed.

Key message

- The nervous systems of children are more vulnerable to the effects of electromagnetic waves than adults.
- The exposure to EMFs among children should be minimized.
- According to IARC, EMFs are possibly carcinogenic, it should not be overlooked or interpreted with bias.

Open access paper: <https://www.e-cep.org/journal/view.php?doi=10.3345/cep.2019.01494>

ESTIMATED WHOLE-BRAIN AND LOBE-SPECIFIC RADIOFREQUENCY ELECTROMAGNETIC FIELDS DOSES AND BRAIN VOLUMES IN PREADOLESCENTS

Alba Cabré-Riera, Hanan El Marroun, Ryan Muetzel, Luuk van Wel, Ilaria Liorni, Arno Thielens, Laura Ellen Birks, Livia Pierotti, Anke Huss, Wout Joseph, Joe Wiart, Myles Capstick, Manon Hillegers, Roel Vermeulen, Elisabeth Cardis, Martine Vrijheid, Tonya White, Martin Röösli, Henning Tiemeier, Mònica Guxens. 142, September 2020, 105808. <https://doi.org/10.1016/j.envint.2020.105808>.

Highlights

- We estimated overall and source-specific RF-EMF doses to the brain.
- Estimated overall whole-brain RF-EMF dose was 84.3 mJ/kg/day.
- Overall whole-brain or lobe-specific RF-EMF doses were not related to brain volumes.
- Whole-brain RF-EMF dose from mobile communication devices for screen activities while wirelessly connected to the internet was associated with smaller caudate volume.
- We cannot discard residual confounding, chance finding, or reverse causality.

Abstract

Objective To assess the association between estimated whole-brain and lobe-specific radiofrequency electromagnetic fields (RF-EMF) doses, using an improved integrated RF-EMF exposure model, and brain volumes in preadolescents at 9–12 years old.

Methods Cross-sectional analysis in preadolescents aged 9–12 years from the Generation R Study, a population-based birth cohort set up in Rotterdam, The Netherlands (n = 2592). An integrated exposure model was used to estimate whole-brain and lobe-specific RF-EMF doses (mJ/kg/day) from different RF-EMF sources including mobile and Digital Enhanced Cordless Telecommunications (DECT) phone calls, other mobile phone uses than calling, tablet use, laptop use, and far-field sources. Whole-brain and lobe-specific RF-EMF doses were estimated for all RF-EMF sources together (i.e. overall) and for three groups of RF-EMF sources that lead to a different pattern of RF-EMF exposure. Information on brain volumes was extracted from magnetic resonance imaging scans.

Results Estimated overall whole-brain RF-EMF dose was 84.3 mJ/kg/day. The highest overall lobe-specific dose was estimated in the temporal lobe (307.1 mJ/kg/day). Whole-brain and lobe-specific RF-EMF doses from all RF-EMF sources together, from mobile and DECT phone calls, and from far-field sources were not associated with global, cortical, or subcortical brain volumes. However, a higher whole-brain RF-EMF dose from mobile phone use for internet browsing, e-mailing, and text messaging, tablet use, and laptop use while wirelessly connected to the internet was associated with a smaller caudate volume.

Conclusions Our results suggest that estimated whole-brain and lobe-specific RF-EMF doses were not related to brain volumes in preadolescents at 9–12 years old. Screen activities with mobile communication devices while wirelessly connected to the internet lead to low RF-EMF dose to the brain and our observed association may thus rather reflect effects of social or individual factors related to these specific uses of mobile communication devices. However, we cannot discard residual confounding, chance finding, or reverse causality. Further studies on mobile communication devices and their potential negative associations with brain

development are warranted, regardless whether associations are due to RF-EMF exposure or to other factors related to their use.

Open access paper:

<https://www.sciencedirect.com/science/article/pii/S0160412020317633?via%3Dihub>

Note: The caudate nucleus plays important roles in various nonmotor functions including procedural learning, associative learning, and inhibitory control of action. Moreover, it has long been associated with motor processes due to its role in Parkinson's disease.

ARE CONTEMPORARY SMARTWATCHES AND MOBILE PHONES SAFE FOR PATIENTS WITH CARDIOVASCULAR IMPLANTABLE ELECTRONIC DEVICES?

Philipp Lacour, Abdul ShokorParwani, Franziska Schuessler, Felix Hohendanner, Frank R. Heinzl, Tobias D.Trippel, Leif-Hendrik Bold, Burkert Pieske, Florian Blaschke. JACC: Clinical Electrophysiology. 29 July 2020. <https://doi.org/10.1016/j.jacep.2020.04.033>.

Abstract

Objectives Given the increasing prevalence of mobile phone and smartwatch use, this study tested patients with cardiovascular implantable electronic devices (CIEDs) for the incidence and consequence of contemporary mobile phone and smartwatch-produced electromagnetic interferences.

Background Electromagnetic interferences can be hazardous for patients with CIEDs.

Methods In total, 148 patients with CIEDs and leads from 4 different manufacturers were subjected to 1,352 tests. Analyzed CIEDs included 51 pacemakers, 5 cardiac resynchronization therapy pacemakers, 46 implantable cardioverter-defibrillators, 43 cardiac resynchronization therapy defibrillators, and 3 implantable loop recorders. To analyze a possible influence of certain distances between the mobile phone (iPhone 6) and the smartwatch (Apple Watch A1553) to the CIED, both were placed either directly above implanted devices or at the right wrist. All possible activations of the iPhone and the Apple Watch, including the standby, dialing, and connecting modes (telephone connection and Internet access) were tested. In addition, we studied incidence and characteristics of interferences with interrogation telemetry.

Results In this study, only a single case of mobile phone–induced electromagnetic interference on a dual-chamber pacemaker was observed. Utilizing wand telemetry, iPhone induced interferences were found in 14% of the patients. However, none of the patients showed any interference with the Apple Watch.

Conclusions The risk of electromagnetic interferences of the iPhone 6 and the Apple Watch with CIEDs is low. However, close proximity of the iPhone 6 to implanted devices can cause telemetry interferences.

<https://www.sciencedirect.com/science/article/abs/pii/S2405500X20303625>

THERMOREGULATORY STRESS AS POTENTIAL MEDIATING FACTOR IN THE NTP CELL PHONE TUMOR STUDY

Jens Kuhne, Janine-Alison Schmidt, Dirk Geschwentner, Blanka Pophof, Gunde Ziegelberger. Thermoregulatory Stress as Potential Mediating Factor in the NTP Cell Phone Tumor Study. Bioelectromagnetics. 21 July 2020. <https://doi.org/10.1002/bem.22284>.

No abstract.

Open access letter: <https://onlinelibrary.wiley.com/doi/10.1002/bem.22284>

ENVIRONMENTAL POLLUTION, OXIDATIVE STRESS AND THIORETINACO OZONIDE: EFFECTS OF GLYPHOSATE, FLUORIDE AND ELECTROMAGNETIC FIELDS ON MITOCHONDRIAL DYSFUNCTION IN CARCINOGENESIS, ATHEROGENESIS AND AGING

Kilmer S. McCully. Environmental Pollution, Oxidative Stress and Thioretinaco Ozonide: Effects of Glyphosate, Fluoride and Electromagnetic Fields on Mitochondrial Dysfunction in Carcinogenesis, Atherogenesis and Aging. Annals of Clinical and Laboratory Science. 50(3):408-411. May-June 2020.

Abstract

Environmental pollutants, such as pesticides, herbicides, additives to food and water, and electromagnetic fields threaten public health by promotion of cancer, heart disease and chronic diseases of aging. Many of these pollutants cause adverse health outcomes by effects on mitochondrial function to produce oxidative stress through loss of the active site complex for oxidative phosphorylation, thioretinaco ozonide oxygen nicotinamide adenine dinucleotide phosphate, from opening of the mitochondrial permeability transition pore. Glyphosate, fluoride, and electromagnetic fields are examples of carcinogenic pollutants that promote loss and decomposition of the active site for oxidative phosphorylation, producing mitochondrial dysfunction and oxidative stress. Ionizing radiation has long been known to be carcinogenic, and non-ionizing electromagnetic fields from microwaves, radar, cell phones and cathode ray screens are carcinogenic and produce deleterious effects on capillaries, nerve cells, blood brain barrier, embryonic and germ cells, lenses and cardiac function.

Adverse health effects of electromagnetic fields include cataracts, infertility, congenital malformations, cancer, lymphocytosis, leukemia, hearing loss, blindness, retinal hemorrhages, cardiac arrhythmias, dermatitis, hair loss, depression, memory loss, premature aging, heart attacks, and weaponized mind control. The hyperhomocysteinemia, suppressed immunity, and altered oxidative metabolism observed in atherosclerosis and dementia are attributed to deficiency of adenosyl methionine which results from increased polyamine biosynthesis by pathogenic microbes that are demonstrated in atherosclerotic plaques and cerebral plaques.

Thus, environmental pollutants potentially promote diseases of aging, atherosclerosis, cancer, and premature aging by production of mitochondrial dysfunction.

<http://www.annclinlabsci.org/content/50/3/408.abstract>

CHARACTERIZATION OF EXPOSURE TO ELECTROMAGNETIC EMISSIONS FROM PUBLIC MOBILE SYSTEMS USING THE TIME- AVERAGED AND INTEGRAL-BASED MEASURE

Darko Šuka, Predrag Pejović, Mirjana Simić-Pejović. Characterization of Exposure to Electromagnetic Emissions from Public Mobile Systems Using the Time-Averaged and Integral-Based Measure. Radiat Prot Dosimetry. 2020 Jul 22;ncaa091. doi: 10.1093/rpd/ncaa091.

Abstract

Since radio frequency (RF) signals from public mobile systems are stochastic and exhibit large temporal variations, the results of measurements, typically E field measurements, are time dependent and highly variable. Therefore, any 6-min measurements and 6-min averaged results to obtain the mean level strength at a given place may not be so reliable when it comes to determine long-term exposure levels. Specifically, the results of such short-term exposure assessments can be both under- or overestimated depending on whether the extreme value is caught during the measurement time. Because the RF range is active 24 h a day, the authors suggest that the monitoring process should cover the same time period. To evaluate the variability of measurement results, the analysis in this paper was conducted through descriptive statistics of the 24-h instantaneous, time- averaged and integral-based values. By applying the 24-h time-averaged and integral-based measure on a 24-h data set of measurements, the variability of daily exposure could be reduced to $\pm 20\%$ of the mean week value obtained either with the time-averaged or integral-based measure.

<https://pubmed.ncbi.nlm.nih.gov/32696961/>

TRANSIENT THERMAL RESPONSES OF SKIN TO PULSED MILLIMETER WAVES

Kenneth R. Foster, Marvin C. Ziskin, Quirino Balzano, Akimasa Hirata. Transient Thermal Responses of Skin to Pulsed Millimeter Waves. IEEE Access. in press. Jul 9, 2020. doi: 10.1109/ACCESS.2020.3008322

Abstract

This study examines thermal responses of skin to pulsed millimeter wave (mm-wave) radiofrequency (RF) radiation. We review limits for pulse fluence in the IEEE Std. C95.1-2019 and the 2020 guideline of the International Commission on Nonionizing Radiation Protection (ICNIRP), as well as the recently re-affirmed guidelines of the U.S. Federal Communications Commission (FCC). The study employs a simple one-dimensional thermal model for skin and Pennes' bioheat equation (BHTE). The predicted temperature increases produced by 3-sec pulses at 94 GHz agree well with previous experimental results with no adjustable parameters in the model, and the anticipated threshold of cutaneous thermal pain and burns are consistent with the scant available data for pulsed mm-waves, as well as a larger body of data on thermal hazards from pulsed infrared radiation. The model suggests that the implicit limits on pulse fluence in present FCC guidelines might allow, in extreme (and, in practice, unrealistic) cases, transient increases in skin temperature that can approach thresholds for thermal pain but well below those anticipated to cause thermal damage. Limits on pulse fluence in the current IEEE and ICNIRP exposure guidelines would preclude such effects. For realistic exposures from wireless and other technologies that transmit pulsed RF energy that comply with time-averaged exposure limits, the pulse fluence is far too low to produce hazardous thermal transients in skin. A thermal analysis of FCC's proposed "device-based time averaging" shows that the resulting limits on device emissions will result in thermal transients

in skin that are roughly an order of magnitude below much slower increases in temperature due to time-averaged exposure. An appendix discusses the applicability of two approximations to the bioheat equation that can be used to estimate temperature increases in skin from exposure to mm-waves. This work was supported in part by the Microwave and Wireless Forum to three of the present authors (KRF, MCZ, and QB).

Open access paper: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9137269>

DESIGN OF AN INTEGRATED PLATFORM FOR MAPPING RESIDENTIAL EXPOSURE TO RF-EMF SOURCES

Corentin Regrain, Julien Caudeville, René de Seze, Mohammed Guedda, Amirreza Chobineh, Philippe de Doncker, Luca Petrillo, Emma Chiaramello, Marta Parazzini, Wout Joseph, Sam Aerts, Anke Huss, Joe Wiart. Design of an Integrated Platform for Mapping Residential Exposure to Rf-Emf Sources. *Int J Environ Res Public Health*. 2020 Jul 24;17(15):E5339. doi: 10.3390/ijerph17155339.

Abstract

Nowadays, information and communication technologies (mobile phones, connected objects) strongly occupy our daily life. The increasing use of these technologies and the complexity of network infrastructures raise issues about radiofrequency electromagnetic fields (Rf-Emf) exposure. Most previous studies have assessed individual exposure to Rf-Emf, and the next level is to assess populational exposure. In our study, we designed a statistical tool for Rf-Emf populational exposure assessment and mapping. This tool integrates geographic databases and surrogate models to characterize spatiotemporal exposure from outdoor sources, indoor sources, and mobile phones. A case study was conducted on a 100 × 100 m grid covering the 14th district of Paris to illustrate the functionalities of the tool. Whole-body specific absorption rate (SAR) values are 2.7 times higher than those for the whole brain. The mapping of whole-body and whole-brain SAR values shows a dichotomy between built-up and non-built-up areas, with the former displaying higher values. Maximum SAR values do not exceed 3.5 and 3.9 mW/kg for the whole body and the whole brain, respectively, thus they are significantly below International Commission on Non-Ionizing Radiation Protection (ICNIRP) recommendations. Indoor sources are the main contributor to populational exposure, followed by outdoor sources and mobile phones, which generally represents less than 1% of total exposure.

Conclusions

We have designed a statistical tool that uses surrogate models for spatiotemporal mapping of Rf-Emf exposure. Using a mathematical and probabilistic approach, this tool aggregates spatiotemporal surrogate models of Rf-Emf exposure with geographical data, population distributions, socioeconomic data, and ICT use patterns. Data fusion of all this heterogeneous information results in an innovative and advanced mapping of residential exposure providing information on variability, occurrence, and exposure quantiles relevant for the public, health researchers, political decision-makers, and risk assessors. Future works will improve the approaches developed. For the Rf-Emf exposure, some exposure sources (laptop, 4G, 5G, and other future technology) will have to be integrated into the exposure assessment to consider the evolution of technologies and usages. Certain exposure mechanisms such as outdoor-to-indoor attenuation or electric-field propagation will need to be better characterized. For the

methodological aspect, some methods used in this study will also be applied to larger and heterogeneous territories as well as for exposure assessment to chemical agents or biological risk factors.

Open access paper: <https://www.mdpi.com/1660-4601/17/15/5339>

EVALUATION OF FREQUENCY MAGNETIC FIELD, STATIC FIELD, AND TEMOZOLOMIDE ON VIABILITY, FREE RADICAL PRODUCTION AND GENE EXPRESSION (P53) IN THE HUMAN GLIOBLASTOMA CELL LINE (A172)

Ahmad Ashta, Gholamreza Motalleb, Meysam Ahmadi-Zeidabadi. Evaluation of frequency magnetic field, static field, and Temozolomide on viability, free radical production and gene expression (p53) in the human glioblastoma cell line (A172). *Electromagn Biol Med.* 2020 Jul 15;1-12. doi: 10.1080/15368378.2020.1793171.

Abstract

Thirteen million cancer deaths and 21.7 million new cancer cases are expected in the world by 2030. Glioblastoma is the most common primary malignant tumor of the central nervous system which is the most lethal type of primary brain tumor in adults with the survival time of 12-15 months after the initial diagnosis. Glioblastoma is the most common and most malignant type of brain tumor, and despite surgery, chemotherapy and radiation treatment, the average survival of patients is about 14 months. The current research showed that the frequency magnetic field (FMF) and static magnetic field (SMF) can influence cancer cell proliferation and coupled with anticancer drugs may provide a new strategy for cancer therapy. At the present study, we investigated the effects of FMF (10 Hz, 50 G), SMF (50 G) and Temozolomide (200 μ m) on viability, free radical production, and p53 followed by p53 protein expression in the human glioblastoma cell line (A172) by MTT, NBT, RT-PCR and Western blot. Results showed that the effect of Temozolomide (TMZ) with SMF and FMF together increased the cytotoxicity, free radical production, and p53 followed by p53 protein expression in the human glioblastoma cell line (A172).

<https://pubmed.ncbi.nlm.nih.gov/32666844/>

CO-DESIGNED EXPOSURE PROTOCOL IN THE STUDY OF IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS

Maryse Ledent, Benjamin Vatoz, Willy Pirard, Jimmy Bordarie, Nicolas Prignot, Gunnhild Oftedal, Christophe Geuzaine, Véronique Beauvois, Catherine Bouland, Luc Verschaeve, Maël Dieudonné. Co-Designed Exposure Protocol in the Study of Idiopathic Environmental Intolerance Attributed to Electromagnetic Fields. *Bioelectromagnetics.* 29 June 2020. <https://doi.org/10.1002/bem.22281>.

Abstract

The hypothesis of an electromagnetic origin of idiopathic environmental intolerance (IEI) attributed to electromagnetic fields (EMF) has been widely investigated by provocation studies, which consist of deliberately exposing people with IEI-EMF in laboratory settings to particular EMF to observe volunteers' reactions. In the majority of these studies, reactions have been found to be independent of exposure. However, most of these studies suffer from design and methodological limitations that might bias their findings or reduce their precision.

As provocation studies are best suited for isolating the effects of EMF, innovative protocols should be applied. In the ExpoComm project (PNREST Anses, EST/2017/2 RF/19), several innovations have been introduced: the involvement of people with IEI-EMF in the development of the protocol, the attenuation of the anxiogenic nature of the tests, the individualization of the protocol, the validation of the neutral or normal reactivity state before the test, and the use of a cocktail of real, rather than artificially generated, sources. The objective of involving people with IEI-EMF was to increase the relevance and acceptability of the protocol, while respecting technical constraints and scientific quality requirements. This paper describes the protocol resulting from the collaborative process.

<https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.22281>

WI-FI (2.4 GHZ) AFFECTS ANTI-OXIDANT CAPACITY, DNA REPAIR GENES EXPRESSION AND, APOPTOSIS IN PREGNANT MOUSE PLACENTA

Homeira Vafaei, Ghazal Kavari, Hamid Reza Izadi, Zahra Zare Dorahi, Mehdi Dianatpour, Afrooz Daneshparvar, Iman Jamhiri. Wi-Fi (2.4 GHz) affects anti-oxidant capacity, DNA repair genes expression and, apoptosis in pregnant mouse placenta. Iran J Basic Med Sci. 2020 Jun;23(6):833-840. doi: 10.22038/ijbms.2020.40184.9512.

Abstract

Objectives: The placenta provides nutrients and oxygen to embryo and removes waste products from embryo's blood. As far as we know, the effects of exposure to Wi-Fi (2.4 GHz) signals on placenta have not been evaluated. Hence, we examined the effect of prenatal exposure to Wi-Fi signals on anti-oxidant capacity, expressions of CDKN1A, and GADD45a as well as apoptosis in placenta and pregnancy outcome.

Materials and methods: Pregnant mice were exposed to Wi-Fi signal (2.4 GHz) for 2 and 4 hr. Placenta tissues were examined to measure the MDA and SOD levels. To measure SOD, CDKN1A, GADD45a, Bax, and Bcl-2 expressions were compared by real-time PCR analysis. TUNEL assay was used to assess apoptosis in placenta tissues. The results were analyzed by one-way analysis of variance (ANOVA) using Prism version 6.0 software.

Results: MDA and SOD levels had significantly increased in exposed Wi-Fi signal groups (P-value< 0.05). Also, quantitative PCR experiment showed that SOD mRNA expression significantly increased in Wi-Fi signal groups. The data showed that CDKN1A and GADD45a genes were increased in Wi-Fi groups (P-value<0.05). The quantitative PCR and the TUNEL assay showed that apoptosis increased in Wi-Fi groups (P-value<0.05).

Conclusion: Our results provide evidence that Wi-Fi signals increase lipid peroxidation, SOD activity (oxidative stress), apoptosis and CDKN1A and GADD45a overexpression in mice placenta tissue. However, further experimental studies are warranted to investigate other genes and aspects of pregnancy to determine the role of Wi-Fi radiation on fertility and pregnancy.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7351435/>

INVESTIGATING THE EFFECTS OF EXPOSURE TO EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS ON JOB BURNOUT SYNDROME AND THE SEVERITY OF DEPRESSION; THE ROLE OF OXIDATIVE STRESS

Majid Bagheri Hosseinabadi, Narges Khanjani, Mohammad Hossein Ebrahimi, Seyed Habib Mousavi, Fereshteh Nazarkhani. Investigating the effects of exposure to extremely low frequency electromagnetic fields on job burnout syndrome and the severity of depression; the role of oxidative stress. *J Occup Health*. 2020 Jan;62(1):e12136. doi: 10.1002/1348-9585.12136.

Abstract

Objectives: This study was designed to investigate the possible effect of exposure to extremely low frequency electromagnetic fields (ELF-EMFs) on occupational burnout syndrome and the severity of depression experienced among thermal power plant workers and the role of oxidative stress.

Methods: In this cross-sectional study, 115 power plant workers and 124 administrative personnel of a hospital were enrolled as exposed and unexposed groups, respectively, based on inclusion and exclusion criteria. Levels of oxidative stress biomarkers, including malondialdehyde (MDA), superoxide dismutase (SOD), catalase (Cat), and total antioxidant capacity were measured in serum samples. Exposure to electric and magnetic fields was measured using the IEEE Std C95.3.1 standard at each workstation. The burnout syndrome and the severity of depression were assessed using the Maslach Burnout and Beck Depression Inventory.

Results: The levels of MDA and SOD were significantly lower in the exposed group than the unexposed group. The exposed group reported a higher prevalence of burnout syndrome and higher depression severity. Multiple linear regression showed that work experience, MDA level, and levels of exposure to magnetic fields are the most important predictor variables for burnout syndrome and severity of depression. In addition, a decrease in the level of Cat was significantly associated with increased burnout syndrome.

Conclusion: The thermal power plant workers exposed to ELF-EMFs are at risk of burnout syndrome and depression. These effects may be caused directly by exposure to magnetic fields or indirectly due to increased oxidative stress indices.

Open access paper: <https://onlinelibrary.wiley.com/doi/full/10.1002/1348-9585.12136>

EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELD INDUCES A CHANGE IN PROLIFERATIVE CAPACITY AND REDOX HOMEOSTASIS OF HUMAN LUNG FIBROBLAST CELL LINE MRC-5

Maida H Lekovic, Nerkesa E Drekovic, Nihat Dz Granica, Elvis H Mahmutovic, Natasa Z Djordjevic. Extremely low- frequency electromagnetic field induces a change in proliferative capacity and redox homeostasis of human lung fibroblast cell line MRC-5. *Environ Sci Pollut Res Int.* 2020 Jul 10. doi: 10.1007/s11356-020-10039-0.

Abstract

Numerous studies have shown that extremely low-frequency electromagnetic field (ELF-EMF) by modulating oxidative-antioxidative balance in the cells achieved beneficial and harmful effects on living organisms. The aim of this study was to research changes of both proliferative capacity and redox homeostasis of human lung fibroblast cell line MRC-5 during exposure to ELF-EMF (50 Hz). The human lung fibroblast cell line MRC-5 were exposed to ELF-EMF once a day in duration of 1 h during 24 h (1 treatment 1 h/day), 48 h (2 treatments 1h/day), 72 h (3 treatments 1 h/day), and 7 days (7 treatments 1 h/day). After 24 h of the last treatment, the proliferative capacity of the cells and the concentrations and activities of the components of the oxidative/antioxidative system were determined: superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), nitric oxide (NO), peroxynitrite ($ONOO^-$), reduced glutathione (GSH), oxidized glutathione (GSSG), superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px), glutathione reductase (GR), and glutathione- S-transferase (GST). The results of this study show that ELF-EMF may affect a cell cycle regulation of human lung fibroblast cell line MRC-5 through modulation of oxidative/antioxidative defense system. The effects of ELF-EMF on proliferation and redox balance of human lung fibroblast cell line MRC-5 depend on exposure time.

<https://pubmed.ncbi.nlm.nih.gov/32651790/>

EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS EXPOSURE MEASUREMENT DURING LESSONS IN ELEMENTARY SCHOOLS

JinKyung Park, EunHye Jeong, GyeongAe Seomun. Extremely Low-Frequency Magnetic Fields Exposure Measurement during Lessons in Elementary Schools. *Int J Environ Res Public Health.* 2020 Jul 22;17(15):E5284. doi: 10.3390/ijerph17155284.

Abstract

Schools are an important place for children's exposure to electromagnetic fields, which may cause adverse health effects. To better understand environmental extremely low-frequency magnetic fields (ELF-MFs) exposure among elementary school students, we measured numeric values of ELF-MFs in five classrooms at four schools during digital learning class hours. The measurement of ELF-MFs was taken with an EMDEX II field analyzer. Specifically, we examined the level of exposure to ELF-MFs for each student's seating position in the classroom. The results showed that ELF-MFs exposure levels were lower than those in the International Commission on Non-Ionizing Radiation Protection guidelines; however, there were significant differences in the level of magnetic field exposure at each school and at each student's seat. The exposure to ELF-MFs at students' seat positions was mostly caused by electrical appliances, electronic wiring, and distribution boxes, but the exposure level decreased as the distance increased. Therefore, it is important to design safe and appropriate

environments for digital learning in schools, such as proper seating arrangements, to avoid ELF-MFs exposure to students as much as possible. Future studies should measure ELF-MFs levels in other areas and investigate the effects of exposure to ELF-MFs during school hours on children's health.

Excerpts

The average ELF-MFs exposure in all schools measured in this study was lower than the exposure standard level for the general public recommended by the ICNIRP guidelines [22]. These measurements were similar to the exposure levels in homes (0.025–0.07 μ T in Europe and 0.055–0.11 μ T in the USA) [1] and were higher than those recorded in the study of Tardón et al. (0.01 and 0.02 μ T) [25] and Nassiri et al. (0.15 μ T) [26]. However, in the present study, ELF-MFs exposure was measured in digital learning classrooms at seven points at different heights rather than at a single spot in the classroom, and a comparison with the results of previous studies is therefore difficult. This study proposes meaningful methods and criteria for measuring ELF-MFs exposure that can be used in future studies.

The exposure levels of ELF-MFs detected in this study could affect children's perception [27] and is associated with a higher risk of childhood leukemia [13,14,15,16]. Disorders of cognitive function [17,18,19], disorders of memory performance, headaches, and sleep disorders [20,21] are also associated with these exposure levels. Although there has been no explicit evidence for adverse health effects in children by ELF-MFs exposure, since the nervous and immune systems of children could be more sensitive to ELF-MFs [2,28], children should avoid exposure to ELF-MFs as much as possible. Therefore, a reduction policy should be established to minimize exposure levels for children.

Open access paper: <https://www.mdpi.com/1660-4601/17/15/5284>

RESPONSE OF YOUNG NERIUM OLEANDER PLANTS TO LONG-TERM NON-IONIZING RADIATION

Aikaterina L Stefi, Konstantina Mitsigiorgi, Dido Vassilacopoulou, Nikolaos S Christodoulakis. Response of Young Nerium Oleander Plants to Long-Term Non-Ionizing Radiation. *Planta*. 2020 May 27;251(6):108. doi: 10.1007/s00425-020-03405-2.

Abstract

Although exposure to low frequency electromagnetic radiation is harmful to plants, LF-EM irradiated Nerium oleander seedlings exhibited enhanced development and growth, probably taking advantage of defined structural leaf deformations. Currently, evidence supports the undesirable, often destructive impact of low frequency electromagnetic (LF-EM) radiation on plants. The response of plants to LF-EM radiation often entails induction in the biosynthesis of secondary metabolites, a subject matter that is well documented. Nerium oleander is a Mediterranean plant species, which evolved remarkable resistance to various environmental stress conditions. In the current investigation, cultivated N. oleander plants, following their long-term exposure to LF- EM radiation, exhibited major structural modifications as the flattening of crypts, the elimination of trichomes and the reduction of the layers of the epidermal cells. These changes co-existed with an oxidative stress response manifested by a significant increase in reactive oxygen species at both the roots and the above ground parts, a decline in the absorbance of light by photosynthetic pigments and the substantially

increased biosynthesis of L-Dopa decarboxylase (DDC), an enzyme catalyzing the production of secondary metabolites that alleviate stress. The exposed plants exhibited greater primary plant productivity, despite a manifested photosynthetic pigment limitation and the severe oxidative stress. This unique response of *N. oleander* to severe abiotic stress conditions may be owed to the advantage offered by a structural change consistent to an easier diffusion of CO₂ within the leaves. A major plant response to an emerging "pollutant" was documented.

<https://pubmed.ncbi.nlm.nih.gov/32462472/>

THE MAGNETIC RECEPTOR OF MONASCUS RUBER M7: GENE CLONE AND ITS HETEROLOGOUS EXPRESSION IN ESCHERICHIA COLI

Hongyi Zhou, Shuyan Yang, Fusheng Chen. The Magnetic Receptor of *Monascus ruber* M7: Gene Clone and Its Heterologous Expression in *Escherichia coli*. *Front Microbiol.* 2020 Jun 19;11:1112. doi: 10.3389/fmicb.2020.01112.

Abstract

It is well known that many organisms can perceive the magnetic field (MF), including the geomagnetic field, but how to feel MF is unclear. Recently, a study has claimed that a biological compass, namely a complex of the magnetic receptor (MagR) and blue light (BL) receptor (cryptochrome), has been found in *Homo sapiens*, *Drosophila melanogaster*, and *Danaus plexippus*, which may bring some new ideas to explore the mechanism of biomagnetism. *Monascus* spp. are edible filamentous fungi that can produce abundant beneficial secondary metabolites and have been used to produce food colorants for nearly 2000 years in the world, especially in China, Japan, and Korea. In this work, we firstly treated *M. ruber* M7 by BL (500 lux, 465-467 nm), MF (5, 10, 30 mT), and the combination of MF and BL (MF-BL), respectively. The results revealed that, compared with the control (CK, neither BL nor MF), the MF alone had no effect on the growth and morphological characteristics of M7, but BL made the colonial diameters only 66.7% of CK's and inhibited the formation of cleistothecia. Under MF-BL, the colony diameters were still 66.7% of CK's, but the colonial growth and cleistothecia production inhibited by BL were partially restored. Then, we have found that the *magR* gene widely exists in the genomes of animals, plants, and microorganisms, and we have also discovered a *magR* gene in the M7 genome, hereinafter referred to *mr-magR*. Finally, the full-length cDNA of *mr-magR* was successfully cloned and expressed in *Escherichia coli* BL21 (DE3), and the Mr-MagR protein was purified by a Ni²⁺-NTA column and identified by Western blot. These results have laid a foundation for further investigation on the relationship between Mr MagR and BL receptor(s) that might exist in M7. According to a literature search, it is the first time to report *magR* in filamentous fungi.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7318567/>

RADIOFREQUENCY ELECTROMAGNETIC FIELD AFFECTS HEART RATE VARIABILITY IN RABBITS

J Misek, M Veterník, I Tonhajzerova, V Jakusova, L Janousek, J Jakus. Radiofrequency electromagnetic field affects heart rate variability in rabbits. *Physiol Res*. 2020 Jul 16.

Abstract

The aim of this study was to assess the effects of radiofrequency electromagnetic field (RF EMF) on heart rate variability (HRV) in rabbits with intensity slightly exceeding the limits for occupations. Totally 21 New Zealand white rabbits divided into two groups were used in this double-blind study. The first group of animals without general anesthesia was subjected to HRV examination under exposure to a device generated RF EMF source (frequency 1788 MHz, intensity 160 V/m, lasting 150 min.). The second group (premedications + alpha chloralose mg/kg) underwent the same protocol under the exposure to the real RF EMF signal from the base stations of mobile providers (frequency range 1805 - 1870 MHz - corresponding to the downlink signal of Slovak mobile providers, 160 V/m, 150 min., respectively). Individual 5 min records were used to analyze the HRV parameters: heart rate and root Mean Square of the Successive Differences (rMSSD) for time domain analysis and spectral powers in the low (LF-VFS) and high frequency (HF-VFS) bands for frequency domain analysis. Our study revealed the increase in HRV parameters (HF-HRV, rMSSD) associated with lower heart rate indicating increased cardiac vagal control under the exposure to RF EMF in experimental methods.

Open access paper: <http://www.biomed.cas.cz/physiolres/pdf/prepress/934425.pdf>

ARABIDOPSIS CRYPTOCHROME IS RESPONSIVE TO RADIOFREQUENCY (RF) ELECTROMAGNETIC FIELDS

Maria Albaqami, Merfat Hammad, Marootpong Pooam, Maria Procopio, Mahyar Sameti, Thorsten Ritz, Margaret Ahmad, Carlos F Martino. *Sci Rep*. 2020 Jul 9;10(1):11260. doi: 10.1038/s41598-020-67165-5.

Abstract

How living systems respond to weak electromagnetic fields represents one of the major unsolved challenges in sensory biology. Recent evidence has implicated cryptochrome, an evolutionarily conserved flavoprotein receptor, in magnetic field responses of organisms ranging from plants to migratory birds. However, whether cryptochromes fulfill the criteria to function as biological magnetosensors remains to be established. Currently, theoretical predictions on the underlying mechanism of chemical magnetoreception have been supported by experimental observations that exposure to radiofrequency (RF) in the MHz range disrupt bird orientation and mammalian cellular respiration. Here we show that, in keeping with certain quantum physical hypotheses, a weak 7 MHz radiofrequency magnetic field significantly reduces the biological responsivity to blue light of the cryptochrome receptor cry1 in *Arabidopsis* seedlings. Using an in vivo phosphorylation assay that specifically detects activated cryptochrome, we demonstrate that RF exposure reduces conformational changes associated with biological activity. RF exposure furthermore alters cryptochrome-dependent plant growth responses and gene expression to a degree consistent with theoretical predictions. To our knowledge this represents the first demonstration of a biological receptor responding to RF exposure, providing important new implications for magnetosensing as well as possible future applications in biotechnology and medicine.

Open access paper: <https://www.nature.com/articles/s41598-020-67165-5>

MODULATION OF VOLTAGE-GATED CALCIUM INFLUX BY ELECTROMAGNETIC IRRADIATION WITH TERAHERTZ GAUSSIAN PULSE

Wenfei Bo, Lianghao Guo, Kaicheng Wang, Jialu Ma, Jingchao Tang, Zhe Wu, Baoqing Zeng, Yubin Gong. Modulation of voltage-gated calcium influx by electromagnetic irradiation with terahertz Gaussian pulse. IEEE Access. Jul 21, 2020. 10.1109/ACCESS.2020.3010870

Abstract

The voltage-gated calcium influxes modulated with terahertz Gaussian pulse is presented in this paper, and temperature rise is evaluated to monitor the terahertz thermal effects involved in the modulation. From the numerical results, inhibition effect on voltage-gated calcium influx because of the loss of the influx from electric drift is transparently revealed in the modulation with terahertz Gaussian pulse. And the inhibition effect becomes significant reflected by considerable reduction in voltage-gated calcium influx as the irradiated amplitude is raised intense enough. Compared to the terahertz sinusoidal wave, Gaussian pulse reduces the inhibition effect dramatically. The decrease in the increment of intracellular calcium concentration with the irradiated amplitude due to the inhibition effect is substantially relieved by the modulation of the calcium influx with terahertz Gaussian pulse. The thermal analyses reveal that the modulation is non-thermal effect.

Meanwhile, to raise the intracellular calcium concentration to a same amount by means of the voltage-gated calcium influx, application of terahertz Gaussian pulse induces much less concurrent temperature rise than application of terahertz sinusoidal wave of the same amplitude that is intense enough to cause the inhibition effect. Additionally, terahertz Gaussian pulse irradiation remains the dependence of the increment of the calcium concentration on the irradiated time duration and frequency in terahertz sinusoidal wave irradiation. These numerical results lay the theoretical basis for the modulation of voltage-gated calcium fluxes with terahertz Gaussian pulse and for further potential clinical applications of terahertz Gaussian pulse.

Open access paper: <https://ieeexplore.ieee.org/document/9145579>

A CURRENT SYNTHESIS ON THE EFFECTS OF ELECTRIC AND MAGNETIC FIELDS EMITTED BY SUBMARINE POWER CABLES ON INVERTEBRATES

Luana Albert, François Deschamps, Aurélie Jolivet, Frédéric Olivier, Laurent Chauvaud, Sylvain Chauvaud. A current synthesis on the effects of electric and magnetic fields emitted by submarine power cables on invertebrates. Mar Environ Res. 2020 Jul;159:104958. doi: 10.1016/j.marenvres.2020.104958.

Highlights

- Submarine power cables produce both magnetic and electric fields.
- Marine invertebrate species inhabit the benthic or sediment compartment where cables are laid or buried.
- Evidence shows magneto and electro-sensitivity in some invertebrates but their response to artificial fields is poorly known.
- Invertebrate species are likely to experience the highest and longest exposures and should be prioritised in future studies.

Abstract

The goal of clean renewable energy production has promoted the large-scale deployment of marine renewable energy devices, and their associated submarine cable network. Power cables produce both electric and magnetic fields that raise environmental concerns as many marine organisms have magneto and electroreception abilities used for vital purposes. Magnetic and electric fields' intensities decrease with distance away from the cable.

Accordingly, the benthic and the sedimentary compartments are exposed to the highest field values. Although marine invertebrate species are the major fauna of these potentially exposed areas, they have so far received little attention. We provide extensive background knowledge on natural and anthropogenic marine sources of magnetic and electric fields. We then compile evidence for magneto- and electro-sensitivity in marine invertebrates and further highlight what is currently known about their interactions with artificial sources of magnetic and electric fields. Finally we discuss the main gaps and future challenges that require further investigation.

<https://pubmed.ncbi.nlm.nih.gov/32662447>

CHALLENGES IN COUPLING ATMOSPHERIC ELECTRICITY WITH BIOLOGICAL SYSTEMS

Ellard R Hunting, James Matthews, Pablo Fernández de Arróyabe Hernáez, Sam J England, Konstantinos Kourtidis, Kuang Koh, Keri Nicoll, R Giles Harrison, Konstantine Manser, Colin Price, Snezana Dragovic, Michal Cifra, Anna Odzimek, Daniel Robert. Challenges in coupling atmospheric electricity with biological systems. *Int J Biometeorol*. 2020 Jul 14. doi: 10.1007/s00484-020-01960-7.

Abstract

The atmosphere is host to a complex electric environment, ranging from a global electric circuit generating fluctuating atmospheric electric fields to local lightning strikes and ions. While research on interactions of organisms with their electrical environment is deeply rooted in the aquatic environment, it has hitherto been confined to interactions with local electrical phenomena and organismal perception of electric fields. However, there is emerging evidence of coupling between large- and small-scale atmospheric electrical phenomena and various biological processes in terrestrial environments that even appear to be tied to continental waters. Here, we synthesize our current understanding of this connectivity, discussing how atmospheric electricity can affect various levels of biological organization across multiple ecosystems. We identify opportunities for research, highlighting its complexity and interdisciplinary nature and draw attention to both conceptual and technical challenges lying ahead of our future understanding of the relationship between atmospheric electricity and the organization and functioning of biological systems.

<https://pubmed.ncbi.nlm.nih.gov/32666310/>

Excerpts

In biological systems, alternating currents (AC) range from a fraction of hertz to approximately 1000 Hz. Early studies focussed on biological effects of electromagnetic fields in the ELF range in relation to possible effects since ELF is measurable—albeit weak in comparison—in the activity of the human central nervous system (e.g., König et al. 1981). An increasing interest in higher radiofrequencies and microwaves subsequently developed due to the growing

application in radio-communication and industry (Repacholi 1998). This interest persists as ELF is now nearly ubiquitous in both industrial and domestic environments (e.g., Bortkiewicz et al. 2006). ELF has also been considered to present potential health or therapeutic applications (König et al. 1981). While biological organisms have been naturally subjected to geomagnetic and electromagnetic fields over the course of the evolution of life on earth, scientific knowledge on the possible beneficial or deleterious effects of such fields remains sparse. Yet, evidence points to responses of biological systems, albeit inconsistent, to the action of electromagnetic fields and waves, including the current expansion of 5G wireless communication with potential adverse effects on DNA and membrane integrity, sperm function, and viability as well as immune and neuronal functioning (Marron et al. 1975; König et al. 1981; Liboff et al. 1984; Mikolajczyk 1990; Bortkiewicz et al. 2006; Valberg et al. 2006; Huss et al. 2007; Engels et al. 2014; Panagopoulos et al. 2015; Kocaman et al. 2018; Russell 2018; Saliev et al. 2019).

LOW STRENGTH MAGNETIC FIELDS SERVE AS A CUE FOR FORAGING HONEY BEES BUT PRIOR EXPERIENCE IS MORE INDICATIVE OF CHOICE

Ana M Chicas-Mosier, Medhat Radi, Jack Lafferrandre, John F O'Hara, Hitesh D Vora, Charles I Abramson. Low Strength Magnetic Fields Serve as a Cue for Foraging Honey Bees but Prior Experience is More Indicative of Choice. Bioelectromagnetics. 2020 Jul 20. doi: 10.1002/bem.22285.

Abstract

Species of migrating insects use magnetic fields as a navigational tool that is independent of current weather conditions and non-migrating species have been shown to discriminate anomalies in magnetic field from the earth's baseline. Honey bee discrimination of magnetic field has been studied in the context of associative learning, physiology, and whole hive responses. This article uses a combination of free-flight and laboratory studies to determine how small fluctuations from Earth's magnetic field affect honey bee (*Apis mellifera* L.) decision-making. Honey bees were tested in three experiments: (i) recruitment to an aqueous sucrose feeder, (ii) an artificial free-flight flower patch with floral color-dependent magnetic field strength, and (iii) a Y-maze with alternating colors on a stronger magnetic field. In free-flying feeder experiments, magnetic field served as a temporary cue, but when offered an equal caloric alternative with lesser magnetic field, the latter was preferred. Flower patch experiments showed initial color biases that were abandoned as a response to magnetic field induction. In laboratory experiments, bees showed a color-dependent behavioral response to the magnetic field. The results of this study indicate that bees may use small fluctuations in magnetic fields as a cue but that it is likely low-value as compared with other stimuli.

<https://pubmed.ncbi.nlm.nih.gov/32691429/>

ANIMAL NAVIGATION: SEABIRDS HOME TO A MOVING MAGNETIC TARGET

Nathan F Putman. Animal Navigation: Seabirds Home to a Moving Magnetic Target Curr Biol. 2020 Jul 20;30(14):R802-R804. doi: 10.1016/j.cub.2020.05.061.

Abstract

Shifts in the return locations of juvenile seabirds migrating from the Irish Sea to Argentina can be accurately predicted by changes in Earth's magnetic field, suggesting that these birds rely on a geomagnetic map for navigation.

<https://pubmed.ncbi.nlm.nih.gov/32693071/>

MOBILE PHONE USE DURING PREGNANCY: WHICH ASSOCIATION WITH FETAL GROWTH?

Nathalie Boileau, François Margueritte, Tristan Gauthier, Nedjma Boukeffa, Pierre-Marie Preux, Anaïs Labrunie, Yves Aubard. Mobile Phone Use During Pregnancy: Which Association With Fetal Growth? J Gynecol Obstet Hum Reprod. 2020 Jul 2;101852. doi: 10.1016/j.jogoh.2020.101852.

Abstract

Introduction: Few studies have investigated the effect of electromagnetic waves on the human fetus whereas nowadays mobile phone use is ubiquitous. The aim of this study was to evaluate the association between mobile phone use by pregnant women and fetal development during pregnancy in the general population.

Material and methods: Data came from the NéHaVi cohort ("prospective follow-up, from intrauterine development to the age of 18 years, for children born in Haute-Vienne"), a prospective, longitudinal, multicenter (three maternity units in Haute-Vienne) observational cohort focusing on children born between April 2014 and April 2017. Main objective was to investigate the association of mobile phone use on fetal growth. Univariate and multivariate models were generated adjusted for the socioprofessional category variables of the mother, and other variables likely to influence fetal growth.

Results: For the analysis 1,378 medical charts were considered from which 1,368 mothers (99.3%) used their mobile phones during pregnancy. Mean phone time was 29.8 minutes (range: 0.0 - 240.0 minutes) per day. After adjustment, newborns whose mothers used their mobile phones for more than 30 minutes/day were significantly more likely to have an AUDIPOG score $\leq$ 10th percentile than those whose mothers used their mobile phones for less than 5 minutes/day during pregnancy (aOR = 1.54 [1.03; 2.31], $p = 0.0374$). For women using their cell phones 5 to 15 min and 15 to 30 min, there wasn't a significant association with an AUDIPOG score $\leq$ 10th, respectively aOR = 0.98 [0.58; 1.65] and aOR = 1.68 [0.99; 2.82].

Conclusion: Using a mobile phone for calls for more than 30 minutes per day during pregnancy may have a negative impact on fetal growth. A prospective study should be performed to further evaluate this potential link.

<https://pubmed.ncbi.nlm.nih.gov/32623065/>

CONSEQUENCES OF ELECTROMAGNETIC FIELD RADIATION DURING EARLY PREGNANCY - ANDROGEN SYNTHESIS AND RELEASE FROM THE MYOMETRIUM OF PIGS IN VITRO

Anita Franczak, Ewa M Waszkiewicz, Wiktoria Kozłowska, Agata Zmijewska, Anna Koziorowska. Consequences of Electromagnetic Field Radiation During Early Pregnancy - Androgen Synthesis and Release From the Myometrium of Pigs in Vitro. *Animal Reproduction Science*. Vol. 218, July 2020, 106465. <https://doi.org/10.1016/j.anireprosci.2020.106465>.

Highlights

- EMF radiation causes alterations in myometrial androgens synthesis and release.
- The consequences of EMF mainly depend on the frequency and duration of EMF exposure.
- The presence of P4 does not protect from EMF during the peri-implantation period.

Abstract

An electromagnetic field (EMF) has been found to affect reproductive processes in females. The aim of this study was to determine the effect of low, non-ionizing EMF radiation on the steroidogenic activity of myometrium collected from pigs during the fetal peri-implantation period. Myometrial slices were treated with an EMF (50 and 120 Hz, 2 and 4 h of incubation) and examined for the aromatase cytochrome P450 17 α -hydroxylase/C17-20lyase (CYP17A1) and 3 β -hydroxysteroid dehydrogenase/ Δ 5- Δ 4 isomerase (HSD3B1) mRNA transcript abundance, cytochrome P450c17 and 3 β HSD protein abundance and the secretion of androstenedione (A4) and testosterone (T). To determine whether progesterone (P4) functions as a protectant from EMF radiation, the selected slices were treated with P4. In slices incubated without P4, EMF at 50 Hz altered cytochrome P450c17 protein abundance (4 h), HSD3B1 mRNA transcript abundance (4 h) and A4 release (2 h) as well as T release (2 h) in P4-treated slices. The EMF at 120 Hz in non P4-treated slices altered A4 release (2 and 4 h) whereas in P4- treated slices altered CYP17A1 mRNA transcript abundance (4 h), 3 β HSD protein abundance (4 h), A4 (4 h) and T release (2 h). In conclusion, EMF radiation in the myometrium collected during the peri-implantation period alters the CYP17A1 and HSD3B1 mRNA transcript and encoded protein abundance, and androgen release due to the time of treatment and P4 presence or absence. The P4 did not function directly as an obvious protector against EMF radiation in the myometrium of pigs during the fetal peri-implantation period. <https://pubmed.ncbi.nlm.nih.gov/32507253/>

THE EFFECTS OF PRENATAL RADIATION OF MOBILE PHONES ON WHITE MATTER IN CEREBELLUM OF RAT OFFSPRING

Mei-Li Yang, Shan-Yan Hong, Hong-Hong Huang, Guo-Rong Lyu, Ling-Xing Wang. [The Effects of Prenatal Radiation of Mobile Phones on White Matter in Cerebellum of Rat Offspring] [Article in Chinese]. *Zhongguo Ying Yong Sheng Li Xue Za Zhi*. 2020 Jan 28;36(1):77-81. DOI: 10.12047/j.cjap.5880.2020.017.

Abstract

Objective: To evaluate the effects of prenatal radiation of 850 -1,900 MHz mobile phone on white matter in cerebellum of adult rat offspring.

Methods: Pregnant rats were randomly divided into short term maternal radiation group, long term maternal radiation group and control group. Rats in short term and long term maternal radiation group were exposed to 6 h/d and 24 h/d mobile phone radiation during 1-17 days of pregnancy, respectively. The cerebellums of offspring rats at the age of 3 month (n = 8) were taken. Cell morphology in cerebellum was studied by hematoxylin-eosin (HE) staining. The expressions of myelin basic protein (MBP), neurofilament-L (NF-L) and glial fibrillary acidic protein (GFAP) in cerebellum of rat offspring were detected by immunohistochemistry and Western blot.

Results: Compared to control group, the morphological changes of purkinje cells in cerebellum were obvious in rat offspring of short term and long term maternal radiation group. Compared to control group, decreased MBP and NF-L expressions and increased GFAP expression were observed in long term maternal radiation group (all $P < 0.05$). Compared to short term radiation group, the expressions of MBP and NF-L were down-regulated (all $P < 0.05$) and the expression of GFAP was up-regulated (< 0.05) in long term radiation group.

Conclusion: Prenatal mobile phone radiation might lead to the damage of myelin and axon with activity of astrocytes in cerebellum of male rat offspring, which is related to the extent of radiation.

<https://pubmed.ncbi.nlm.nih.gov/32476377/>

ENRICHED ENVIRONMENT DECREASES COGNITIVE IMPAIRMENT IN ELDERLY RATS WITH PRENATAL MOBILE PHONE EXPOSURE

Shanyan Hong, Honghong Huang, Meili Yang, Haining Wu, Lingxing Wang. Enriched Environment Decreases Cognitive Impairment in Elderly Rats With Prenatal Mobile Phone Exposure. *Front Aging Neurosci.* 2020 Jun 4;12:162. doi: 10.3389/fnagi.2020.00162.

Abstract

Mobile phone use has rapidly increased worldwide, and pregnant women are passively or actively exposed to the associated electromagnetic radiation. Maternal cell phone exposure is related to behavioral difficulties in young offspring. However, whether prenatal mobile phone exposure can predispose the elderly offspring to cognitive impairment is unclear. The enriched environment (EE) has shown positive effects on cognition in an immature brain, but its impact on aging offspring after prenatal cell phone exposure is unknown. This study aimed to investigate whether prenatal exposure to mobile phone exerts long-term effects on cognition in elderly rat offspring and whether EE during adulthood can rescue cognitive impairment by altering the synaptic plasticity. Pregnant rats were subjected to prenatal short-term or long-term cell phone exposure and offspring rats were randomly assigned to standard or EE. Spatial learning and memory were investigated using Morris water maze (MWM) in elderly rat offspring. Hippocampal cellular morphology was assessed by hematoxylin-eosin staining and synaptic ultrastructure was evaluated with transmission electron microscopy. Expression of synaptophysin (SYN), postsynaptic density-95 (PSD-95), and brain-derived neurotrophic factor (BDNF) were detected by western blot. The results demonstrated that prenatal long-term but not short-term exposure to mobile phone lead to cognitive impairment, morphological changes in the hippocampal cells, reduced synaptic number,

decreased SYN, PSD-95, and BDNF expression in elderly offspring, which were alleviated by postnatal EE housing. These findings suggest that prenatal long-term mobile phone exposure may pose life-long adverse effects on elderly offspring and impair cognition by disrupting the synaptic plasticity, which may be reversed by postnatal EE housing.

Open access paper: <https://www.frontiersin.org/articles/10.3389/fnagi.2020.00162/full>

ECOLOGICAL STUDY ON THE PENETRATION OF INDUCTION HEATING COOKERS AND BIRTH OUTCOMES IN JAPAN

Yasuto Sato, Kosuke Kiyohara, Sachiko Takehara, Noriko Kojimahara. Ecological Study on the Penetration of Induction Heating Cookers and Birth Outcomes in Japan. AIMS Public Health. 2020 Jun 5;7(2):336-343. doi: 10.3934/publichealth.2020028.

Abstract

In recent years, equipment that generates intermediate-frequency electromagnetic fields (IF-EMFs) has become increasingly prevalent, and the influence of IF-EMFs on human health is thus attracting increasing attention. The present study was conducted with the aim of analyzing whether there is a relationship between the penetration of induction heating cookers and birth outcomes using an ecological study design at the prefectural level. We created data sets for all 47 prefectures in Japan using previously published statistics. Spontaneous fetal death rate, fetal death rate after 22 weeks of pregnancy, perinatal mortality rate, and proportion of newborns weighing less than 2500 g were used as birth outcomes in correlation analysis. A weak positive association was observed between the penetration of induction heating cookers and the fetal death rate after the 22nd week of pregnancy ($r = 0.27$, $p = 0.07$), but it was not statistically significant. In addition, a weak negative association was observed between the penetration of induction heating cookers and the spontaneous fetal death rate ($r = -0.27$, $p = 0.07$), but it was not statistically significant. In the present ecological study, no statistically significant association were shown between the penetration of induction heating cookers and birth outcomes. To demonstrate further the safety of induction heating cooker use, observations in epidemiological studies of other designs should be considered.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7327398/>

TELECOMMUNICATIONS HEALTH AND SAFETY: US FCC AFFIRMS ITS CURRENT SAFETY LIMITS FOR RF RADIATION AND 5G WIRELESS

James C Lin. Telecommunications health and safety: US FCC affirms its current safety limits for RF radiation and 5G wireless. Radio Science Bulletin; 2019 (371): 87-89. doi:10.23919/URSIRSB.2019.9117254.

No Abstract

Open access paper: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9117254>

IEEE COMMITTEE ON MAN AND RADIATION—COMAR TECHNICAL INFORMATION STATEMENT: HEALTH AND SAFETY ISSUES CONCERNING EXPOSURE OF THE GENERAL PUBLIC TO ELECTROMAGNETIC ENERGY FROM 5G WIRELESS COMMUNICATIONS NETWORKS

Bushberg JT, Chou CK, Foster KR, Kavet R, Maxson DP, Tell RA, Ziskin MC. June 22, 2020. doi: 10.1097/HP.0000000000001301.

Abstract

This COMAR Technical Information Statement (TIS) addresses health and safety issues concerning exposure of the general public to radiofrequency (RF) fields from 5G wireless communications networks, the expansion of which started on a large scale in 2018 to 2019. 5G technology can transmit much greater amounts of data at much higher speeds for a vastly expanded array of applications compared with preceding 2-4G systems; this is due, in part, to using the greater bandwidth available at much higher frequencies than those used by most existing networks. Although the 5G engineering standard may be deployed for operating networks currently using frequencies extending from 100s to 1,000s of MHz, it can also operate in the 10s of GHz where the wavelengths are 10 mm or less, the so-called millimeter wave (MMW) band. Until now, such fields were found in a limited number of applications (e.g., airport scanners, automotive collision avoidance systems, perimeter surveillance radar), but the rapid expansion of 5G will produce a more ubiquitous presence of MMW in the environment. While some 5G signals will originate from small antennas placed on existing base stations, most will be deployed with some key differences relative to typical transmissions from 2-4G base stations. Because MMW do not penetrate foliage and building materials as well as signals at lower frequencies, the networks will require “densification,” the installation of many lower power transmitters (often called “small cells” located mainly on buildings and utility poles) to provide for effective indoor coverage. Also, “beamforming” antennas on some 5G systems will transmit one or more signals directed to individual users as they move about, thus limiting exposures to non-users. In this paper, COMAR notes the following perspectives to address concerns expressed about possible health effects of RF field exposure from 5G technology. First, unlike lower frequency fields, MMW do not penetrate beyond the outer skin layers and thus do not expose inner tissues to MMW. Second, current research indicates that overall levels of exposure to RF are unlikely to be significantly altered by 5G, and exposure will continue to originate mostly from the “uplink” signals from one’s own device (as they do now).

Third, exposure levels in publicly accessible spaces will remain well below exposure limits established by international guideline and standard setting organizations, including ICNIRP and IEEE. Finally, so long as exposures remain below established guidelines, the research results to date do not support a determination that adverse health effects are associated with RF exposures, including those from 5G systems. While it is acknowledged that the scientific literature on MMW biological effect research is more limited than that for lower frequencies, we also note that it is of mixed quality and stress that future research should use appropriate precautions to enhance validity. The authorship of this paper includes a physician/biologist, epidemiologist, engineers, and physical scientists working voluntarily and collaboratively on a consensus basis.

<https://journals.lww.com/healthphysics/pages/articleviewer.aspx?year=9000&issue=0000&article=99768> For a critique see: <https://www.saferemr.com/2020/06/IEEE-COMAR.html>

ABSORPTION OF 5G RADIATION IN BRAIN TISSUE AS A FUNCTION OF FREQUENCY, POWER AND TIME

David H. Gultekin, Peter H. Siegel. Published online June 12, 2020. DOI: 10.1109/ACCESS.2020.3002183.

Abstract

The rapid release of 5G wireless communications networks has spurred renewed concerns regarding the interactions of higher radiofrequency (RF) radiation with living species. We examine RF exposure and absorption in ex vivo bovine brain tissue and a brain simulating gel at three frequencies: 1.9 GHz, 4 GHz and 39 GHz that are relevant to current (4G), and upcoming (5G) spectra. We introduce a highly sensitive thermal method for the assessment of radiation exposure, and derive experimentally, accurate relations between the temperature rise (ΔT), specific absorption rate (SAR) and the incident power density (F), and tabulate the coefficients, $\Delta T/\Delta F$ and $\Delta(\text{SAR})/\Delta F$, as a function of frequency, depth and time. This new method provides both ΔT and SAR applicable to the frequency range below and above 6 GHz as shown at 1.9, 4 and 39 GHz, and demonstrates the most sensitive experimental assessment of brain tissue exposure to millimeter-wave radiation to date, with a detection limit of 1 mW. We examine the beam penetration, absorption and thermal diffusion at representative 4G and 5G frequencies and show that the RF heating increases rapidly with frequency due to decreasing RF source wavelength and increasing power density with the same incident power and exposure time. We also show the temperature effects of continuous wave, rapid pulse sequences and single pulses with varying pulse duration, and we employ electromagnetic modeling to map the field distributions in the tissue. Finally, using this new methodology, we measure the thermal diffusivity of ex vivo bovine brain tissue experimentally.

Open access paper: <https://ieeexplore.ieee.org/document/9115853>

Also see: IEEE Committee on Man and Radiation (COMAR)

CENTRAL NERVOUS SYSTEM LYMPHOMA AND RADIOFREQUENCY RADIATION – A CASE REPORT AND INCIDENCE DATA IN THE SWEDISH CANCER REGISTER ON NON-HODGKIN LYMPHOMA

Lennart Hardell, Michael Carlberg, Tarmo Koppel, Marie Nordström, Lena K Hedendahl. Available online 29 June 2020, 110052. <https://doi.org/10.1016/j.mehy.2020.110052>

Abstract

Earlier animal studies have provided evidence that non-Hodgkin lymphoma (NHL) may be caused by exposure to radiofrequency (RF) radiation. This was recently confirmed by the U.S. National Toxicology (NTP) study that showed an increased incidence of malignant lymphoma in female mice exposed to the GSM modulated or the CDMA modulated cell phone RF radiation. Primary central nervous system lymphoma (PCNSL) is a rare malignancy in humans with poor prognosis. An increasing incidence has been reported in recent years. Based on a case-report we present the hypothesis that use of the hand-held mobile phone may be a risk factor for PCNSL. The increasing incidence of non-Hodgkin lymphoma in Sweden is discussed in relation to etiologic factors.

<https://www.sciencedirect.com/science/article/pii/S0306987720309567?via%3Dihub>

EXPOSURE OF 1800 MHZ RADIOFREQUENCY WITH SAR 1.6 W/KG CAUSED A SIGNIFICANT REDUCTION IN CD4+ T CELLS AND RELEASE OF CYTOKINES IN-VITRO

Maimun Zulhaidah Arthamin, Anis Sulalah, Resvina Resvina, Chomsin Widodo, Agustina Tri Endharti, Edi Widjajanto, Tedy Juliandhy. Iran J Immunol. 2020 Jun;17(2):154-166. doi: 10.22034/iji.2020.84760.1671.

Abstract

Background: Although there have been many studies investigating the effects of electromagnetic fields on humans cells and tissues, the effects of radiofrequency electromagnetic fields exposure on the cells of the immune system are still controversial.

Objective: To investigate the effects of 1800 MHz RF-EMF exposure on peripheral blood mononuclear cells by measuring T helper cells count and the cytokine profile under different conditions of durations and distances.

Methods: The peripheral blood mononuclear cells (PBMCs) from healthy human subjects were exposed to 1800 MHz RF-EMF, with durations of 15, 30, 45, and 60 minutes and distances of 5 and 25 cm. The effects of RF-EMF exposure on the number of CD4+ T cells, and the expression of IL-2, IL-10, and IL-17a after 48 hours of culture were evaluated using flow cytometry.

Results: Our findings indicated that closer distance and longer exposure induced lower number of CD4+ T cells. Similarly the percentages of IL-2, IL-10 and IL-17a expressing CD4+ T cells were decreased significantly. The number of IL-2 expressing CD4+T cells was increased significantly as the duration of exposure was increased, but the number was decreased after 60 minutes exposure when compared with control group with no exposure.

Conclusion: Exposure to RF-EMF for 60 minutes at 5 cm distance causes a significant reduction in the number of CD4+ T cells, IL-2, IL-10 and IL-17a expressing T cells.
<https://pubmed.ncbi.nlm.nih.gov/32602469/>

A THEORETICAL AND EXPERIMENTAL INVESTIGATION ON THE MEASUREMENT OF THE ELECTROMAGNETIC FIELD LEVEL RADIATED BY 5G BASE STATIONS

Adda S, Aureli T, D'elia S, Franci D, Grillo E, Migliore MD, Pavoncello S, Schettino F, Suman R. IEEE Access 2020 [in press]. doi:10.1109/ACCESS.2020.2998448.

Abstract

This paper presents some theoretical considerations and experimental results regarding the problem of maximum power extrapolation for the assessment of the exposure to electromagnetic fields radiated by 5G base stations. In particular the results of an extensive experimental campaign using an extrapolation procedure recently proposed for 5G signal is discussed and experimentally checked on a SU-MIMO signal. The results confirm the effectiveness of the extrapolation technique. Starting from an analysis (that represents a further novel contribution of this paper) on the impact of Spatial Division Multiple Access techniques used in 5G on the measurement of EMF level, some indications of possible extension of the technique to the highly complex MU- MIMO case are also given.
<https://ieeexplore.ieee.org/document/9103530>

CORRELATION OF BLOOD OXIDATIVE STRESS PARAMETERS TO INDOOR RADIOFREQUENCY RADIATION: A CROSS SECTIONAL STUDY IN JORDAN

Yazan Akkam, Ahmed A Al-Taani, Salam Ayasreh, Abeer Almutairi, Nosaibah Akkam. Correlation of Blood Oxidative Stress Parameters to Indoor Radiofrequency Radiation: A Cross Sectional Study in Jordan. *Int J Environ Res Public Health*. 2020 Jun 29;17(13):E4673. doi: 10.3390/ijerph17134673.

Abstract

Background: Electromagnetic pollution is a general health concern worldwide, as cell phone towers are ubiquitous and are located adjacent to or on the roof of schools, and hospitals. However, the health risks are still inconclusive. This cross-sectional study evaluated the potential effect of electromagnetic radiation generated from various resources including cell phone towers on blood glutathione S transferase activity (e-GST) and total antioxidant activity of the Jordanian population.

Methods: The power density of three districts in the city of Irbid, Jordan was mapped to generate "outside the houses" and "inside the houses" maps. The effect of categorical variables (gender, using a cell phone, presence of Wi-Fi modem, previous exposure to medical imaging) and continuous variables (distance from the base station, the elevation of the house, the duration of stay in the house, power density outside houses, power density inside houses) on e-GST and total antioxidant activity were investigated.

Results: The EMR generated outside the houses-including cell phone towers-did not reach inside the houses at the same power and had no significant influence on e-GST activity. The EMR inside the house, which primarily came from internal resources, has a significant effect on e-GST activity. The duration of stay inside the house, the use of cell phones, and the presence of a Wi-Fi modem had a proportional effect on e-GST activity. The total antioxidant activity was statistically equal between the tested and control groups.

Conclusions: Several factors such as building materials restricted the penetration of EMR reaching inside the houses. EMR generated inside rather than outside the houses had a proportional effect on e-GST. The differences in e-GST were compensated successfully by other antioxidant mechanisms. Further research is needed to identify other possible sources of antioxidants, and to evaluate long-term effects and genetic polymorphism.

Open access paper: <https://www.mdpi.com/1660-4601/17/13/4673>

Technical Assessment of Ultrasonic Cerebral Tomosphygmography and New Scientific Evaluation of Its Clinical Interest for the Diagnosis of Electrohypersensitivity and Multiple Chemical Sensitivity

Frédéric Greco. Technical Assessment of Ultrasonic Cerebral Tomosphygmography and New Scientific Evaluation of Its Clinical Interest for the Diagnosis of Electrohypersensitivity and Multiple Chemical Sensitivity. *Diagnostics* (Basel). 2020 Jun 24;10(6):E427. doi: 10.3390/diagnostics10060427.

Abstract

Ultrasonic cerebral tomosphygmography (UCTS), also known as "encephaloscan", is an ultrasound-based pulsatile echoencephalography for both functional and anatomical brain imaging investigations. Compared to classical imaging, UCTS makes it possible to locate precisely the spontaneous brain tissue pulsations that occur naturally in temporal lobes. Scientific publications have recently validated the scientific interest of UCTS technique but clinical use and industrial development of this ancient brain imaging technique has been stopped notably in France, not for scientific or technical reasons but due to a lack of financing support. UCTS should be fundamentally distinguished from transcranial Doppler ultrasonography (TDU), which, although it also uses pulsed ultrasounds, aims at studying the velocity of blood flow (hemodynamics) in the cerebral arteries by using Doppler effect, especially in the middle cerebral artery of both hemispheres. Instead, UCTS has the technical advantage of measuring and locating spontaneous brain tissue pulsations in temporal lobes. Recent scientific work has shown the possibility to make an objective diagnosis of electrohypersensitivity (EHS) and multiple chemical sensitivity (MCS) by using UCTS, in conjunction with TDU investigation and the detection of several biomarkers in the peripheral blood and urine of the patients. In this paper, we independently confirm the clinical interest of using UCTS for the diagnosis of EHS and MCS. Moreover, it has been shown that repetitive use of UCTS in EHS and/or MCS patients can contribute to the objective assessment of their therapeutic follow-up. Since classical CT scan and MRI are usually not contributive for the diagnosis and are poorly tolerated by these patients, UCTS should therefore be considered as one of the best imaging technique to be used for the diagnosis of these new disorders and the follow-up of patients.

Open access paper: <https://www.mdpi.com/2075-4418/10/6/427>

ELECTRIC FIELD AND SAR DISTRIBUTION IN THE VICINITY OF ORTHODONTIC BRACE EXPOSED TO THE CELL PHONE RADIATION

Jovanovic DB, Krasic DD, Stankovic VB, Cvetkovic, NN, Vuckovic DD. Electric Field and SAR Distribution in the Vicinity of Orthodontic Brace Exposed to the Cell Phone Radiation. *Applied Computational Electromagnetics Society Journal* 34(12):1904-1914. Dec 2019.

Abstract

The aim of this study is to investigate the impact of orthodontic brace on the electric field distribution and amount of the absorbed energy from the cell phone within the teeth. A comparative analysis of the models (child and adult) with and without brace has been carried out due to different morphological and tissue characteristics of child's and adult's head. The 3D realistic models of the child's and adult's head, with the jaw having the orthodontic brace, have been designed. The shapes and features of the child and adult head model, as well as the distance between the electromagnetic source and the exposed object, have an important

role in the evaluation of the Specific Absorption Rate (SAR). The applied procedure is based on the numerical solution of the electromagnetic waves propagation equations. The numerical analysis has been performed at the frequency of 3G (0.9GHz). The obtained results are represented within the teeth positioned on the side of the electromagnetic radiation source. Based on the obtained results, one can conclude that the presence of orthodontic brace affects the increase of electric field and SAR within the teeth.

Excerpts

"According to previous studies, one can find that the metal objects can significantly increase the amount of absorbed energy. The authors in [1] have found that the SAR values can be several times greater in the presence of metal object. The effect of electromagnetic radiation from mobile phone on nickel release from orthodontic brackets has been taken into consideration in study [2]. It is found that the concentration of nickel in the artificial saliva in the exposure group was significantly higher than that of the control group. The level of the nickel released in this investigation was far below the toxic level but maybe enough that can lead to allergic reaction in humans. One of the previously studies [3] reported the involuntary movements of the subjects, which had gold (metal) alloy dental inlay, caused by electromagnetic waves."

"It is evident that the value of the electric field is significantly greater in the presence of an orthodontic brace for both models. Based on the results shown in Figs. 6-8, as well as the results given in Table 3, the overall conclusion is that the presence of an orthodontic brace increases the electric field strength within the teeth.

Also it is noticeable that the electric field strength in the case of a child is higher comparing to the adult case."

"Since the referent value for the electric field, prescribed by adequate standards at 0.9 GHz, is 41 V/m, comparing the results obtained by numerical calculation with values prescribed by safety standards, it is evident that obtained results exceed the referent levels inside all teeth in both models (with and without the orthodontic brace). However, it should be kept in mind that in the case of model with orthodontic brace the values are many times greater than the allowable values."

"Regarding the obtained results for SAR within the teeth, in the presence of an orthodontic brace, a significant increase in the amount of absorbed energy can be observed. The maximum of SAR_{1g} occurs in the tooth No. 6 in the case of a child (2.46W/kg). This value is about 65% higher comparing to the adult with orthodontic brace and 45% higher comparing to the results obtained for a child without orthodontic brace. In this tooth and tooth No. 5, the SAR_{1g} overcomes the safety values but only in the case of child in the presence of the orthodontic brace. The amount of absorbed energy inside the other teeth satisfies basic restriction.

However, the increase in the amount of absorbed energy in the presence of an orthodontic brace is not negligible."

"Based on the obtained results, one can conclude that the presence of orthodontic brace

causes increase of electric field and SAR within the teeth. In some cases, those values overcome referent limits for electric field strength, i.e., safety limits for SAR values."

"Because of the mentioned before and the fact that each standard contains specific safety limits of exposure to electromagnetic fields but they have been developed based on the research for adults, it should be established if they are sufficiently valid also in case of children.

The future researches should be focused on the impact of orthodontic brace on the electric field strength and amount of absorbed energy at the frequency of LTE-4G, and the latest generation of mobile networks – 5G."

Open access paper:

https://accessociety.org/includes/downloadpaper.php?of=ACES_Journal_December_2019_Paper_17&nf=19-12-17

COMPARISON OF INTRAOCULAR PRESSURE CHANGES DUE TO EXPOSURE TO MOBILE PHONE ELECTROMAGNETICS RADIATIONS IN NORMAL AND GLAUCOMA EYE

Saeed Shokoohi-Rad, Mohammad-Rez Ansari, Fatemeh Sabzi, Rahim Saffari, Parisa Rajaei, Farshid Karimi. Middle East Afr J Ophthalmol. 2020 Apr 29;27(1):10-13. doi: 10.4103/meajo.MEAJO_20_19. DOI: 10.4103/meajo.MEAJO_20_19

Abstract

Purpose: The aim of this study is to investigate the effects of electromagnetic waves (EMWs) emitted by a mobile phone on the intraocular pressure (IOP) in the eyeball.

Methods: This quasi-experimental study was conducted on 166 eyes from 83 individuals in the 40-70 age range who referred to "Khatam-al-Anbia Hospital, Mashhad, Iran" in 2016. There were two groups of participants, and the first one consisted of 41 participants who had normal eyes, whereas the second one comprised 42 participants who suffered from open-angle glaucoma disease. The IOP in both groups was measured and recorded by a specialist before and after talking 5 min on the cellphone with the help of the Goldman method. Statistical analysis such as paired t-test and analysis of variance was performed and all tests are statistically significant at ($P < 0.05$). For this purpose, the SPSS software (version 16) was applied.

Results: IOP in the glaucoma eye (42 eyes) ipsilateral to mobile phone before and after the intervention was 18.64 ± 6.7 and 23.53 ± 6.3 , respectively ($P < 0.001$). However, IOP in the control group (41 eyes) ipsilateral to mobile phone before and after the intervention was 12.95 ± 3.5 and 13.39 ± 2.8 , respectively ($P = 0.063$). IOP change in the opposite glaucomatous eye to mobile phone in glaucoma group (39 eyes) and normal group (44 eyes) was not significantly different before and after the phone call ($P = 0.065$ and $P = 0.85$, respectively).

Conclusion: We found that the acute effects of EMWs emitted from the mobile phones can significantly increase the IOP in glaucoma eye, while such changes were not observed in normal eyes.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7276173/>

CONTINUOUS EXPOSURE TO 1.7 GHZ LTE (4G) ELECTROMAGNETIC FIELDS INCREASES INTRACELLULAR REACTIVE OXYGEN SPECIES TO DECREASE HUMAN CELL PROLIFERATION AND INDUCE SENESCENCE

Jisu Choi, Kyeongrae Min, Sangbong Jeon, Nam Kim, Jeong-Ki Pack, Kiwon Song. Continuous Exposure to 1.7 GHz LTE Electromagnetic Fields Increases Intracellular Reactive Oxygen Species to Decrease Human Cell Proliferation and Induce Senescence. *Sci Rep.* 2020 Jun 8;10(1):9238. doi: 10.1038/s41598-020-65732-4.

Abstract

Due to the rapid development of mobile phone technology, we are continuously exposed to 1.7 GHz LTE radio frequency electromagnetic fields (RF-EMFs), but their biological effects have not been clarified. Here, we investigated the non-thermal cellular effects of these RF-EMFs on human cells, including human adipose tissue- derived stem cells (ASCs), Huh7 and Hep3B liver cancer stem cells (CSCs), HeLa and SH-SY5Y cancer cells, and normal fibroblast IMR-90 cells. When continuously exposed to 1.7 GHz LTE RF-EMF for 72 h at 1 and 2 SAR, cell proliferation was consistently decreased in all the human cells. The anti-proliferative effect was higher at 2 SAR than 1 SAR and was less severe in ASCs. The exposure to RF-EMF for 72 h at 1 and 2 SAR did not induce DNA double strand breaks or apoptotic cell death, but did trigger a slight delay in the G1 to S cell cycle transition. Cell senescence was also clearly observed in ASC and Huh7 cells exposed to RF-EMF at 2 SAR for 72 h. Intracellular ROS increased in these cells and the treatment with an ROS (reactive oxygen species) scavenger recapitulated the anti-proliferative effect of RF-EMF. These observations strongly suggest that 1.7 GHz LTE RF-EMF decrease proliferation and increase senescence by increasing intracellular ROS in human cells.

Excerpt

Altogether, this study as well as other studies strongly suggest that RF-EMF exposure leads to a change in intracellular ROS levels that may result in genotoxic stress, decreased proliferation and cell senescence, or no physiological effects depending on ROS concentration and the differential sensitivity of various cells to ROS. Thus, the mechanism behind RF-EMF exposure altering intracellular ROS levels should be further studied to elucidate the biological effects of RF-EMFs.

It is not plausible to directly predict the physiological effects of 1.7 GHz LTE RF-EMF from our cell-based study. However, the anti-proliferative effect of 1.7 GHz LTE RF-EMF on various human cells in this study suggests that the exposure to 1.7 GHz LTE RF-EMF would be more harmful to children, whose adult stem cells should be very active for growth and may accelerate the aging of body cells. We also carefully suggest that the anti-proliferative effect of various cancer cells by 1.7 GHz LTE RF-EMF would be interpreted with care, considering that both positive and negative effects of RF-EMF have been reported on cancer development.

Open access paper: <https://www.nature.com/articles/s41598-020-65732-4>

ELECTROMAGNETIC EXPOSURE STUDY ON A HUMAN LOCATED INSIDE THE CAR USING THE METHOD OF AUXILIARY SOURCES

Jeladze VB, Nozadze TR, Tabatadze VA, et al. Electromagnetic Exposure Study on a Human Located inside the Car Using the Method of Auxiliary Sources J Communications Technology Electronics. 65(5): 457-464. May 2020.

Abstract

The article studies the effect of the electromagnetic field of wireless communications on a human inside a car in the frequency ranges of 450, 900, and 1800 MHz, corresponding to the operational range of police radios and modern mobile phones. A comparative analysis of the influence of the Earth's surface under the car is presented. The results of numerical calculations using the Method of Auxiliary Sources show the presence of resonance phenomena and a high reactive field inside the car, which leads to an undesirable increase in the level of absorbed energy in human tissues.

Conclusions

The Method of Auxiliary Sources was used to study the exposure of the electromagnetic field of a mobile phone's antenna on a human inside a car. The calculations took into account the effect of Earth's reflective surface under the car. The results showed that high-amplitude reactive fields inside the car can lead to a multiple increase in the SAR coefficient in human tissues compared to values obtained in the free space. It is recommended to reduce the duration of mobile phone calls inside a car.

<https://link.springer.com/article/10.1134/S1064226920050034>

EFFECT OF ELECTROMAGNETIC FIELD EXPOSURE ON MOUSE BRAIN MORPHOLOGICAL AND HISTOPATHOLOGICAL PROFILING

Judita Zymantiene, Vida Juozaitiene, Rasa Zelvyte, Vaidas Obarauskas, Ugne Spancerniene, Antanas Sederevicius, Albina Aniuliene. J Vet Res. 2020 May 8;64(2):319-324. doi: 10.2478/jvetres-2020-0030.

Abstract

Introduction: Mobile phones (MP) and other electronic and communication devices that are used daily expose users to electromagnetic fields (EMF) and contribute to an increasing incidence of neurological disorders. Brain tissue is the closest organ to the MP as it operates, thus the influence of MP radiation on brain tissue is of particular concern, although research is still inconclusive. The present study investigated the possible effect of an EMF (1,350-1,375 megahertz (MHz)) from an MP on morphological and histopathological profiles in the mouse brain.

Material and methods: Healthy BALB/c mice were assigned to three equal groups (a control and two experimental groups, n = 10 each). Experimental mice were exposed to EMFs continuously for 72 h, those of experimental group I to a 1,350 MHz field at a specific absorption rate (SAR) of 4.0 W/kg, and group II to a 1,375 MHz field EMF at an SAR of 4.0 W/kg. Brain segmentation and histopathological analysis were applied to detect changes in the morphometric parameters of the brain lobes and identify pathological lesions, respectively.

Results: Histopathology results revealed shrinkage of pyramidal neurons, presence of mild perivascular and perineural oedema, and some vacuolation of neurons and glial cells derived from mouse great hemispheres. The lesions also included reduction of Purkinje cells, vacuolisation of neurons and glial cells, and interstitial oedema in the cerebellum.

Conclusion: MP distance of 3 cm from the cage may induce appreciable morphological changes in mouse brain structures; therefore, more comprehensive research is essential for assessment of safe distance. These pronounced effects may interfere with the results of laboratory tests on murine experimental models in veterinary or biomedical research.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7305646/>

INVESTIGATING THE IMPACT OF MOBILE RANGE ELECTROMAGNETIC RADIATION ON THE MEDIAL PREFRONTAL CORTEX OF THE RAT DURING WORKING MEMORY

Tafakori S, Farrokhi A, Shalchyan V, Daliri MR. Investigating the impact of mobile range electromagnetic radiation on the medial prefrontal cortex of the rat during working memory. Behavioural Brain Research. Available online 24 May 2020, 112703. <https://doi.org/10.1016/j.bbr.2020.112703>.

Highlights

- Investigating the effects of radio-frequency electromagnetic radiation on local field potential signal.
- Monitoring the effects of radio-frequency electromagnetic radiation on working memory of the rat.
- Evaluating the impact of mobile phone range exposure on medial prefrontal cortex of the rat.
- Radio-frequency electromagnetic radiation may lead to temporary abnormal brain functioning.
- Theta band of medial prefrontal cortex during working memory affected by mobile phone range radiation.

Abstract

Research has been focused on the effects of radiofrequency electromagnetic radiation (RF-EMR) emitted from a mobile phone on general health, especially the nervous system.

The purpose of this study was to investigate the impact of RF-EMR on the brain mechanism of rats by recording local field potentials (LFPs) signals during working memory (WM) task.

Subjects were exposed to 900 MHz from a dipole antenna daily for three hours. Exposure was applied, first on a short term base (1 week) and then on a long term base (4 weeks). Behavioral parameters were measured weekly while rats performed T-maze tasks in two types of normal and delayed. LFPs signals were simultaneously recorded by implanted microelectrode arrays on the medial prefrontal cortex (mPFC) of rats.

Results showed a significant increase (* $p < 0.05$) in the task completion time of exposed rats which vanished shortly after the end of short term RF-EMR exposure. Before exposure, during

correctly performed delayed tasks, an increase (peak) in power changes of theta band (4-12 Hz) was observed. But during correctly performed normal tasks, an increase appeared only by applying RF-EMR exposure. The similarity in power changes pattern of theta band in both types of tasks was observed after long term exposure. Classification accuracy of LFPs in truly done normal and delayed tasks was compared in pre and post-exposure states. Initial classification accuracy was 84.2% which decreased significantly (*P < 0.05) after exposure.

These observations indicated that RF-EMR may cause unusual brain functioning which is temporary at least for short term exposure.

<https://pubmed.ncbi.nlm.nih.gov/32461126/>

NEUROPROTECTIVE EFFICACY OF LUTEOLIN ON A 900-MHZ ELECTROMAGNETIC FIELD-INDUCED CEREBELLAR ALTERATION IN ADULT MALE RAT

Ahmad Yahyazadeh, Berrin Zuhail Altunkaynak. Neuroprotective Efficacy of Luteolin on a 900-MHz Electromagnetic Field-Induced Cerebellar Alteration in Adult Male Rat. *Brain Res.* 2020 May 30;146919. doi: 10.1016/j.brainres.2020.146919.

Abstract

The adverse health consequences of exposure to electromagnetic field emitted from cell phone has recently raised public concerns worldwide. Also, the Global System for Mobile Communications (GSM) standard that operates in 900 MHz frequency is the most popular. Therefore, we aimed to investigate the adverse effect of exposure to 900 MHz EMF (1 h/day) on the cerebella of 12-week-old rats. We also evaluated the protective activity of luteolin (20 µg/kg/day) against possible biological change in the cerebellar tissues exposed to EMF. Twenty-four male wistar albino rats were randomly assigned into four group of six rats: Control, EMF, EMF+luteolin, luteolin. Serological and biochemical analyses, as well as histopathological examination were performed on all cerebellar samples. We found that SOD (superoxide dismutase) level was significantly increased in the EMF group compared to the control group ($p < 0.05$). To the contrary, decreased SOD activity was detected in the EMF+luteolin group compared to control group ($p < 0.05$). The total number of Purkinje and granular cells was significantly decreased in the EMF group compared to the control group ($p < 0.05$). In the EMF+luteolin group, the total number of Purkinje and granular cells was significantly higher than the EMF group ($p < 0.05$). Histopathological evaluation also showed destructive damage to the architectures of cerebellar tissues. Our results suggest that exposure to EMF may cause cellular damage to the rat cerebellum. Further, the improvement of cerebellar damage may have resulted from antioxidant efficacy of luteolin by alleviating oxidative stress.

<https://pubmed.ncbi.nlm.nih.gov/32485174/>

DECREASED LEVEL OF PLASMA NESFATIN-1 IN RATS EXPOSED TO CELL PHONE RADIATION IS CORRELATED WITH THYROID DYSFUNCTION, OXIDATIVE STRESS, AND APOPTOSIS

Noha I Hussien, Ayman M Mousa, Abeer A Shoman. Decreased Level of Plasma nesfatin-1 in Rats Exposed to Cell Phone Radiation Is Correlated With Thyroid Dysfunction, Oxidative Stress, and Apoptosis Arch Physiol Biochem. 2020 Jun 17;1-7. doi: 10.1080/13813455.2020.1778037.

Abstract

Context: Exposure to Electromagnetic radiation fields of cell phones causes thyroid dysfunction and a previous study revealed that nesfatin-1 may affect functions of the thyroid gland.

Objective: To study the role of nesfatin-1 on functions of rat's thyroid gland exposed to EMRF.

Materials and methods: Thirty adult male rats were divided equally into 3 groups as group I, group II and group III. The experiment extended for 30 days then the plasma nesfatin-1 level, thyroid functions, and thyroid tissue oxidative stress were assessed. Also; histological and immunohistochemical study studies were done to evaluate structural and apoptotic changes of the thyroid gland.

Results: There was a significant decrease in plasma nesfatin-1 level and thyroid functions with an increase in oxidative stress and apoptosis. Interestingly, there was a correlation between nesfatin-1 level and markers of thyroid function, oxidative stress and apoptosis.

Conclusion: Nesfatin-1 plays a role in thyroid dysfunctions of rats exposed to mobile phone radiation. <https://pubmed.ncbi.nlm.nih.gov/32552170/>

Machine Learning-Based Identification of Radiofrequency Electromagnetic Radiation (RF-EMR) Effect on Brain Morphology: A Preliminary Study

Ritesh Maurya , Neha Singh , Tanu Jindal, Vinay Kumar Pathak , Malay Kishore Dutta. Machine Learning-Based Identification of Radiofrequency Electromagnetic Radiation (RF-EMR) Effect on Brain Morphology: A Preliminary Study. Med Biol Eng Comput. 2020 Jun 1. doi: 10.1007/s11517-020-02198-6.

Abstract

The brain of a human and other organisms is affected by the electromagnetic field (EMF) radiations, emanating from the cell phones and mobile towers. Prolonged exposure to EMF radiations may cause neurological changes in the brain, which in turn may bring chemical as well as morphological changes in the brain. Conventionally, the identification of EMF radiation effect on the brain is performed using cellular-level analysis. In the present work, an automatic image processing-based approach is used where geometric features extracted from the segmented brain region has been analyzed for identifying the effect of EMF radiation on the morphology of a brain, using drosophila as a specimen. Genetic algorithm-based evolutionary feature selection algorithm has been used to select an optimal set of geometrical features, which, when fed to the machine learning classifiers, result in their optimal performance. The best classification accuracy has been obtained with the neural network with an optimally selected subset of geometrical features. A statistical test has also been

performed to prove that the increase in the performance of classifier post-feature selection is statistically significant. This machine learning-based study indicates that there exists discrimination between the microscopic brain images of the EMF-exposed drosophila and non-exposed drosophila. Graphical abstract Proposed Methodology for identification of radiofrequency electromagnetic radiation (RF-EMR) effect on the morphology of brain of Drosophila.

<https://pubmed.ncbi.nlm.nih.gov/32483764/>

REPEATED EXPOSURE TO NANOSECOND HIGH POWER PULSED MICROWAVES INCREASES CANCER INCIDENCE IN RAT

René de Seze, Carole Poutriquet, Christelle Gamez, Emmanuelle Maillot-Maréchal, Franck Robidel, Anthony Lecomte, Caroline Fonta. Repeated exposure to nanosecond high power pulsed microwaves increases cancer incidence in rat. PLOS One. 2020; 15(4): e0226858. doi: 10.1371/journal.pone.0226858

Abstract

High-power microwaves are used to inhibit electronics of threatening military or civilian vehicles. This work aims to assess health hazards of high-power microwaves and helps to define hazard threshold levels of modulated radiofrequency exposures such as those emitted by the first generations of mobile phones. Rats were exposed to the highest possible field levels, under single acute or repetitive exposures for eight weeks. Intense microwave electric fields at 1 MV m⁻¹ of nanoseconds duration were applied from two sources at different carrier frequencies of 10 and 3.7 GHz. The repetition rate was 100 pps, and the duration of train pulses lasted from 10 s to twice 8 min. The effects on the central nervous system were evaluated, by labelling brain inflammation marker GFAP and by performing different behavioural tests: rotarod, T-maze, beam-walking, open-field, and avoidance test. Long-time survival was measured in animals repeatedly exposed, and anatomopathological analysis was performed on animals sacrificed at two years of life or earlier in case of precocious death. Control groups were sham exposed. Few effects were observed on behaviour. With acute exposure, an avoidance reflex was shown at very high thermal level (22 W kg⁻¹); GFAP was increased some days after exposure. Most importantly, with repeated exposures, survival time was 4-months shorter in the exposed group, with eleven animals exhibiting a large sub-cutaneous tumour, compared to two in the sham group. A residual X-ray exposure was also present in the beam (0.8 Gy), which is probably not a bias for the observed result. High power microwaves below thermal level in average, can increase cancer prevalence and decrease survival time in rats, without clear effects on behaviour. The parameters of this effect need to be further explored, and a more precise dosimetry to be performed.

Open access paper:

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0226858>

REVISITING 35 AND 94 GHZ MILLIMETER WAVE EXPOSURE TO THE NON-HUMAN PRIMATE EYE

James E Parker, Charles W Beason, Stephen P Sturgeon, William B Voorhees, Samuel S Johnson, Kaitlin S Nelson, Leland R Johnson, Jeffrey N Whitmore. Revisiting 35 and 94 GHz Millimeter Wave Exposure to the Non-human Primate Eye. Health Phys. 2020 Jun 3. doi: 10.1097/HP.0000000000001216.

Abstract

A previous study reported thermal effects resulting from millimeter wave exposures at 35 and 94 GHz on non- human primates, specifically rhesus monkeys' (*Macaca mulatta*) corneas, but the data exhibited large variations in the observed temperatures and uncertainties in the millimeter wave dosimetry. By incorporating improvements in models and dosimetry, a non-human primate experiment was conducted involving corneal exposures that agreed well with a three-layer, one-dimensional, thermodynamic model to predict the expected surface temperature rise. The new data indicated that the originally reported safety margins for eye exposures were underestimated by $41 \pm 20\%$ over the power densities explored. As a result, the expected minimal visible lesion thresholds should be raised to 10.6 ± 1.5 and 7.1 ± 1.0 J cm at 35 and 94 GHz, respectively, provided that the power density is less than 6 W cm for subjects that are unable to blink. If the blink reflex was active, a power density threshold of 20 W cm could be used to protect the eye, although the eyelid could be burned if the exposure was long enough.

<https://pubmed.ncbi.nlm.nih.gov/32501817/>

SAFETY ASSESSMENT OF ELECTROMAGNETIC EXPOSURE IN HIGH-SPEED TRAIN CARRIAGE WITH FULL PASSENGERS

Rui Tian, Mai Lu. Ann Work Expo Health. 2020 Jun 2;wxaa048. doi: 10.1093/annweh/wxaa048.

Abstract

The objective of this work is to evaluate the safety of the electromagnetic environment in the carriage of high- speed trains exposed to power cables when the train is full of passengers. The electromagnetic model of a real carriage, two sets of power cables and the 84 passengers were set up by using COMSOL Multiphysics software based on CRH5. The distributions of induced electric and magnetic fields in the carriage, inside and on the surface of passengers were investigated. The results show that the induced electric and magnetic fields on the windows are greater than on the passengers and the max value of induced magnetic field is 2627.10 μ T, and the max value of induced electric field is 2.0×10^5 mV m⁻¹. The maximum values of the induced electric and magnetic fields in 84 passengers' brain tissues were obtained, and it was found that the maximum values occurred in the third row passengers. The distribution of induced electric and magnetic fields at the cross- section of passengers' heads in the third row was also obtained, and we found that the passengers at the window side were greater than those of aisle passengers. In the third row, the maximum values of the induced electric and magnetic fields in the head of two passengers near the window were 94.6 mV m⁻¹, 90.9 μ T, 96.3 mV m⁻¹, and 90.4 μ T, respectively. We also found the all data were below the ICNIRP Reference Levels, which indicates the electromagnetic exposure caused by power cables when the train is full of passengers will not threat passengers' health.

<https://pubmed.ncbi.nlm.nih.gov/32483584/>

CIRCADIAN POTENCY SPECTRUM WITH EXTENDED EXPOSURE TO POLYCHROMATIC WHITE LED LIGHT UNDER WORKPLACE CONDITIONS

Martin Moore-Ede, Anneke Heitmann, Rainer Guttkuhn. *J Biological Rhythms*. June 16, 2020. <https://doi.org/10.1177/0748730420923164>

Abstract

Electric light has enabled humans to conquer the night, but light exposure at night can disrupt the circadian timing system and is associated with a diverse range of health disorders. To provide adequate lighting for visual tasks without disrupting the human circadian timing system, a precise definition of circadian spectral sensitivity is required. Prior attempts to define the circadian spectral sensitivity curve have used short (≤ 90 -min) monochromatic light exposures in dark-adapted human subjects or in vitro dark-adapted isolated retina or melanopsin. Several lines of evidence suggest that these dark-adapted circadian spectral sensitivity curves, in addition to 430- to 499-nm (blue) wavelength sensitivity, may include transient 400- to 429-nm (violet) and 500- to 560-nm (green) components mediated by cone- and rod-originated extrinsic inputs to intrinsically photosensitive retinal ganglion cells (ipRGCs), which decay over the first 2 h of extended light exposure. To test the hypothesis that the human circadian spectral sensitivity in light-adapted conditions may have a narrower, predominantly blue, sensitivity, we used 12-h continuous exposures of light-adapted healthy human subjects to 6 polychromatic white light-emitting diode (LED) light sources with diverse spectral power distributions at recommended workplace levels of illumination (540 lux) to determine their effect on the area under curve of the overnight (2000–0800 h) salivary melatonin. We derived a narrow steady-state human Circadian Potency spectral sensitivity curve with a peak at 477 nm and a full-width half-maximum of 438 to 493 nm. This light-adapted Circadian Potency spectral sensitivity permits the development of spectrally engineered LED light sources to minimize circadian disruption and address the health risks of light exposure at night in our 24/7 society, by alternating between daytime circadian stimulatory white light spectra and nocturnal circadian protective white light spectra.

<https://journals.sagepub.com/doi/full/10.1177/0748730420923164>

PROPAGATION OF THZ IRRADIATION ENERGY THROUGH AQUEOUS LAYERS: DEMOLITION OF ACTIN FILAMENTS IN LIVING CELLS

Shota Yamazaki, Masahiko Harata, Yuya Ueno, Masaaki Tsubouchi, Keiji Konagaya, Yuichi Ogawa, Goro Isoyama, Chiko Otani, Hiromichi Hoshina. *Sci Rep*. 2020 Jun 2;10(1):9008. doi: 10.1038/s41598-020-65955-5.

Abstract

The effect of terahertz (THz) radiation on deep tissues of human body has been considered negligible due to strong absorption by water molecules. However, we observed that the energy of THz pulses transmits a millimeter thick in the aqueous solution, possibly as a shockwave, and demolishes actin filaments. Collapse of actin filament induced by THz irradiation was also observed in the living cells under an aqueous medium. We also confirmed that the viability of the cell was not affected under the exposure of THz pulses. The potential of THz waves as an invasive method to alter protein structure in the living cells is demonstrated.

Open access paper: <https://www.nature.com/articles/s41598-020-65955-5>

INSIGHTS IN THE BIOLOGY OF EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS EXPOSURE ON HUMAN HEALTH

Abbas Karimi, Farzaneh Ghadiri Moghaddam, Masoumeh Valipour. Insights in the Biology of Extremely Low- Frequency Magnetic Fields Exposure on Human Health. Mol Biol Rep. 2020 Jun 8. doi: 10.1007/s11033-020- 05563-8.

Abstract

The extremely low-frequency magnetic fields (ELF-EMF) are generated by electrical devices and power systems (1 to 300 Hz). In recent decades, exposure to ELF-EMF has emerged potential concerns on public health. Here, we discuss recent progress in the understanding of ELF-EMF biology with a focus on mechanisms of ELF-EMF- mediated disease and summarize the results of more recent experimental and epidemiological studies of ELF- EMF exposure effects on cancer, neurological, cardiovascular, and reproductive disorders. Current views on genomic instability effects, as well as scientific evidence about ELF-EMF therapy, are put forth. According to our literature review, exposure to ELF-EMF has an adverse biological effect depending on the current intensity, strength of the magnetic field, and duration of exposure. Accumulated epidemiologic evidence indicates a correlation between exposure to ELF-EMF and childhood cancer incidence, Alzheimer's disease (AD), and miscarriage. However, adult cancer does not show augmented risk caused by the ELF-EMF. Also, no consistent evidence exists in cardiovascular disease mortality due to ELF-EMF exposure. There is a lack of comprehensive mechanisms for explaining the biological effect of ELF-EMF. Eventually, more studies are needed to clarify the mechanisms of these magnetic fields.

Conclusion

This review suggest that exposure to ELF-EMF has an adverse biological effect, which depends on the current intensity, strength of the magnetic field, and duration of exposure. Accumulated epidemiologic evidence indicates a correlation between exposure to ELF-EMF and childhood cancer incidence, AD, and miscarriage. However, adult cancer does not show augmented risk caused by the ELF-EMF. Besides, no consistent evidence exists on the mortality of cardiovascular disease due to ELF-EMF exposure. Additional epidemiological studies in large study populations with improved exposure assessments are needed to clarify current inconclusive relationships. The in vivo and in vitro evidence confirms the association between DNA strands breaks and exposure to ELF-EMF. On the other hand, some studies show the therapeutic effect of these fields. There is a lack of a comprehensive mechanism for explaining the biological effect of ELF-EMF on human health. Eventually, more studies are needed to clarify the mechanisms of these magnetic fields.

<https://pubmed.ncbi.nlm.nih.gov/32515000/>

BIOLOGICAL AND HEALTH-RELATED EFFECTS OF WEAK STATIC MAGNETIC FIELDS (≤ 1 MT) IN HUMANS AND VERTEBRATES: A SYSTEMATIC REVIEW

Sarah Driessen, Lambert Bodewein, Dagmar Dechent, David Graefrath, Kristina Schmiedchen, Dominik Stunder, Thomas Kraus, Anne-Kathrin Petri. Biological and Health-Related Effects of Weak Static Magnetic Fields (≤ 1 mT) in Humans and Vertebrates: A Systematic Review. PLoS One. 2020 Jun 9;15(6):e0230038. doi: 10.1371/journal.pone.

Abstract

Background: There is a rapid development in technologies that generate weak static magnetic fields (SMF) including high-voltage direct current (HVDC) lines, systems operating with batteries, such as electric cars, and devices using permanent magnets. However, few reviews on the effects of such fields on biological systems have been prepared and none of these evaluations have had a particular focus on weak SMF (≤ 1 mT). The aim of this review was to systematically analyze and evaluate possible effects of weak SMF (≤ 1 mT) on biological functioning and to provide an update on the current state of research.

Methods: This review was prepared in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. Methodological limitations in individual studies were assessed using the Office of Health Assessment and Translation (OHAT) Risk-of-Bias Rating Tool.

Results: Eleven studies fulfilled the eligibility criteria and were included in this review. All included studies were experimental animal studies as no human studies were among the eligible articles. Eight of the eleven studies reported responses of rat, rabbits and quails to weak SMF exposure that were expressed as altered melatonin biosynthesis, reduced locomotor activity, altered vasomotion and blood pressure, transient changes in blood pressure-related biochemical parameters, or in the level of neurotransmitters and increases in enzyme activities. It remained largely unclear from the interpretation of the results whether the reported effects in the evaluated studies were beneficial or detrimental for health.

Conclusion: The available evidence from the literature reviewed is not sufficient to draw a conclusion for biological and health-related effects of exposure to weak SMF. There was a lack of homogeneity regarding the exposed biological systems and the examined endpoints as well as a lack of scientific rigor in most reviewed studies which lowered credibility in the reported results. We therefore encourage further and more systematic research in this area. Any new studies should particularly address effects of exposure to SMF on biological functioning in humans to evaluate whether SMF pose a risk to human health.

Conflict of interest statement

The authors have declared that no competing interests existed during the conduct of the study. However, during the revision of the document, DS has become an employee of Amprion GmbH, a German grid operator.

Open access paper:

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230038>

INTER-INDIVIDUAL VARIATIONS IN ELECTRIC FIELDS INDUCED IN THE BRAIN BY EXPOSURE TO UNIFORM MAGNETIC FIELDS AT 50 HZ

Marco Soldati, Takenobu Murakami, Ilkka Laakso. Inter-individual Variations in Electric Fields Induced in the Brain by Exposure to Uniform Magnetic Fields at 50 Hz. *Phys Med Biol*. 2020 Jul 2. doi: 10.1088/1361- 6560/aba21e.

Abstract

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines and the Institute of Electrical and Electronics Engineers (IEEE) standard establish safety limits for human exposure to electromagnetic fields. At low frequencies, only a limited number of computational body models or simplified geometrical shapes are used to relate the internal induced electric fields and the external magnetic fields. As a consequence, both standard/guidelines derive the exposure reference levels for the external magnetic field without considering the variability between individuals. Here we provide quantitative data on the variation of the maximum electric field strengths induced in the brain of 118 individuals when exposed to uniform magnetic fields at 50 Hz. We found that individual characteristics, such as age and skull volume, as well as incident magnetic field direction, have a systematic effect on the peak electric field values. Older individuals show higher induced electric field strengths, possibly due to age-related anatomical changes in brain. Peak electric field strengths are found to increase for larger skull volumes, as well as for incident magnetic fields directed along the lateral direction. Moreover, the maximum electric fields provided by the anatomical models used by ICNIRP for deriving exposure limits are considerably higher than those obtained here. On the contrary, the IEEE elliptical exposure model produces a weaker peak electric field strength. Our findings are useful for the revision and harmonization of the current exposure standard and guidelines. The present investigation reduces the dosimetric uncertainty of the induced electric field among different anatomical induction models. The obtained results can be used as a basis for the selection of appropriate reduction factors when deriving exposure reference levels for human protection to low-frequency electromagnetic exposure.

<https://pubmed.ncbi.nlm.nih.gov/32615544/>

THE EFFECT OF ELECTROMAGNETIC FIELD ON DECREASING AND INCREASING OF THE GROWTH AND PROLIFERATION RATE OF DERMAL FIBROBLAST CELL

Mehran Naghibzadeh, Seifollah Gholampour, Majid Naghibzadeh, Fatemeh Sadeghian-Nodoushan, Habib Nikukar. *Dermatol Ther.* 2020 Jun 11;e13803. doi: 10.1111/dth.13803.

Abstract

Maintaining the health of dermal fibroblast cells and controlling their growth and proliferation would directly affect the health of skin tissues. The present study encompassed three control and three experimental specimens, which were different in terms of the duration of exposure to electromagnetic field (EMF) and intensity. With a decrease in intensity from 2 mT to 1 mT during 24, 48, and 72 hours after exposing the cells to EMF, the frequency of the sample fibroblast cells increased by 60.3%, 144.9%, and 90.1%, respectively. With an increase in intensity from 3 mT to 4 mT during 48 and 72 hours of exposure to EMF, the frequencies of the sample fibroblast cells decreased by 6.8% and 86.7%, respectively. It seems to be possible to achieve the most desirable condition to help the restoration of wounds and skin lesions through decreasing the exposure intensity from 2 mT to 0.5 mT and increasing EMF exposure time from 24 hours to 72 hours simultaneously and non-invasively. The most desirable approach to improve the treatment of skin cancers non-invasively is to increase the intensity from 3 mT to 5 mT and to enhance EMF exposure time from 48 to 72 hours.

<https://pubmed.ncbi.nlm.nih.gov/32526050/>

EFFECTS OF MODERATE STATIC MAGNETIC FIELD ON NEURAL SYSTEMS IS A NON-INVASIVE MECHANICAL STIMULATION OF THE BRAIN POSSIBLE THEORETICALLY?

Antonio Hernando, Fernando Galvez, Miguel A García, Vanesa Soto-León, Carlos Alonso-Bonilla, Juan Aguilar, Antonio Oliviero. *Front Neurosci.* 2020 May 19;14:419. doi: 10.3389/fnins.2020.00419.

Abstract

Static magnetic fields have been shown to induce effects on the human brain. Different experiments seem to support the idea that moderate static magnetic field can exert some influence on the gating processes of the membrane channels. In this article we visit the order of magnitude of the energy magnetic terms associated with moderate applied field (between 10 and 200 milliteslas). It is shown that gradients of the Zeeman energy associated with the inhomogeneous applied fields can induce pressures of the order of 10-2Pa. The surface tension generated by the magnetic pressure, on the surface delimiting the brain region subject to relevant field and gradients, is found to range between 10⁻¹ and 1 mN·m⁻¹. These pressures seem to be strong enough to interfere with the elastic and electrostatic energies involved in the channel activation-inactivation-deactivation mechanisms of biological membranes. It has been described that small mechanical force can activate voltage gated potassium channels. Moreover, stretch-activated ion channels are widely described in different biological tissues. Virtually, all these channels can modify their activity if stressed by a sufficient pressure delivered for enough time. We propose mechanical stimulation - possibly not exclusively - as a candidate mechanism how static magnetic field can produce effects in biological systems. It must be emphasized, that such field gradients were not previously proposed as a possible source of neural activity modification.

Open access paper: <https://www.frontiersin.org/articles/10.3389/fnins.2020.00419/full>

ELECTRIC FIELD-INDUCED CHANGES IN BIOMECHANICAL PROPERTIES IN HUMAN DERMAL FIBROBLASTS AND A HUMAN SKIN EQUIVALENT

Se Jik Han, Donggerami Moon, Moon Young Park, Sangwoo Kwon, Minjoo Noh, Jihui Jang, Jun Bae Lee, Kyung Sook Kim. 2020 Jun 28. doi: 10.1111/srt.12894.

Abstract

Purpose: An electric field (EF) can be used to change the mechanical properties of cells and skin tissues. We demonstrate EF-induced elasticity changes in human dermal fibroblasts (HDFs) and a human skin equivalent and identify the underlying principles related to the changes.

Methods: HDFs and human skin equivalent were stimulated with electric fields of 1.0 V/cm. Change in cellular elasticity was determined by using atomic force microscopy. Effects of EF on the biomechanical and chemical properties of a human skin equivalent were analyzed. In cells and tissues, the effects of EF on biomarkers of cellular elasticity were investigated at the gene and protein levels.

Results: In HDFs, the cellular elasticity was increased and the expression of biomarkers of cellular elasticity was regulated by the EF. Expression of the collagen protein in the human skin equivalent was changed by EF stimulation; however, changes in density and microstructure of the collagen fibrils were not significant. The viscoelasticity of the human skin equivalent increased in response to EF stimulation, but molecular changes were not observed in collagen.

Conclusions: Elasticity of cells and human skin equivalent can be regulated by electrical stimulation. Especially, the change in cellular elasticity was dependent on cell age.

<https://pubmed.ncbi.nlm.nih.gov/32594564/>

MAGNETIC ALIGNMENT ENHANCES HOMING EFFICIENCY OF HUNTING DOGS

Kateřina Benediktová, Jana Adámková, Jan Svoboda, Michael Scott Painter, Luděk Bartoš, Petra Nováková, Lucie Vynikalová, Vlastimil Hart, John Phillips, Hynek Burda. Elife. 2020 Jun 16;9:e55080. doi: 10.7554/eLife.55080.

Abstract

Despite anecdotal reports of the astonishing homing abilities in dogs, their homing strategies are not fully understood. We equipped 27 hunting dogs with GPS collars and action cams, let them freely roam in forested areas, and analyzed components of homing in over 600 trials. When returning to the owner (homewards), dogs either followed their outbound track ('tracking') or used a novel route ('scouting'). The inbound track during scouting started mostly with a short (about 20 m) run along the north-south geomagnetic axis, irrespective of the actual direction homewards. Performing such a 'compass run' significantly increased homing efficiency. We propose that this run is instrumental for bringing the mental map into register with the magnetic compass and to establish the heading of the animal.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7297537/>

HALF DUPLEX RADIO: TOWARDS GREEN 5G NR HALF DUPLEX RADIO: TOWARDS GREEN 5G NR

Kour H, Jha RK. Half Duplex Radio: Towards Green 5G NR. IEEE Consumer Electronics Magazine. May 2020. doi:10.1109/MCE.2020.2993105.

Abstract

The standardization of the 5th Generation of mobile communication networks is paving its way in 3GPP, involving the evolution of 5G New Radio (NR). One of the key features of NR is its operation at high frequencies such as mm Wave, involving high human exposure to electromagnetic (EM) radiation in the atmosphere. This increases the power density levels in our ecosystem, high specific absorption rates in body tissues because of temperature elevation due to heating. The article provides an overview of the harmful impacts of the Radio Frequency (RF) fields with some radiation reduction techniques. A potential solution as a proposal in the form of “Thermal Radiation” (TR) mode to design the future mobile communication networks is presented. The proposed mode validates its performance by decreasing Power Density (PD), complexity and temperature elevation. Also high energy efficiency is obtained for proposed TR mode hence contributing towards Green Communication.

Excerpt

Various biological effects of radiofrequency electromagnetic field (RF-EMF) and mmWave radiation have been studied in literature. Some of them are summarized in Table 1. It can be seen that at low frequencies of exposure the power density values obtained for the study targets are within the exposure limits as specified by ICNIRP [3]. With the rise in frequency exposure, the PD and Specific absorption Rate (SAR) obtained rise correspondingly. The damage caused is seen in terms of reduced growth rate, reproductive capacity, corneal damage, altered memory and so on. There is a major contribution to the climate change caused by emission of harmful gases such as *CO2* due to proliferation in the ICT industry [4] and mobile communication systems which is expected to be 51% (179 Mt *CO2 e*) by 2020 [5].

In humans the eyes, skin tissues, brain are the most vulnerable areas and the power density exposure is maximum [7]. There are concerns regarding planning of the 5G networks in a way as to abide by the EMF limits and constraints. Various 5G enabling technologies have been discussed in literature to provide new opportunities for reducing the exposure and for EMF aware network planning to plan the future communication networks [8]. In [9], the authors discuss EM radiation reduction techniques for mobile communication systems such as Massive MIMO which increases the spatial diversity by transmitting parallel streams of information channels called as spatial multiplexing. Various other techniques discussed include Electromagnetic Shielding, Beamforming, Coordinated multipoint (CoMP), Spectrum Sharing. In [10] an algorithm to achieve better quality of experience and service in 5G systems is proposed. In addition, zonal based approach is followed in [11] to prolong battery lifetime of users in a spectrum-shared network contemplating Green Communication.

<https://ieeexplore.ieee.org/document/9089191>

LIMITATIONS OF INCIDENT POWER DENSITY AS A PROXY FOR INDUCED ELECTROMAGNETIC FIELDS

Christ A, Samaras T, Neufeld E, Kuster N. Bioelectromagnetics. 2020 May 14. doi: 10.1002/bem.22268.

Abstract

The most recent safety guidelines define basic restrictions for electromagnetic field exposure at frequencies more than 6 GHz in terms of spatial- and time-averaged transmitted power density inside the body. To enable easy-to-perform evaluations in situ, the reference levels for the incident power density were derived. In this study, we examined whether compliance with the reference levels always ensures compliance with basic restrictions. This was evaluated at several distances from different antennas (dipole, loop, slot, patch, and helix). Three power density definitions based on integration of the perpendicular real part of the Poynting vector, the real part of its three vector components, and its modulus were compared for averaging areas of $\lambda^2/16$, 4 cm² (below 30 GHz) and 1 cm² (30 GHz). In the reactive near-field ($d < \lambda/(2\pi)$), the transmitted power density can be underestimated if an antenna operates at the free space exposure limit. This underestimation may exceed 6 dB (4.0 times) and depends on the field source due to different coupling mechanisms. It is frequency-dependent for fixed-size averaging areas (4 and 1 cm²). At larger distances, transmission can be larger than the theoretical plane-wave transmission coefficient due to backscattering between the body and field source. Using the modulus of the incident Poynting vector yields the smallest underestimation.

<https://www.ncbi.nlm.nih.gov/pubmed/32410291>

Conclusions

The ratio of the transmitted to incident averaged PD was quantified considering near- and far-field effects with the objective of establishing a correlation that can be used for the assessment of the compliance of wireless devices operating above 6 GHz based on free space measurements. The following additional aspects need be taken into consideration for the quantification of the average transmitted PD:

- Increased coupling in the near-field, which has already been described by Kuster and Balzano [1992], can lead to an underestimation of the average transmitted PD by more than 6 dB (4.0 times) or a factor of 4 for $d < \lambda/2$ if the real part of the Poynting vector that is perpendicular to the phantom (Equation (1)) is applied to calculate the averaged PD as the exposure metric.
- The underestimation is frequency-independent, if the averaging area is normalized to $(\lambda/4)^2$, instead of being kept fixed at 4 or 1 cm². If the averaging area is normalized to the wavelength, frequency independence for array antennas can be assumed provided that the array topology (e.g. number and spatial arrangement of array elements) is kept constant.
- Calculating the averaged PD using the modulus of the Poynting vector (Equation (3)) yields a better proxy for the transmitted power in the near-field, i.e. for $d < \lambda/(2\pi)$, because it takes into account losses that are induced by the reactive field components, which do not contribute to the real part of the Poynting vector.
- At distances $d > \lambda/(2\pi)$, at which the Poynting vector approaches the PD of TEM wave

propagation, the transmission coefficient may deviate by more than ± 2 dB (1.6 times) from the plane-wave equivalent transmission due to backscattering and constructive or destructive interference. Within the considered distance range of up to 2λ , the impact of backscattering cannot be neglected.

These results should be considered in the assessment of compliance of wireless devices with the basic restrictions. The incident PD calculated from the real part of the Poynting vector that is perpendicular to the phantom (Equation (1)) is a poor proxy for any EM source in the reactive near-field, i.e. at $d < \lambda/(2\pi)$ or at a distance of 2 mm below 24 GHz. According to the results of the evaluated EM sources in this study, the modulus of the Poynting vector (Equation (3)) approximates the exposure much more reliably. The most reliable method of determining the exposures at 2 mm below 24 GHz, however, is the direct assessment of the transmitted PD in a skin simulating phantom instead of the incident PD, as it also takes into account the coupling and backscattering effects. Above 24 GHz, current methods have proven to be sufficiently accurate and reliable.

COMPARISON OF EFFECTS OF 2.4 GHZ WI-FI AND MOBILE PHONE EXPOSURE ON HUMAN PLACENTA AND CORD BLOOD

Bektas H, Dasdag S, Bektas MS. 34(1): 154-162, DOI: 10.1080/13102818.2020.1725639.

Abstract

The aim of this study was to investigate the effects of radiofrequency radiation emitted from Wi-Fi systems and mobile phones on cord blood and placenta. The study included 149 pregnant women who were divided in subgroups: unexposed (control), mobile phone exposed, Wi-Fi exposed and mobile phone plus Wi-Fi exposed groups. Immediately after birth, placenta and cord blood samples were collected and protein carbonyl (PCO), malondialdehyde (MDA), total oxidant status (TOS), total antioxidant status, 8-hydroxy-2'-deoxyguanosine (8- OHdG) levels and DNA single strand breaks were analysed. The results of the study showed an increase in 8- OHdG, MDA, PCO and TOS in cord blood and placenta in the group exposed to mobile phones during gestation. However, the group exposed to Wi-Fi did not show alterations in the studied oxidative stress parameters. On the other hand, tail intensity and tail moment of DNA in the mobile phone exposure groups were higher than those in the control and Wi-Fi exposure groups. In conclusion, the results of this study indicated that mobile phone exposure during pregnancy could have an important potential to cause oxidative stress and DNA damage in cord blood and placenta. The results of this study also indicated that combined effects of Wi-Fi plus mobile phone exposure have a higher potential to cause synergistic harmful effects.

Excerpts

The use of wireless Internet and mobile phones has been increasing rapidly. Nowadays, access points to the internet are present in workplaces, public places, houses, and schools. These sources of RFR are raising the public concern regarding the potential health effects. Possibly, these systems are particularly popular with children and the young population. However, exact proof is not present on whether these RFR systems are harmful or not for humans. Therefore, people, especially pregnant women and children should be cautious around such equipment until there are sufficient data. Some animal studies have recently indicated that RFR exposure during pregnancy induced some adverse effects on infants [13–15]. On the

other hand, in a human pregnancy study, it is reported that RFR exposure during pregnancy caused significant changes in some biochemical parameters of cord blood [16].

There is a correlation between radiofrequency and body penetration. When the frequency of the RFR increases, it penetrates less into the body tissues [8]. Consequently, the penetration of 2.4 GHz Wi-Fi should be lower than that of 900, 1800 and 2100 MHz, which are the mobile phone frequencies. On the other hand, there are two frequency zones (around 100 MHz and 1–4 GHz) in which children absorb more RF than adults [8]. However, the strength and distance to sources are very important for the health effects of RFR. As it is known, when RFR moves away from the source, its power density decreases in proportion to $1/d^2$ (where d^2 is the square of the distance to the source). People are exposed to local RFR when talking with mobile phones, whereas RFR emitted from Wi-Fi affects the entire body. It is thought that public exposure levels arising from Wi-Fi are lower than those from mobile phones [8]. Additionally, frequency, power density, distance and physical properties of the biological material (permeability and dielectric constant) are the determinative factors for the interaction between RFR and the biological material. It is also reported that tissues with high water content are more sensitive to RFR than others [9]. Therefore, another issue that needs attention is pregnancy because the body water content increases in pregnancy. It is also verified that RFR has potential to develop some anomalies during pregnancy [10,11]. Additionally, the specific absorption rate (SAR) levels in fetuses exposed to 900 MHz plane waves have been found 14% lower than those of their mothers [12].

In our study, the tail moment and tail intensity, which are DNA damage indicators, were found higher in Group 1 (mobile phone only) than in the control group. However, no significant change was observed in the Wi-Fi group (Group 2) in terms of the parameters under discussion. The 8-OHdG level, which is also another oxidative DNA damage indicator, was higher in Group 1 than in the Control. On the other hand, no significant alteration was observed in Group 2 as compared to the control. We also observed differences in the 8-OHdG levels, tail moment and tail intensity between the experimental groups ($p < 0.001$). Therefore, we suggest that RFR emitted from mobile phones was more effective in inducing oxidative DNA damage than RFR emitted from Wi-Fi. On the other hand, the results from our study indicated that Wi-Fi has the potential to contribute to the detrimental effects of mobile phones.

In cord blood, the values of TOS and OSI in Groups 1 and 3 were higher than those in the control group ($p < 0.001$), whereas the TAS levels were lower than that in the control ($p < 0.05$). Alterations in TAS, TOS, OSI were not observed in the Wi-Fi exposed group. In placenta, TAS in Group 2 was higher than that in Group 1 ($p < 0.001$), OSI in Group 2 were acquired lower than Group 1. The results obtained from our study showed that the exposure to mobile phones during the gestation period might be able to induce oxidative stress, but exposure to Wi-Fi does not appear to cause oxidative stress. The reason behind this difference may be attributed to absorption and attenuation of RFR emitted from Wi-Fi devices by walls and materials in the vicinity. In addition, mobile phone users are exposed to more RFR in the near field. Known harmful effects of RFR on living organisms depend on some physical characteristics of radiation [7]. The body RF penetration decreases when RF frequency increases [8].

There are some limitations to this study. For example, although all efforts were made to carefully select the participants enrolled in this study, the study design could not possibly exclude all potential effects of other factors on the pregnant women that may have affected the levels of the parameters in this study. However, the confounding factors presented in Tables 1 and 2 indicated that external factors were found statistically insignificant ($p>0.05$).

ELECTROMAGNETIC HYPERSENSITIVITY: A CRITICAL REVIEW OF EXPLANATORY HYPOTHESES

Dieudonné M. Electromagnetic hypersensitivity: a critical review of explanatory hypotheses. Environ Health. 2020 May 6;19(1):48. doi: 10.1186/s12940-020-00602-0.

Abstract

BACKGROUND: Electromagnetic hypersensitivity (EHS) is a condition defined by the attribution of non-specific symptoms to electromagnetic fields (EMF) of anthropogenic origin. Despite its repercussions on the lives of its sufferers, and its potential to become a significant public health issue, it remains of a contested nature. Different hypotheses have been proposed to explain the origin of symptoms experienced by self-declared EHS persons, which this article aims to review.

METHODS: As EHS is a multi-dimensional problem, and its explanatory hypotheses have far-reaching implications, a broad view was adopted, not restricted to EHS literature but encompassing all relevant bodies of research on related topics. This could only be achieved through a narrative approach. Two strategies were used to identify pertinent references. Concerning EHS, a complete bibliography was extracted from a 2018 report from the French Agency for Food, Environmental and Occupational Health & Safety and updated with more recent studies. Concerning related topics, the appropriate databases were searched. Systematic reviews and expert reports were favored when available.

FINDINGS: Three main explanatory hypotheses appear in the literature: (1) the electromagnetic hypothesis, attributing EHS to EMF exposure; (2) the cognitive hypothesis, assuming that EHS results from false beliefs in EMF harmfulness, promoting nocebo responses to perceived EMF exposure; (3) the attributive hypothesis, conceiving EHS as a coping strategy for pre-existing conditions. These hypotheses are successively assessed, considering both their strengths and limitations, by comparing their theoretical, experimental, and ecological value.

CONCLUSION: No hypothesis proves totally satisfying. Avenues of research are suggested to help decide between them and reach a better understanding of EHS.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7201940/>

THE ENIGMA OF HEADACHES ASSOCIATED WITH ELECTROMAGNETIC HYPERFREQUENCIES: HYPOTHESES SUPPORTING NON- PSYCHOGENIC ALGOGENIC PROCESSES.

Toffa DH, Sow AD. The enigma of headaches associated with electromagnetic hyperfrequencies: Hypotheses supporting non-psychogenic algogetic processes. Electromagn Biol Med. 2020 May 13:1-10. doi: 10.1080/15368378.2020.1762638.

Abstract

Although an electrohypersensitivity (EHS) is reported in numerous studies, some authors associate hyperfrequencies (HF)-related pains with a placebo effect while others suggest a biological effect. Therefore, we aimed to suggest hypotheses about the complex mechanisms of headaches related to HF-exposure. We crossed basic features of headaches with relevant studies (from the year 2000 up to 2018) emphasizing on the HF effects that may lead to pain genesis: neuroglial dysmetabolism, neuroinflammation, changes in cerebral blood perfusion, blood-brain barrier dysfunction and electrophysiological evidences of hyperexcitability. We privileged studies implying a sham exposure (for in vivo studies) and a specific absorption rate lower than 4 W/Kg. HF- induced headaches may involve an indirect inflammatory process (neurogenic, magnetogenic or thermogenic) as well as a direct biophysical effect (thermogenic or magnetogenic). We linked inflammatory processes to meningeal dysperfusion or primary neuroglial dysfunction triggered by non-thermal irradiation or HF-induced heating at thermal powers. In the latter case, HF-induced excitotoxicity and oxidative stress probably play a crucial role. Such disorders may lead to vascular-trigeminal activation in predisposed people. Interestingly, an abnormal oxidative stress predisposition had been demonstrated in overall 80% of EHS self-reporting patients. In the case of direct effects, pain pathways' activation may be directly triggered by HF-irradiation (heating and/or transcranial HF-induced ectopic action potentials). Further research on HF-related headaches is needed.

<https://www.ncbi.nlm.nih.gov/pubmed/32401641>

Excerpts

Electromagnetic HFs are non-ionizing radiations that have complex interactions with intracranial structures. These radiations can significantly impact on neuroglial excitability and induce direct or indirect changes in the permeability of the BBB and meningeal capillaries. All these objective interactions can lead to the induction of headaches either by non-thermal/thermal proinflammatory mechanisms, by thermal stimulation of trigeminal endings, or also by ectopic discharges genesis. However, we believe that unless there occurs a prolonged and high-intensity exposure, a low threshold for vascular trigeminal activation seems crucial to promote headaches in EHS people. Our hypotheses are based on the conclusions of several studies targeting the brain effects of HF. However, further experiments based on the current assumptions should be conducted. In practice, since it is impossible to avoid HF exposure in modern society, it is important to emphasize awareness to reduce this exposure, especially in EHS individuals. Moreover, since some of the mechanisms described above can lead to durable neuroglial processes, chronic exposure in predisposed people can result in brain disorders (headaches or other) that increasingly evolve independently from HF triggering.

EMPIRICAL STUDY ON SPECIFIC ABSORPTION RATE OF HEAD TISSUES DUE TO INDUCED HEATING OF 4G CELL PHONE RADIATION

Christopher B, Mary YS, Khandaker MU, Jojo PJ. Published online Apr 4, 2020. <https://doi.org/10.1016/j.radphyschem.2020.108910>

Highlights

- Induced heating of 4G cell phone radiation affects the functions of neural cells.
- Temperature and SAR of brain, eye and skin tissues are measured in laboratory condition.
- Rise in temperature and SAR values are found in the studied tissues for confrontation of 600s.
- Long time and over exposure to mobile phone radiation may affect the individual health.

Abstract

Exposures to electromagnetic radiation mainly from the extended use of mobile phones may initiate biological damages in the human body at the macromolecular level. Several studies on human and animal models have shown significant changes in the functions of neural cells. Present empirical study analyses the thermal changes and the specific absorption rates (SAR) of brain, eye and skin tissues due to prolonged exposure to mobile phone radiation. A phantom, simulating human head with skin, skull and brain was used for the study. The Phantom was exposed to radiation for longer durations (600 s and more) and the temperature variations at different specific points were studied with sensitive thermocouple probes. SAR (1 g of contiguous tissue) values were determined using the variations of temperature and other parameters. The average rise in brain temperature was found to be 0.10 ± 0.05 °C at 30 mm deep in the brain and the estimated SAR was 0.66 ± 0.35 Wkg⁻¹. The increase in temperature for the eye socket was 0.03 ± 0.02 °C with SAR 0.15 ± 0.08 Wkg⁻¹. The average rise in temperature for skin was 0.14 ± 0.05 °C and the SAR was 0.66 ± 0.42 Wkg⁻¹. Although the measured SAR lie within the safe limit of 2 Wkg⁻¹ recommended by the international regulatory body, considering the tremendous growth in the number of mobile phone users and prolonged use of mobile phone in communication purposes, the cumulative effects could be a real concern for human health.

<https://www.sciencedirect.com/science/article/abs/pii/S0969806X20302085>

AN EXPERIMENTAL STUDY OF EFFECTS OF MEDIA IMPLICATION ON SELF-REPORT SYMPTOMS RELATED WITH MOBILE PHONE USE

Gao P, Zheng F-Z, He M-D, Li M, Deng P, Zhou Z, Yu Z-P, Zhang L. Front. Public Health, 13 May 2020 | <https://doi.org/10.3389/fpubh.2020.00175>.

Along with gradual increases in mobile phone (MP) use, the mass media has played a vital role in informing the public regarding the potential health hazards of MP use. These media warnings have prompted public worries about health. The aim of the present study is to investigate the effects of media warnings about the possible health hazards of MP use on self-reported symptoms. Participants were 703 undergraduate students who volunteered to take part in an experimental study between August 2013 and July 2015. After completing baseline

questionnaires containing information on demographics, MP usage and possible confounding variables, the participants were randomly clustered assigned to a video treatment group (watching a 5-min video about the possible health hazards of MP use) or a control group. Then, they completed another set of questionnaires containing 6 self-reported physical symptoms and the Beck Depression Inventory (BDI). Chi-squared tests, Mann-Whitney U-tests and logistic regression models were applied in the data analysis. Participants in the video group reported significantly more frequent headache ($P = 0.01$), fatigue ($P = 0.00$), memory loss ($P = 0.03$), inattention ($P = 0.00$), and higher level of depression ($P = 0.05$) than those in the control group. Additionally, the prevalence of memory loss ($\beta = 0.071$, $P = 0.03$) and inattention ($\beta = 0.110$, $P = 0.00$) were significantly higher in participants with higher level of depression who watched the video. Media warnings about the possible health hazards of MP use promote people to report physical symptoms and psychological problems. Considering this tendency, more moderate and scientific media information is needed to alleviate public worries about MP use.

Open access paper: <https://www.frontiersin.org/articles/10.3389/fpubh.2020.00175/full>

SPENDING THE NIGHT NEXT TO A ROUTER - RESULTS FROM THE FIRST HUMAN EXPERIMENTAL STUDY INVESTIGATING THE IMPACT OF WI-FI EXPOSURE ON SLEEP

Danker-Hopfe H, Bueno-Lopez A, Dorn H, Schmid G, Hirtl R, Eggert T. Spending the night next to a router - Results from the first human experimental study investigating the impact of Wi-Fi exposure on sleep. *Int J Hyg Environ Health*. 2020 May 11;228:113550. doi: 10.1016/j.ijheh.2020.113550.

Abstract

BACKGROUND: The use of wireless telecommunication systems such as wireless fidelity (Wi-Fi)-enabled devices has steadily increased in recent years. There are persistent concerns that radiofrequency electromagnetic field (RF-EMF) exposure might affect health. Possible effects of RF-EMF exposure on human sleep were examined with regard to mobile phones and base stations, but not with regard to Wi-Fi exposure.

OBJECTIVES: The present double-blind, sham-controlled, randomized, fully counterbalanced cross-over study addressed for the first time the question whether a whole night Wi-Fi exposure has an effect on sleep.

METHODS: Thirty-four healthy young male subjects (mean $\pm$ SD: 24.1 $\pm$ 2.9 years) spent five nights in the sleep laboratory. A screening and adaptation night was followed by two experimental nights. Each of the experimental nights was preceded by a baseline night. Sleep was evaluated at the subjective level by a questionnaire and at the objective level (macro- and microstructure) by polysomnography. Either 2.45 GHz Wi-Fi (max psSAR10g of 6.4 mW/kg) or sham signals were delivered by a newly developed head exposure facility.

RESULTS: Results showed no statistically significant acute effects of a whole-night Wi-Fi exposure on subjective sleep parameters as well as on parameters characterizing the macrostructure of sleep. Analyses of the microstructure of sleep revealed a reduction in global EEG power in the alpha frequency band (8.00-11.75 Hz) during NREM sleep under acute Wi-Fi exposure compared to sham.

DISCUSSION: The results of the present human experimental study are well in line with several other neurophysiological studies showing that acute RF-EMF exposure has no effect on the macrostructure of sleep. The slight physiological changes in EEG power observed under Wi-Fi exposure are neither reflected in the subjective assessment of sleep nor at the level of objective measurements. The present results are not indicative of a sleep disturbing effect of Wi-Fi exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/32408065>

REVIEW OF AUDIOVESTIBULAR SYMPTOMS FOLLOWING EXPOSURE TO ACOUSTIC AND ELECTROMAGNETIC ENERGY OUTSIDE CONVENTIONAL HUMAN HEARING

Lubner RJ, Kondamuri NS, Knoll RM, Ward BK, Littlefield PD, Rodgers D, Abdullah KG, Remenschneider AK, Kozin ED. Review of Audiovestibular Symptoms Following Exposure to Acoustic and Electromagnetic Energy Outside Conventional Human Hearing. *Front Neurol*. 2020 Apr 28;11:234. doi: 10.3389/fneur.2020.00234.

Abstract

Objective: We aim to examine the existing literature on, and identify knowledge gaps in, the study of adverse animal and human audiovestibular effects from exposure to acoustic or electromagnetic waves that are outside of conventional human hearing.

Design/Setting/Participants: A review was performed, which included searches of relevant MeSH terms using PubMed, Embase, and Scopus. Primary outcomes included documented auditory and/or vestibular signs or symptoms in animals or humans exposed to infrasound, ultrasound, radiofrequency, and magnetic resonance imaging. The references of these articles were then reviewed in order to identify primary sources and literature not captured by electronic search databases. Results: Infrasound and ultrasound acoustic waves have been described in the literature to result in audiovestibular symptomology following exposure. Technology emitting infrasound such as wind turbines and rocket engines have produced isolated reports of vestibular symptoms, including dizziness and nausea and auditory complaints, such as tinnitus following exposure. Occupational exposure to both low frequency and high frequency ultrasound has resulted in reports of wide-ranging audiovestibular symptoms, with less robust evidence of symptomology following modern-day exposure via new technology such as remote controls, automated door openers, and wireless phone chargers. Radiofrequency exposure has been linked to both auditory and vestibular dysfunction in animal models, with additional historical evidence of human audiovestibular disturbance following unquantifiable exposure. While several theories, such as the cavitation theory, have been postulated as a cause for symptomatology, there is extremely limited knowledge of the pathophysiology behind the adverse effects that particular exposure frequencies, intensities, and durations have on animals and humans. This has created a knowledge gap in which much of our understanding is derived from retrospective examination of patients who develop symptoms after postulated exposures.

Conclusion and Relevance: Evidence for adverse human audiovestibular symptomology following exposure to acoustic waves and electromagnetic energy outside the spectrum of human hearing is largely rooted in case series or small cohort studies. Further research on the pathogenesis of audiovestibular dysfunction following acoustic exposure to these frequencies

is critical to understand reported symptoms.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7199630/>

COMPREHENSIVE RADIOFREQUENCY ELECTROMAGNETIC FIELD MEASUREMENTS AND ASSESSMENTS: A CITY CENTER EXAMPLE

Kurnaz C, Mutlu M. Comprehensive radiofrequency electromagnetic field measurements and assessments: a city center example. *Environ Monit Assess.* 2020 May 7;192(6):334. doi: 10.1007/s10661-020-08312-3.

Abstract

In this study, radiofrequency electromagnetic field (RF-EMF) measurements were carried out between 2016 and 2018 in one the largest provinces of Turkey; measurement results are compared with the limit values determined by International Commission on Non-Ionizing Radiation Protection (ICNIRP) and Turkey's Information and Communication Technologies Authority (ICTA). In the first stage of a three-phase evaluation, short-term RF-EMF measurements were conducted in 500 locations over a 2-year period. In the second stage, short-term RF-EMF measurement results were analyzed to determine selected locations for long-term RF-EMF measurements to be carried out, including variation of RF-EMF during the day. In the last stage, band selective measurements were taken and the main sources of RF-EMF in the environment were determined. Overall, RF-EMF values do not exceed the limits determined by ICNIRP and ICTA, and they are below levels that threaten public health. In the short-term RF-EMF measurements, RF-EMF levels doubled after fourth generation (4G) systems were introduced. In the long-term RF-EMF measurements, RF-EMF values in the day are 35.4% more than at night. The total measured RF-EMF within the city center is 99.3% base station sourced. Among the six main RF-EMF sources, the devices operating in UMTS2100 band have the most contribution to total RF-EMF of medium with 31.2%. Additionally, we found short-term average electric field strength data are best described by the "exponential distribution," while long-term RF-EMF measurement data is best described by the "Burr distribution." <https://www.ncbi.nlm.nih.gov/pubmed/32382839>

Excerpts

Short-term and long-term RF-EMF measurements were taken using the PMM-8053 EMF meter (PMM-8053 2020) with the EP-330 electric field isotropic probe. Band selective RF-EMF measurements were performed with the SRM-3006 EMF meter (SRM-3006 2020) with 3501/03 isotropic electric field probe. The PMM-8053 measures the total RF-EMF for the frequency spectrum of 100 kHz–3GHz, while the SRM-3006 measures the RF-EMF for a selective band in the 27 MHz–3 GHz frequency band. Technical details for PMM-8053 and SRM-3006 used in measurements are given in Table 2.

Conclusions

This study undertook three stages of RF-EMF measurement between 2016 and 2018 in the Altinordu District of Ordu, Turkey. In the first stage, short-term RF-EMF measurements, in the frequency range of 100 kHz–3 GHz, were performed at 500 locations during 2016 and 2017. The highest measured E_{avg} value in 2016 was 4.55 V/m (21.66% of the lowest ICTA reference level (21 V/m) and 16.25% of the lowest ICNIRP reference level (28 V/m) for the considered frequency band), which increased to 5.86 V/m (27.9% of the lowest ICTA reference level) in

2017. The average of all short-term RF-EMF measurements in 2016 was 0.39 V/m (corresponding to 1.85% of the ICTA reference level), which increased to 0.79 V/m (corresponding to 4.23% of the ICTA reference level) in 2017, an increase of 102.5%. The main reason for this increase appears to be due to the introduction of the 4G system in 2017. Our short-term RF-EMF measurement results (0.39 V/m and 0.79 V/m) were in agreement with those obtained in similar studies, where average electric field strength levels ranged between 0.22 and 0.41 V/m (Urbinello et al. 2014a), from 0.02 to 2.05 V/m (Sanchez-Montero et al. 2017), from 0.07 to 1.27 V/m (Jalilian et al. 2019), from 0.32 to 1.70 V/m (Tang et al. 2019), between 0.08 and 1.8 V/m (Gajsek et al. 2015), 0.47 V/m in city centers (Sagar et al. 2016), 0.74 V/m in urban environments (Joseph et al. 2012). The Eavg of the short-term RF-EMF data are best described by the exponential distribution.

In the second stage, long-term RF-EMF measurements at the 17 locations where the short-term RF-EMF measurement exceeded 1.90 V/m were performed to determine the variation of RF-EMF over the day. The maximum overall RF-EMF and average values were observed as 9.54 V/m and 5.13 V/m (45.42% and 24.42% of the corresponding of the lowest ICTA reference level (21 V/m) for the considered frequency band), respectively. RF-EMF values measured during the afternoon are higher than night and morning, being 35% greater than at night. Long-term RF-EMF measurement data is best described by the “Burr distribution.”

In the last stage, band selective RF-EMF measurements were performed at the same locations as the long-term measurements to identify the sources of RF-EMF. From all the locations considered, the highest average RF-EMF level was 5.013 V/m (23.87% of the lowest ICTA reference level for FM frequency band)) generated by the FM band. The greatest contribution to RF-EMF was from base stations, with 57.3% in the overall measurements, and increasing to 99.3% in the city center. The highest city center RF-EMF level (2.284 V/m for LTE 800 band) measured represented 8.41% of the ICTA limit for LTE 800.

Comprehensive RF-EMF measurements were conducted between 2016 and 2018 and over 510 h (short-term RF- EMF measurements took 100 h, while long-term and band selective RF-EMF measurements took 408 h and more than 2 h respectively) show that the values in Altınordu District are below the limits set by ICTA and ICNIRP. However, an annual increase in RF-EMF was observed, and it is recommended that measurements should be made annually to ensure levels remain below the limits set by ICTA and ICNIRP to reduce risks to public health. These measurements and assessments, especially with the deployment of fifth generation (5G) wireless infrastructure in the near future, will be of great importance to determine and keep under control the level of RF-EMF in the environment.

CASE-CONTROL STUDY ON OCCUPATIONAL EXPOSURE TO EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELDS AND THE ASSOCIATION WITH ACOUSTIC NEUROMA

Carlberg M, Koppel T, Ahonen M, Hardell L. Environmental Research. Available online 7 May 2020, 109621

Highlights

- Exposure to ELF-EMF has been classified as a possible human carcinogen by IARC.
- Risk for acoustic neuroma was investigated for occupations with ELF-EMF exposure.
- No increased risk for acoustic neuroma was found in any exposure category.

Abstract

Exposure to extremely low-frequency electromagnetic fields (ELF-EMF) was in 2002 classified as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer at WHO based on an increased risk for childhood leukemia. In case-control studies on brain and head tumours during 1997-2003 and 2007-2009 we assessed life-time occupations in addition to exposure to different agents. The INTEROCC ELF- EMF Job-Exposure Matrix was used for associating occupations with ELF-EMF exposure (μT) with acoustic neuroma. Cumulative exposure (μT -years), average exposure (μT) and maximum exposed job (μT) were calculated. No increased risk for acoustic neuroma was found in any category. For cumulative exposure in the highest exposure category $8.52+ \mu\text{T}$ years odds ratio (OR) = 1.2, 95 % confidence interval (CI) = 0.8-2.0, p linear trend = 0.37 was calculated. No statistically significant risks were found in the time windows 1-14 years, and 15+ years, respectively. In conclusion occupational ELF-EMF was not associated with an increased risk for acoustic neuroma.

<https://pubmed.ncbi.nlm.nih.gov/32422481/>

MOBILE ELECTROMAGNETIC RADIATION AFFECTS VITELLINE VESSELS DEVELOPMENT IN CHICK EMBRYO: A MORPHOMETRIC STUDY

Al-Qudsi F, Al-Quahtani A. Bioscience Research. 17(1):383-398. 2020.

Abstract

Smart mobile phone use has increased dramatically in the last five years. Electromagnetic radiation (EMR) emitted from mobile phones might affect embryonic development. However the mechanism of this effect is not completely understood. Vitelline vessels are the first blood vessels formed, playing a vital role in embryonic nutrition during development. The aim of this research was to study the effect of mobile phone EMR (450-2100 MHz) on the formation of vitelline vessels in chick embryo (*Gallus gallus domesticus*) and detect the resulting congenital malformations. Fertilized chicken eggs were divided into three groups: control (C), exposed without call (EO) and exposed with call (EW). In EW group the mobile phone was called every 6 hours for 15 minutes, (60min/24hr.). While the EO group was exposed to a mobile phone connected through the Wi-Fi to the internet only. Embryos were extracted on day 2, 3, 4 and 5 of incubation. A major decrease in the formation of vitelline vessels was seen in the treated groups compared to the controls causing bleeding seen in several sites of the treated embryos. Congenital malformations increased in treated groups compared to the controls of all experimental ages. The congenital malformations seen were growth retardation, bleeding, clotting and neural tube defects. It was concluded that mobile phone EMR prevented proper formation of vitelline vessels resulting in deformed embryos.

Open access paper: [https://www.isisn.org/BR17\(1\)2020/383-398-17\(1\)2020BR20-34.pdf](https://www.isisn.org/BR17(1)2020/383-398-17(1)2020BR20-34.pdf)

THE INFLUENCE OF ELECTROMAGNETIC RADIATION OF CELL PHONES ON THE BEHAVIOR OF ANIMALS

Sultangaliyeva I, Beisenova R, Tazitdinova R, Abzhalelov A, Khanturin M. Vet World. 2020 Mar;13(3):549-555. doi: 10.14202/vetworld.2020.549-555.

Abstract

Background and Aim: The radiation emitted from cell phones has various deleterious effects on human health. The article considers the problem of the effects of electromagnetic radiation (EMR) of cell phones on the behavior of animals. The use of mobile phones is continually increasing throughout the world. All of the world population uses mobile phones widely; thus, having strong and daily effect on the brain. There is no restriction on the use of mobile phones. Getting more advantages and convenience of mobile communication, the population is trying not to hear the information about possible risks to their health, there is no element of self-restraint. The aim of this work was to study behavioral patterns in response to the influence of cell phones.

Materials and Methods: The experiments were carried out on 90 white outbred rats weighing 250-300 g. Experiments were carried out and the effect of EMR from Samsung Galaxy J1 mini and Xiaomi Redmi S2 phones on animal behavior was studied. Behavioral reactions were studied using the open field method.

Results: By the quality of the act of locomotion in the second experimental group is reduced by 30% and also in this group by the time of the act is 23% lower than in the control data. Vertical motor activity, a support stand, is also suppressed in the second experimental group: 61% lower in number and 47.2% lower in act time compared to the control group. Based on the data, we can conclude that the EMR of the phone Samsung Galaxy J1 Mini affects the behavior of animals to a greater extent than Xiaomi Redmi S2. By the frequency of the act, sniffing is 26% lower; by the time of the act, it remained at the level of control data in the second group. In the third group of the animals, the number and time of the act are 15% lower than the control data. The support stands as an indicator of research activity. In the second group the act of stand with support - by number was lower by 57% than the control data, this indicates that research activity is being suppressed.

Conclusion: According to the above changes under the action of EMR from the Samsung Galaxy J1 Mini and Xiaomi Redmi S2 phones, the motor component of behavior is suppressed. The research component of behavior in all groups of animals is enhanced due to high rates of sniffing. It is possible that in animals under stress, the motivation to interact with the environment decreases, leading to an excessive self-accentuation of the animal. Immobility is seen in all experimental groups, which indicates the suppression of the emotional sphere of brain activity. Defecation and urination change only slightly, which may also indicate the suppression of animal emotions.

Open access paper:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7183456/>

Protective Effects of Vitamin E on Mobile Phone Induced Injury in The Brain of Rats

Sangi S M A, Bawadekji A, Alotaibi N M, Aljameeli A M, Soomro S. Int j pharm phytopharm res 2020;10(1):97-104

Abstract

Aim: With increase in use of cell phone and exposure to radiation emission from Wi-Fi, cell damage in all the body systems is found. It is necessary to find ways and means to prevent that cell damage that may affect normal functioning of the organs etc. The objective of this study was to assess the damage to brain caused by exposure to cell phones connected with Wi-Fi and prevention of that damage with Vitamin E.

Methods: Thirty male Wistar Albino rats were used in the study, rats were divided in different groups, they were exposed to cell phones and Wi-Fi for 8 weeks. The rats were treated with Vit. E 50 IU/kg of bodyweight for 4 weeks.

Results: Histopathological examination of the rat brain revealed that, exposure of rats to cell phones and Wi-Fi caused significant damage to the neurons in different areas of rat brain. The rats treated with Vit. E showed less damage in comparison to untreated rat groups.

Conclusion: In the brain of rats, treated with Vit. E intact neuronal architecture was found along with less inflammation.

<https://eijppr.com/en/article/protective-effects-vitamin-e-on-mobile-phone-induced-injury-in-the-brain-of-rats>

THE IMMUNOMODULATORY EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC FIELD ON SERUM CYTOKINE LEVELS IN A MOUSE MODEL OF HINDLIMB UNLOADING

Aghajari S, Mortazavi SMJ, Kalani M, Nematollahi S, Habibzadeh P, Farjadian S. Cell J. 2021 Jan;22(4):401-405. doi: 10.22074/cellj.2021.6856.

Abstract

Objective: Astronauts are exposed to a wide range of environmental stresses during space flights that reduce their immune responses and make them more susceptible to infections and malignancies. Exposure to a low dose of a certain stress induces an adaptive response, which leads to resistance to higher doses of the same or other types of stress. We designed this study to investigate the effect of radiofrequency electromagnetic field (RF-EMF)-induced adaptive response on immune system modulation in a mouse model of hindlimb unloading (HU) as a ground-based animal model of spaceflight conditions.

Materials and Methods: In this experimental study, serum levels of T helper (Th)-mediated cytokines were determined by the multiplex cytometric bead assay in four groups of mice (n=10 per group): HU mice, RF-EMF- treated mice, HU mice pre-exposed to RF-EMF; and untreated controls. Mice were exposed to 2450 MHz RF- EMF with SAR 0.478 W/ kg for 12 hours/day for three successive days.

Results: Tumor necrosis factor-alpha (TNF- α), interleukin-9 (IL-9) and IL-22 were significantly decreased in HU mice. Comparison between HU mice and RF-EMF-treated mice showed an

opposite change in IL-6, while IL-9, IL-22, IFN- γ and TNF- α decreased in both groups. However, just interferon gamma (IFN- γ) was significantly decreased in HU mice that were pre-exposed to RF-EMF compared to the control group.

Conclusion: The effect of RF-EMF in elevating IL-6 and reducing IL-9 in opposite directions in HU mice suggest a modulating effect of RF-EMF on HU-induced changes in these cytokines, as Th2 and Th9 eventually returned to normal levels and balances in cytokine ratios were also restored in HU mice pre-exposed to RF-EMF.

<https://www.ncbi.nlm.nih.gov/pubmed/32347032>

THE EFFECT OF RADIATION EMITTED BY CELL PHONE ON THE GELATINOLYTIC ACTIVITY OF MATRIX METALLOPROTEINASE-2 AND-9 OF MOUSE PRE-ANTRAL FOLLICLES DURING IN VITRO CULTURE

Azimipour F, Zavareh S, Lashkarbolouki T. Cell J. 2020 Apr;22(1):1-8. DOI: 10.22074/cellj.2020.6548.

Abstract

Objective: The unfavorable effects of electromagnetic radiation (EMR) emitted by the cell phone on reproduction health are controversial. Metalloproteinases play a vital role in ovarian follicle development. This study was designed to investigate the effects of exposure to the cell phone on the gelatinolytic activity of in vitro cultured mouse pre-antral follicle.

Materials and methods: In this experimental study, pre-antral follicles were isolated from ovaries of immature mice (n=16) and cultured with or without exposure to the cell phone in talking mode for 60 minutes. The gelatinolytic activity was evaluated through the zymography method, as well as the gene expression of matrix metalloproteinases (MMPs) namely MMP-2 and -9 and tissue inhibitors of metalloproteinases (TIMPs) namely, TIMP-1 and -2 by the real-time polymerase chain reaction (PCR) method. Also, in parallel, the development of pre-antral follicles was assessed.

Results: The maturation parameters of the cell phone-exposed pre-antral follicles were significantly lower compared with the control group ($P<0.05$). The gelatinolytic activity was significantly decreased in the cell phone-exposed preantral follicles compared with the control group ($P<0.05$). The relative mRNA expression of the MMP-2 gene was significantly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles whereas the expression rate of the MMP-9 gene was considerably ($P<0.05$) reduced when compared with the control group. Conversely, the relative expression of the TIMP-1 was markedly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles while the expression of the TIMP-2 was ($P<0.05$) significantly diminished in comparison with the control group.

Conclusion: Exposure to the cell phone alters the growth and maturation rate of murine ovarian follicle through the changing in the expression of the MMP-2 and -9 genes, as well as the gelatinolytic activity.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6791065/>

OXIDATIVE STRESS AND APOPTOSIS IN ELECTROMAGNETIC WAVES EXPOSED ZEBRAFISH EMBRYOS AND PROTECTIVE EFFECTS OF CONDUCTIVE NONWOVEN FABRIC

Üstündağ ÜV, Özen MS, Ünal İ, Ateş PS, Alturfan AA, Akalın M, Sancak E, Emekli-Alturfan E. Cell Mol Biol (Noisy-le-grand). 2020 Apr 20;66(1):70-75.

Abstract

The amount of technological products including television, radio transmitters, and mobile phone that have entered our daily life has increased in recent years. But these devices may cause adverse effects on human health. Electromagnetic shielding fabrics may limit and inhibit electromagnetic waves. Aim of our study was to evaluate electromagnetic wave blocking performance of nonwoven textile surfaces on zebrafish embryos that were exposed to electromagnetic waves at specific frequencies. Oxidant-antioxidant system parameters were evaluated spectrophotometrically. The expressions of tp53 and casp3a were evaluated by RT-PCR. Results showed that electromagnetic shielding fabrics produced as conductive nonwoven textile surfaces improved oxidant-antioxidant status and tp53 expression that were impaired in electromagnetic waves exposed zebrafish embryos. Also, electromagnetic shielding fabrics decreased casp3a expression responsible for the execution phase of apoptosis that increased in electromagnetic waves exposed zebrafish embryos.

<https://www.ncbi.nlm.nih.gov/pubmed/32359387>

THE ROLE OF 217-HZ ELF MAGNETIC FIELDS EMITTED FROM GSM MOBILE PHONES ON ELECTROCHEMOTHERAPY MECHANISMS

Mansourian M, Firoozabadi M, Hassan ZM. Electromagn Biol Med. 2020 May 15:1-11. doi: 10.1080/15368378.2020.1762635.

Abstract

Electrochemotherapy (ECT), the combination of electric pulses (EPs) and an anticancer drug, is a type of cancer treatment method. We investigated the effect of 217-Hz magnetic fields (MFs) similar to that generated by GSM900 mobile phones, as intervening factors, on proposed mechanisms of ECT including permeability, tumor hypoxia and immune system response. The 4T1 cells were exposed to extremely low-frequency (ELF)-MFs at 93, 120 or 159 μ T intensities, generated by Helmholtz coils 10 min, and then put in individual groups, comprising no treatment, chemotherapy, EPs or ECT. The cell viability was evaluated. Then, two treatment protocols were selected for in vivo experiments. The mice with 4T1 tumor cells were exposed to ELF-MFs 10 min/day until the day their tumors reached 8 mm in diameter. Then, the tumors were treated to ECT. Tumor hypoxia and immune system response were analyzed through immunohistochemistry assay and enzyme-linked immunosorbent assay technique, respectively. The results in vitro indicated a significant decreased ECT efficacy of 60 V/cm, 5 kHz at the flux density of 93 μ T. The results in vivo showed that pre-exposure to ELF-MFs could increase tumor hypoxia induced by ECT. In addition, exposure to ELF-MFs before ECT caused a significant increase in interferon- γ /interleukin-4 in comparison with ECT alone. More studies, including studies on the effect of ELF-MFs emitted from mobile phones on tumor volume changes induced by ECT, are needed to elucidate how the process of ECT is influenced by the MFs.

<https://www.ncbi.nlm.nih.gov/pubmed/32410511>

SETTING GUIDELINES FOR ELECTROMAGNETIC EXPOSURES AND RESEARCH NEEDS

Barnes F, Greenebaum B. Bioelectromagnetics. 2020 Apr 20. DOI: 10.1002/bem.22267

Abstract

Current limits for exposures to nonionizing electromagnetic fields (EMF) are set, based on relatively short-term exposures. Long-term exposures to weak EMF are not addressed in the current guidelines. Nevertheless, a large and growing amount of evidence indicates that long-term exposure to weak fields can affect biological systems and might have effects on human health. If they do, the public health issues could be important because of the very large fraction of the population worldwide that is exposed. We also discuss research that needs to be done to clarify questions about the effects of weak fields. In addition to the current short-term exposure guidelines, we propose an approach to how weak field exposure guidelines for long-term exposures might be set, in which the responsibility for limiting exposure is divided between the manufacturer, system operator, and individual being exposed.

<https://pubmed.ncbi.nlm.nih.gov/32311139/>

Excerpts

Both IEEE and ICNIRP base their analyses on rigorous reviews of the scientific literature and on established firm evidence of health effects in humans. The present guidelines are based on acute exposures; to date both IEEE and ICNIRP have not found sufficient evidence to include health effects of long-term exposures at lower levels. However, over the last 20 years the evidence has become extremely strong that weaker EMF over the whole range for frequencies from static through millimeter waves can modify biological processes. There is now solid experimental evidence and supporting theory showing that weak fields, especially but not exclusively at low frequencies, can modify reactive free radical concentrations and that changes in radical concentration and that of other signaling molecules, such as hydrogen peroxide and calcium, can modify biological processes ...”

The evidence that weak radiofrequency (RF) and low-frequency fields can modify human health is still less strong, but the experiments supporting both conclusions are too numerous to be uniformly written off as a group due to poor technique, poor dosimetry, or lack of blinding in some cases, or other good laboratory practices. Based on recent studies by the National Toxicology Program (NTP) [Smith-Roe et al., 2020] and the Ramazini Foundation [Falcioni et al., 2018] as well as laboratory data, the International Agency for Research on Cancer (IARC) has declared RF fields as possible human carcinogens [IARC, 2013]. A recent paper extends the NTP studies by evaluating genotoxicity in animals exposed to fields at or over the guideline limits and found DNA damage in Comet assays [Smith-Roe et al., 2020]. Many other papers indicate similar results, but many negative results are also in the literature.”

PROPOSED APPROACH TO SETTING EXPOSURE LIMITS

From these and other lines of solid research, the guidelines for exposure could be revised. Increased emphasis on long-term exposures may require refining the concept of dose to more flexibly combine exposure time and field intensity or energy absorbed. Eventual guidelines might suggest limiting cell phone calls to X hours per day with exposure levels above Y W/m², and for Z days per week exposure should be less than Y W/m² to allow the body to reset its baseline.

What is missing in the current guidelines or regulations are guidelines for long-term exposure to weak EMF....”

“Guidelines should be set at three levels: the individual user, local company, and national or international level.... External guidance, in terms of informed recommendations or at least analysis of various intensities and styles of usage from some agency such as the Federal Communications Commission (FCC) or NIH, would be useful.

Limits on the time for operations of base stations and exposures in adjacent living spaces are not controlled by the user and must be set by competent authorities, based on scientific evidence. It is likely to be difficult to specify times when exposures to RF signals are zero or below some limit. What will be needed is being able to say with some certainty that exposure below a given level has not been shown to cause changes in body chemistry above some level. A starting point might be current levels from TV and radio stations that are large enough to give signal-to-noise ratios around 20 dB (100-fold) with typical receiving systems. Currently, mean values for the population's exposure to these systems are estimated to be around 0.1 V/m and peak exposures range up to 2 V/m, which exceed current exposure limits for a small fraction of the population. Therefore, one starting point for exposure limits might be an average of 0.1 V/m, not based on research but on practicality, until further research results dictate either a lower or higher limit.”

REGARDING ICNIRP'S EVALUATION OF THE NATIONAL TOXICOLOGY PROGRAM'S CARCINOGENICITY STUDIES ON RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Melnick R. Health Physics. June 2020; 118(6): 678-682. doi: 10.1097/HP.0000000000001268

Conclusion

ICNIRP's misrepresentation of the methodology and interpretation of the NTP studies on cell phone RF radiation does not support their conclusion that “limitations preclude drawing conclusions about carcinogenicity in relation to RF EMFs.” In contrast to the ICNIRP evaluation, a 3-d independent peer-review of the NTP studies concluded that there was clear evidence of carcinogenic activity in male rats exposed to RF radiation (NTP 2018c). In addition, the dosimetry issue raised in the ICNIRP note falsely portrays the relevance and utility of the NTP cancer data for assessing human cancer risks. After all, it was the US Food and Drug Administration that requested the NTP studies of cell phone radiation in experimental animals to provide the basis to assess the risk to human health. The NTP studies show that the assumption that RF radiation is incapable of causing cancer or other adverse health effects other than by tissue heating is wrong. If ICNIRP's goal is truly aimed at protecting the public from potential harm, then it would be appropriate for this group to quantify the health risks associated with exposure to RF-EMFs and then develop health-protective guidelines for chronic exposures, especially for children, who are likely to be more susceptible than adults to adverse effects of RF radiation. At the very least, ICNIRP should promote precautionary advice for the general public rather than trying to justify their decision to dismiss findings of adverse health effects caused by RF-EMFs and thereby retain their 20+ y-old exposure guidelines that are based on protection against thermal effects from acute exposures.

https://journals.lww.com/healthphysics/Citation/2020/06000/Regarding_ICNIRP_S_Evaluation_of_the_National.11.aspx

ELECTROMAGNETIC HYPERSENSITIVITY (EHS, MICROWAVE SYNDROME) – REVIEW OF MECHANISMS

Stein Y, Udassin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) –Available online 30 March 2020, 109445. <https://doi.org/10.1016/j.envres.2020.109445>

Abstract

Electromagnetic hypersensitivity (EHS), known in the past as “Microwave syndrome”, is a clinical syndrome characterized by the presence of a wide spectrum of non-specific multiple organ symptoms, typically including central nervous system symptoms, that occur following the patient's acute or chronic exposure to electromagnetic fields in the environment or in occupational settings. Numerous studies have shown biological effects at the cellular level of electromagnetic fields (EMF) at magnetic (ELF) and radio-frequency (RF) frequencies in extremely low intensities. Many of the mechanisms described for Multiple Chemical Sensitivity (MCS) apply with modification to EHS. Repeated exposures result in sensitization and consequent enhancement of response. Many hypersensitive patients appear to have impaired detoxification systems that become overloaded by excessive oxidative stress. EMF can induce changes in calcium signaling cascades, significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells as well as altered neurological and cognitive functions and disruption of the blood-brain barrier. Magnetite crystals absorbed from combustion air pollution could have an important role in brain effects of EMF. Autonomic nervous system effects of EMF could also be expressed as symptoms in the cardiovascular system. Other common effects of EMF include effects on skin, microvasculature, immune and hematologic systems. It is concluded that the mechanisms underlying the symptoms of EHS are biologically plausible and that many organic physiologic responses occur following EMF exposure. Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses. More relevant diagnostic tests for EHS should be developed. Exposure limits should be lowered to safeguard against biologic effects of EMF. Spread of local and global wireless networks should be decreased, and safer wired networks should be used instead of wireless, to protect susceptible members of the public. Public places should be made accessible for electrosensitive individuals.

Many of the mechanisms described for Multiple Chemical Sensitivity (MCS) apply with modification to EHS. Repeated exposures result in sensitization and consequent enhancement of response (Overstreet, 2001; Latremoliere and Woolf, 2009; Molot, 2013; Sage, 2015). Many hypersensitive patients appear to have impaired detoxification systems that become overloaded by excessive oxidative stress (Korkina, 2009; De Luca et al., 2014). Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses (Dwyer and Leeper, 1978; Pall, 2016). EMF can induce changes in calcium signaling cascades (Liboff, 1984; Blackman et al., 1985; Smith et al., 1987; Pall, 2013, 2015), significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells (Irmak et al., 2002; Zmyslony et al., 2004; Friedman et al., 2007; Blank and Goodman, 2009; De Iuliis et al., 2009; Georgiou, 2010; Avci et al., 2012; Jing et al., 2012; Bilgici et al., 2013; Burlaka et al., 2013) as well as altered neurological and cognitive functions (Frey, 1961; Thomas et al., 1986; Carrubba et al., 2007; Nittby et al., 2009; Xu et al., 2010; Molot, 2013; Yakymenko et al., 2016; Pall, 2016; Kim et al., 2017) and disruption of the blood-brain barrier

(Salford et al., 2008; Nittby et al., 2009). Magnetite crystals absorbed from combustion air pollution could have an important role in brain effects of EMF (Maher et al., 2016).

Conclusions

In the modern world, exposure to electromagnetic radiation has become inescapable. There are many people who develop adverse health effects as a result of exposure to EMF. This review of the literature included numerous self-reported neurologic and neuropsychiatric symptoms which have a temporal relationship to EMF exposures. Further studies suggest that EMF exposure may be associated with changes in cerebral blood flow which correspond to abnormalities on PET scan of the brain. Some of the researchers have even localized the brain abnormalities to the temporal lobe, thought to be the closest site of exposure to cell phones. Because of the widespread use of EMF technology, it is difficult to avoid exposure.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935120303388?via%3Dihub>

RISKS FOR HEALTH ASSOCIATED WITH USE MODES AND RADIATION LEVEL OF CELL PHONES IN MODERN YOUNGER SCHOOLCHILDREN

Vyatleva OA, Kurgansky AM. [Article in Russian]. Risks for health associated with use modes and radiation level of cell phones in modern younger schoolchildren. *Gigiena i sanitariia* 98(11):1267-1271. Nov 2019. DOI: 10.18821/0016-9900-2019-98-11-1267-1271.

Abstract

Introduction - The wide coverage of modern schoolchildren with cell phones (CP), the increased vulnerability of children to radiofrequency radiation, the lack of age standards for safe CP use determined the aim of the study: to identify CP radiation levels and use modes, associated with the health risks in modern schoolchildren.

Material and methods - In a cross-sectional study of 80 modern schoolchildren (8.57 ± 0.75 y.o; 2017-2018 education years) without neurological complications in history by measuring CP power flux density (PFD), questioning and risks calculating, there were determined the radiation levels and daily modes of CT use (calls number - CN, duration of call - CD, and calls total duration - CTD), which are associated with the risks of clinically significant health deviations (dizziness, 4 or more colds per year, and frequent (several times a week) headaches, sleep disturbances, fatigue, anxiety, low mood, poor attention, and memory).

Results - The risk of dizziness increases when children use CP with a maximal PFD $\geq 100 \mu\text{W}/\text{cm}^2$ (OR = 4.44; 95% CI: 1.15-9.27), or if CTD increases from 6.25 to ≥ 12 minutes (OR= 8.55; 95% CI 1.74-7.11). Increasing CN from 1-2 to 3-5 causes the risk of frequent anxiety (OR 7.86; 95% CI 1.26-31.8). Using the «push-button» CPs in comparison with smartphones is associated with the frequent low mood (OR= 5.42; 95% CI: 1.47-6.10).

Conclusion- The use of «push-button» CP, CP with PFD $\geq 100 \mu\text{W}/\text{cm}^2$, CTD ≥ 6.25 minutes, CN > 1-2 cause risks for children's health.

<https://www.medlit.ru/journalsview/gigsan/view/journal/en/2019/issue-11/3994-risks-for-health-associated-with-use-modes-and-radiation-level-of-cell-phones-in-modern-younger-schoolchildren/>

ASSOCIATION BETWEEN MATERNAL EXPOSURE TO MAGNETIC FIELD NONIONIZING RADIATION DURING PREGNANCY AND RISK OF ATTENTION-DEFICIT/HYPERACTIVITY DISORDER IN OFFSPRING IN A LONGITUDINAL BIRTH COHORT

Li DK, Chen H, Ferber JR, Hirst AK, Odouli R. Association Between Maternal Exposure to Magnetic Field Nonionizing Radiation During Pregnancy and Risk of Attention-Deficit/Hyperactivity Disorder in Offspring in a Longitudinal Birth Cohort. *JAMA Netw Open*. 2020 Mar 2;3(3):e201417. doi: 10.1001/jamanetworkopen.2020.1417.

Abstract

Importance: An association between maternal exposure to magnetic field (MF) nonionizing radiation during pregnancy and the risk of attention-deficit/hyperactivity disorder (ADHD) has been reported in both animal and human studies.

Objectives: To determine whether maternal exposure to high levels of MF nonionizing radiation is associated with an increased risk of ADHD in offspring by using more accurate measurements of MF nonionizing radiation levels and physician-diagnosed ADHD, rather than self-reports, and to determine whether the association differs for the subtypes of ADHD with or without immune-related comorbidities.

Design, Setting, and Participants: A longitudinal birth cohort study was conducted at Kaiser Permanente Northern California among 1482 mother-child pairs whose mothers were participants of an existing birth cohort and whose level of exposure to MF nonionizing radiation was captured during pregnancy in 2 studies conducted from October 1, 1996, to October 31, 1998, and from May 1, 2006, to February 29, 2012. The offspring were followed up from May 1, 1997, to December 31, 2017.

Exposure: All participating women wore a monitoring meter for 24 hours during pregnancy to capture the level of exposure to MF nonionizing radiation from any sources.

Main Outcomes and Measures: Physician-diagnosed ADHD and immune-related comorbidities of asthma or atopic dermatitis up to 20 years of age in offspring captured in the Kaiser Permanente Northern California electronic medical record from May 1, 1997, to December 31, 2017. Confounders were ascertained during in-person interviews during pregnancy.

Results: Among the 1454 mother-child pairs (548 white [37.7%], 110 African American [7.6%], 325 Hispanic [22.4%], 376 Asian or Pacific Islander [25.9%], and 95 other or unknown [6.5%]; mean [SD] maternal age, 31.4 [5.4] years), 61 children (4.2%) had physician-diagnosed ADHD. Using Cox proportional hazards regression to account for follow-up time and confounders, compared with children whose mothers had a low level of exposure to MF nonionizing radiation during pregnancy, children whose mothers were exposed to higher levels of MF nonionizing radiation had more than twice the risk of ADHD (adjusted hazard ratio [aHR], 2.01; 95% CI, 1.06-3.81). The association was stronger for ADHD that persisted into adolescence (≥ 12 years of age), with an aHR of 3.38 (95% CI, 1.43-8.02). When the subtypes of ADHD were examined, the association existed primarily for ADHD with immune-related comorbidities (asthma or atopic dermatitis), with an aHR of 4.57 (95% CI, 1.61- 12.99) for all

ADHD cases and an aHR of 8.27 (95% CI, 1.96-34.79) for persistent cases of ADHD.

Conclusions and Relevance: Consistent with the emerging literature, this study suggests that in utero exposure to high levels of MF nonionizing radiation was associated with an increased risk of ADHD, especially ADHD with immune-related comorbidity. The findings should spur more research to examine the biological association of in utero MF exposure with risk of ADHD in offspring, given that almost everyone is exposed to it.

Excerpts

Approximately 11% of all children aged 4 to 17 years (>6.4 million children) in the United States receive a diagnosis of, or treatment for, attention-deficit/hyperactivity disorder (ADHD). Attention-deficit/hyperactivity disorder has been associated with poor school performance during childhood and with lifelong disabilities....

One nonchemical factor that has not been examined is the ever-present nonionizing radiation, also known as magnetic fields (MFs), emitted from electric appliances, power lines, and wireless devices and networks including cell phone towers....

Once a pregnant woman had given consent to participate in the study, she was asked to wear an EMDEX meter (EnerTech Inc) to capture the level of MF nonionizing radiation exposure. During the 24-hour monitoring period, which occurred during the first or second trimester, the meters (EMDEX II and EMDEX Lite) captured levels of 40 to 800 Hz of MF nonionizing radiation encountered by the participating woman throughout her daily life. The MF nonionizing radiation level was measured in milligauss....

To examine the association of high levels of MF nonionizing radiation with risk of ADHD, we used the 90th percentile of the 24-hour measurements as the MF index, which reflects the MF nonionizing radiation level at or above which a participant was exposed to for 10% of the time during the day. Given that everyone is exposed to MF nonionizing radiation at some levels, to classify participating women into low or high MF nonionizing radiation exposure groups, based on the experience of previous studies,^{9,10,19} we used a cutoff based on the 25th percentile of the MF index's distribution, which corresponded to 1.3 mG. The participants whose MF nonionizing radiation level was lower than 1.3 mG were classified as having a low level of MF nonionizing radiation exposure during pregnancy, while the participants whose MF nonionizing radiation level was 1.3 mG or higher were classified as having a relatively higher daily level of MF nonionizing radiation exposure.

Conclusions Using a longitudinal birth cohort study design, we examined the association between maternal exposure to MF nonionizing radiation during pregnancy and risk of ADHD in offspring throughout childhood up to age 20 years. The study improved over previous studies by enhancing the accuracy of measuring MF nonionizing radiation exposure and of ADHD diagnosis. The findings provide new evidence that in utero exposure to a high level of MF nonionizing radiation is associated with an increased risk of ADHD in offspring. The association is primarily between MF nonionizing radiation exposure and ADHD with immune-related comorbidities and persistent cases of ADHD. The findings reveal a possible new risk factor that is ubiquitous in our modern day lives and should spur more research to examine this potential association.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7093768/>

LONG-TERM EFFECT OF MOBILE PHONE USE ON SLEEP QUALITY: RESULTS FROM THE COHORT STUDY OF MOBILE PHONE USE AND HEALTH (COSMOS)

Tettamanti G, Auvinen A, Åkerstedt T, Kojo K, Ahlbom A, Heinävaara S, Elliott P, Schüz J, Deltour I, Kromhout H, Toledano MB, Poulsen AH, Johansen C, Vermeulen R, Feychting M, Hillert H, Environment International. <https://doi.org/10.1016/j.envint.2020.105687>.

Highlights

- Above median mobile phone call-time was associated with less sleep disturbance.
- Above 90th percentile mobile phone call time was associated with insomnia.
- Adjustment for network suggests association with insomnia was not due to RF-EMF
- Other potential explanations may be related to behavior and psychological factors.

Abstract

Background Effects of radiofrequency electromagnetic field exposure (RF-EMF) from mobile phone use on sleep quality has mainly been investigated in cross-sectional studies. The few previous prospective cohort studies found no or inconsistent associations, but had limited statistical power and short follow-up. In this large prospective cohort study, our aim was to estimate the effect of RF-EMF from mobile phone use on different sleep outcomes.

Materials and methods The study included Swedish (n = 21,049) and Finnish (n = 3120) participants enrolled in the Cohort Study of Mobile Phone Use and Health (COSMOS) with information about operator-recorded mobile phone use at baseline and sleep outcomes both at baseline and at the 4-year follow-up. Sleep disturbance, sleep adequacy, daytime somnolence, sleep latency, and insomnia were assessed using the Medical Outcome Study (MOS) sleep questionnaire.

Results Operator-recorded mobile phone use at baseline was not associated with most of the sleep outcomes. For insomnia, an odds ratio (OR) of 1.24, 95% CI 1.03–1.51 was observed in the highest decile of mobile phone call-time (>258 min/week). With weights assigned to call-time to account for the lower RF-EMF exposure from Universal Mobile Telecommunications Service (UMTS, 3G) than from Global System for Mobile Communications (GSM, 2G) the OR was 1.09 (95% CI 0.89–1.33) in the highest call-time decile.

Conclusion Insomnia was slightly more common among mobile phone users in the highest call-time category, but adjustment for the considerably lower RF-EMF exposure from the UMTS than the GSM network suggests that this association is likely due to other factors associated with mobile phone use than RF-EMF. No association was observed for other sleep outcomes. In conclusion, findings from this study do not support the hypothesis that RF-EMF from mobile phone use has long-term effects on sleep quality.

Open access paper: <https://www.sciencedirect.com/science/article/pii/S0160412019339194>

EXPOSURE TO CELL PHONES REDUCES HEART RATE VARIABILITY IN BOTH NORMAL-WEIGHT AND OBESE NORMOTENSIVE MEDICAL STUDENTS

Alassiri M, Alanazi A, Aldera H, Alqahtani SA, Alraddadi AS, Alberreet MS, Alhussaini AI, Alotaibi Y, Alkhateeb MA, Shatoor AS. 2020 Mar 2. pii: S1550-8307(20)30087-2. doi: 10.1016/j.explore.2020.02.006.

Abstract

BACKGROUND: We investigated and compared the effect of the radiofrequency electromagnetic field (RF-EM) emitted by a cell phone on the electrocardiogram and heart rate variability (HRV) of normotensive normal-weight and obese medical students.

METHOD: Twenty medical student volunteers, normal weight (age = 23 ± 2 , BMI = 23.05 ± 1.72) or obese (age = 24 ± 2 , BMI = 32.39 ± 4.78), were exposed to a cell phone (1) close to the heart in silent mode, no ringing or vibrating; (2) close to the heart in ring and vibration mode; (3) next to the ear (brain) while listening; and (4) next to the ear while listening and speaking.

RESULTS: The average basal HR of obese students significantly increased, while the PR interval; time domains, including standard deviation (SD) of all normal R-R intervals (SDNN), mean of the SD of all normal R-R intervals (SDNNi), SD of the average of normal R-R intervals (SDANN), and percentage of R-R intervals at least 50 ms different from the previous interval (pNN50); and high-power frequency (HF) decreased. The LF/HF ratio also significantly increased. The SDNN, SDNNi, SDANN, pNN50, and HF levels significantly decreased and the LF/HF significantly increased in normal-weight and obese individuals only when the phone was near the apex of the heart in ring and vibration mode. All changes were more profound in obese students.

CONCLUSION: Keeping the phone in a chest pocket reduced the HRV of normal-weight and obese medical students and exaggerated the effect of obesity on sympathetic activation.

<https://www.ncbi.nlm.nih.gov/pubmed/32249199>

THE DIFFERENT SOURCES OF ELECTROMAGNETIC FIELDS: DANGERS ARE NOT LIMITED TO PHYSICAL HEALTH

Deruelle F. The different sources of electromagnetic fields: Dangers are not limited to physical health. *Electromagn Biol Med*. 2020 Mar 10:1-10. doi: 10.1080/15368378.2020.1737811.

Abstract

The impact of electromagnetic waves on health has been clearly established by many studies in recent decades. No State, with the exception of Russia, takes any real precautions in terms of standards for the population.

Conflicts of interest and political lies are used to hide the truth about the dangers of electromagnetic pollution. In addition, it would seem that other sources of radiation than the most well-known ones (mobile phones, digital enhanced cordless telecommunication (DECT) phones, bluetooth, base stations, Wi-Fi, 4G, 5G) come into play. A system such as HAARP (High-frequency Active Auroral Research Program), as well as directed wave beams (related to past and recent scandals) must be analyzed and considered in a comprehensive way to

understand why the wave level is only increasing despite the considerable amount of scientific work demonstrating that the standards are not adequate to maintain public health. Thus, official documents show that the impact of electromagnetic waves is not only physical and biological. Indeed, the climate and the behavior of the population are also targeted.

<https://www.ncbi.nlm.nih.gov.libproxy.berkeley.edu/pubmed/32151189>

Conclusion

Majority of the expert research society has recognized non-thermal EMF effects for long time ago, but the minor group of scientists, which are exclusively appointed by the governmental authorities including European Commission for judgment of EMF health effects, is still of opinion that EMF may be of hazard only at high intensities. Of key importance is to stress that EMF effects depend on a number of physical (carrier frequency, modulation, polarization, stray magnetic fields ...) and biological (sex, age, cell type and density, genotype ...) variables (Belyaev 2010). This dependence can easily account for apparent inconsistency of published results, which in dependence on end-point show effects of low-intensity EMF in 50 – 90% of studies, while lack of EMF effects was observed in other 5 – 10% of studies, which all applied different variables (Huss et al. 2007; IARC 2013; Yakymenko et al. 2016).

There is therefore a clear reason why many States do not take into account the scientific evidence demonstrating the harmfulness of EMFs. Conflicts of interest? Yes, it's obvious. Some authors have already proven this (Carpenter 2013; Hardell 2017; Huss et al. 2007; Maisch 2006; Starkey 2016). While the Precautionary Principle should have been applied for a long time, not only it is not, but worse, the level of electromagnetic radiations is constantly increasing, principally because of RF, aggravating the health situation more and more.

Nevertheless, according to the documents obtained, it would seem that the financial aspect is not the main objective of this technological expansion.

Overall conclusion

It is very clear that States and World Health Organization, through the analytical agencies working for them, are not at all telling the truth about the health effects of electromagnetic fields and the real objectives of such a deployment of connected and wave-generating equipment all over the world.

In most countries, EMFs exposure standards are highly hazardous to health. In addition, the combination of wave-generating technologies and devices, as well as pro-wave legal laws, add up quickly and without prior health checks (example of 5G).

Faced with this, thousands of publications, hundreds of scientists and specialists, show that human health and the environment are in danger because of EMFs. While the precautionary principle should have been established a long time ago, the opposite is being put in place. The sole explanation of conflicts of interest, which have been demonstrated for a long time, does not appear to be sufficient.

Indeed, we can see that in the background (mainly military) have been conducted for years

(just after the Second World War) a considerable amount of experimentation on a very large scale, particularly oriented on mind control as well as more recently on climate change. Many States, but also the United Nations, are aware of the reality of the problem related to the electromagnetic waves and have no decision-making power that is beneficial to health. It would seem that the deleterious impact of EMFs on biology is a side effect (useful for lobbies) of the real goal pursued, which would rather be oriented towards an attempt to control behaviour and climate.

EFFECTS OF MOBILE PHONES ELECTROMAGNETIC RADIATION ON PATIENTS WITH EPILEPSY: AN EEG STUDY

Azmy R, Reham S, Abdalla Farag NA, Elkholy S, Maher E. Egyptian Journal of Neurology Psychiatry and Neurosurgery. 56(1):36. Mar 16, 2020.

Background Recently, an exceptional increase was witnessed in cell phone users. The brain has greater exposure to the electromagnetic field (EMF) created during mobile phone use than the rest of the body, which may impair its function. In persons with epilepsy, the brain has more tendencies towards electrical instability.

Objectives The current study aims at investigating the effect of mobile phone radiation (MPR) on the electroencephalogram (EEG) of persons with epilepsy as well as healthy adults.

Subjects and methods Thirty patients with idiopathic epilepsy and 30 matching controls underwent EEG recording including 15 min of sham exposure followed by 30 min of real exposure to MPR and a final post-exposure recording for extra 15 min. The number of abnormal EEG events was counted during sham and real exposure for each subject. Correlation analysis was done between the number of epileptic events detected during the real exposure to MPR and the patients' clinical data

Results In the control group, the EEG under real MPR exposure showed no abnormal discharges. In persons with epilepsy, all those with abnormal EEG during sham exposure MPR (33%) showed an increase in the number of events with real exposure to MPR. One patient showed a change in the pattern of discharge from interictal changes to an ictal rhythm. Another patient with normal EEG during sham record developed temporal epileptiform discharges during real exposure.

Conclusion Mobile phone radiation shows recognizable effects on the brain rhythm of persons with epilepsy. These results should be confirmed by future studies to establish a recommendation addressing the use of such devices in epileptic patients.

Open access paper: <https://ejnnpn.springeropen.com/track/pdf/10.1186/s41983-020-00167-2>

GEOREFERENCING OF PERSONAL EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS FROM WI-FI IN A UNIVERSITY AREA

Ramirez-Vazquez R, Arabasi S, Al-Taani H, Sbeih S, Gonzalez-Rubio J, Escobar I, Arribas E. 2020 Mar 14;17(6). pii: E1898. doi: 10.3390/ijerph17061898.

Abstract

In the last two decades, due to the development of the information society, the massive increase in the use of information technologies, including the connection and communication of multiple electronic devices, highlighting Wi-Fi networks, as well as the emerging technological advances of 4G and 5G (new-generation mobile phones that will use 5G), have caused a significant increase in the personal exposure to Radiofrequency Electromagnetic Fields (RF-EMF), and as a consequence, increasing discussions about the possible adverse health effects. The main objective of this study was to measure the personal exposure to radiofrequency electromagnetic fields from the Wi-Fi in the university area of German Jordanian University (GJU) and prepare georeferenced maps of the registered intensity levels and to compare them with the basic international restrictions. Spot measurements were made outside the university area at German Jordanian University.

Measurements were made in the whole university area and around two buildings. Two Satimo EME SPY 140 (Brest, France) personal exposimeters were used, and the measurements were performed in the morning and afternoon, and on weekends and weekdays. The total average personal exposure to RF-EMF from the Wi-Fi band registered in the three study areas and in the four days measured was 28.82 $\mu\text{W}/\text{m}^2$. The average total exposure from the Wi-Fi band registered in the ten measured points of the university area of GJU was 22.97 $\mu\text{W}/\text{m}^2$, the one registered in the eight measured points of building H was 34.48 $\mu\text{W}/\text{m}^2$, and the one registered in the eight points of building C was 29.00 $\mu\text{W}/\text{m}^2$. The maximum average values registered in the campus of GJU are below the guidelines allowed by International Commission on Non-ionizing Radiation Protection (ICNIRP). The measurement protocol used in this work has been applied in measurements already carried out in Spain and Mexico, and it is applicable in university areas of other countries.

Open access paper: <https://www.mdpi.com/1660-4601/17/6/1898>

ENVIRONMENTAL AND OCCUPATIONAL RISK FACTORS OF AMYOTROPHIC LATERAL SCLEROSIS: A POPULATION-BASED CASE- CONTROL STUDY

Filippini T, Tesaro M, Fiore M, Malagoli C, Consonni M, et al. 2020 Apr 22;17(8):E2882; doi: 10.3390/ijerph17082882.

Abstract

Objectives: Amyotrophic lateral sclerosis (ALS) is a progressive and fatal neurodegenerative disease with still unknown etiology. We aimed at investigating the association between environmental and occupational factors with ALS risk.

Methods: We performed a population-based case-control study in four Italian provinces (Catania, Modena, Novara, and Reggio Emilia) by administration of tailored questionnaires to ALS cases (n = 95) and randomly selected population referents (n = 135). We estimated ALS risk by calculating the odds ratio (OR) with its 95% confidence interval (CI) using an unconditional logistic regression model.

Results: We found a positive association with disease risk for history of occupation in the agricultural sector (OR= 2.09, 95% CI 0.79-7.54), especially for longer than 10 years (OR = 2.72, 95% 1.02-7.20). Overall occupational exposure to solvents also suggested a positive association, especially for thinners (OR = 2.27, 95% CI 1.14-4.54) and paint removers (OR = 2.01, 95% CI 0.90-4.48). Both occupational and environmental exposure to electromagnetic fields show a slightly increased risk with OR = 1.69 (95% CI 0.70-4.09) and 2.41 (95% CI 1.13-5.12), respectively. Occupational but not environmental exposure to pesticides (OR = 1.22, 95% CI 0.63-2.37), particularly fungicides, and exposure to metals (OR = 4.20, 95% CI 1.88-9.38), particularly lead, mercury, and selenium, showed an imprecise but positive association. Finally, there was an indication of increased risk for living in proximity to water bodies.

Conclusions: Despite the caution that needs to be used due to some study limitations, such as the low number of exposed subjects and the possibility of recall bias, these results suggest the potential role of some environmental and occupational factors in ALS etiology.

Open access paper: <https://www.mdpi.com/1660-4601/17/8/2882>

THE INFLUENCE OF ELECTROMAGNETIC RADIATION OF CELL PHONES ON THE BEHAVIOR OF ANIMALS

Sultangaliyeva I, Beisenova R, Tazitdinova R, Abzhalelov A, Khanturin M. The influence of electromagnetic radiation of cell phones on the behavior of animals. *Veterinary World*, 13(3):549-555. March 2020. DOI: 10.14202/vetworld.2020.549-555.

Abstract

Background and Aim: The radiation emitted from cell phones has various deleterious effects on human health. The article considers the problem of the effects of electromagnetic radiation (EMR) of cell phones on the behavior of animals. The use of mobile phones is continually increasing throughout the world. All of the world population uses mobile phones widely; thus, having strong and daily effect on the brain. There is no restriction on the use of mobile phones. Getting more advantages and convenience of mobile communication, the population is trying not to hear the information about possible risks to their health, there is no element of self-restraint. The aim of this work was to study behavioral patterns in response to the influence of cell phones.

Materials and Methods: The experiments were carried out on 90 white outbred rats weighing 250-300 g. Experiments were carried out and the effect of EMR from Samsung Galaxy J1 mini and Xiaomi Redmi S2 phones on animal behavior was studied. Behavioral reactions were studied using the open field method.

Results: By the quality of the act of locomotion in the second experimental group is reduced by 30% and also in this group by the time of the act is 23% lower than in the control data. Vertical motor activity, a support stand, is also suppressed in the second experimental group: 61% lower in number and 47.2% lower in act time compared to the control group. Based on the data, we can conclude that the EMR of the phone Samsung Galaxy J1 Mini affects the behavior of animals to a greater extent than Xiaomi Redmi S2. By the frequency of the act, sniffing is 26% lower; by the time of the act, it remained at the level of control data in the second group. In the third group of the animals, the number and time of the act are 15% lower than the control data. The support stands as an indicator of research activity. In the second

group the act of stand with support - by number was lower by 57% than the control data, this indicates that research activity is being suppressed.

Conclusion: According to the above changes under the action of EMR from the Samsung Galaxy J1 Mini and Xiaomi Redmi S2 phones, the motor component of behavior is suppressed. The research component of behavior in all groups of animals is enhanced due to high rates of sniffing. It is possible that in animals under stress, the motivation to interact with the environment decreases, leading to an excessive self-accentuation of the animal.

Open access paper: <http://www.veterinaryworld.org/Vol.13/March-2020/23.pdf>

Physical assessments of termites (Termitidae) under 2.45 GHz microwave irradiation

Yanagawa A, Kajiwar A, Nakajima H, Desmond-Le Quéméner E, Steyer JP, Lewis V, Mitani T. Sci Rep. 2020 Mar 23;10(1):5197. doi: 10.1038/s41598-020-61902-6.

Abstract

Demands for chemical-free treatments for controlling insect pests are increasing worldwide. One such treatment is microwave heating; however, two critical issues arise when using microwaves as a heat source: intensive labor and excessive energy-consumption. Optimization is thus required to reduce energy consumption while effectively killing insects. Currently, the lethal effect of microwaves on insects is considered to be due to the temperature of the irradiated materials. This study examines how the conditions of irradiation, such as resonance or traveling mode, changed the conversion of electromagnetic energy into heat when 2.45 GHz microwaves penetrated the body of the termite, *C. formosanus*. Our results indicated that it is possible to heat and kill termites with microwaves under resonance condition. Termites were however found to be very tolerant to microwave irradiation as the permittivity of the insect was low compared with other reported insects and plants. Electron spin resonance revealed that termites contained several paramagnetic substances in their bodies, such as Fe³⁺, Cu²⁺, Mn²⁺, and organic radicals. Interestingly, irradiation with traveling microwaves hardly produced heat, but increased the organic radicals in termite bodies indicating non-thermal effects of microwaves.

<https://www.ncbi.nlm.nih.gov/pubmed/32251346>

CLINICAL PRESENTATION OF YOUNG PEOPLE (10-24 YEARS OLD) WITH BRAIN TUMORS: RESULTS FROM THE INTERNATIONAL MOBI-KIDS STUDY

Zumel-Marne A, Kundi M, Castaño-Vinyals G, Alguacil J, Petridou ET, et al. J Neurooncol. 2020 Mar 3. doi: 10.1007/s11060-020-03437-4.

Abstract

INTRODUCTION: We used data from MOBI-Kids, a 14-country international collaborative case-control study of brain tumors (BTs), to study clinical characteristics of the tumors in older children (10 years or older), adolescents and young adults (up to the age of 24).

METHODS: Information from clinical records was obtained for 899 BT cases, including signs and symptoms, symptom onset, diagnosis date, tumor type and location.

RESULTS: Overall, 64% of all tumors were low-grade, 76% were neuroepithelial tumors and 62% gliomas. There were more males than females among neuroepithelial and embryonal tumor cases, but more females with meningeal tumors. The most frequent locations were cerebellum (22%) and frontal (16%) lobe. The most frequent symptom was headaches (60%), overall, as well as for gliomas, embryonal and 'non-neuroepithelial' tumors; it was convulsions/seizures for neuroepithelial tumors other than glioma, and visual signs and symptoms for meningiomas. A cluster analysis showed that headaches and nausea/vomiting was the only combination of symptoms that exceeded a cutoff of 50%, with a joint occurrence of 67%. Overall, the median time from first symptom to diagnosis was 1.42 months (IQR 0.53-4.80); it exceeded 1 year in 12% of cases, though no particular symptom was associated with exceptionally long or short delays.

CONCLUSIONS: This is the largest clinical epidemiology study of BT in young people conducted so far. Many signs and symptoms were identified, dominated by headaches and nausea/vomiting. Diagnosis was generally rapid but in 12% diagnostic delay exceeded 1 year with none of the symptoms been associated with a distinctly long time until diagnosis.

<https://www.ncbi.nlm.nih.gov/pubmed/32124185>

IMPACTS OF ELECTROMAGNETIC RADIATION FROM CELLPHONES AND WI-FI ON SPERMATOGENESIS [ARTICLE IN CHINESE]

Zha XD, Wang WW, Xu S, Shang XJ. Zhonghua Nan Ke Xue. 2019 May;25(5):451-455.

Abstract

With the development of Wi-Fi technology and widespread exposure to electromagnetic radiation (EMR), people are increasingly concerned about the health hazards caused by radiofrequency electromagnetic fields as from cellphones and Wi-Fi, particularly about the current decline in sperm concentration and increase in male infertility. Long-term exposure to EMR not only damages male reproductive organs, but also affects the number, morphology, motility and oocyte-binding ability of sperm, and indirectly increases the risk of infertility. However, EMR is not unavoidable. Low-intensity short-term or intermittent exposure to EMR has little adverse effect on reproductive organs and sperm. And many antioxidant and anti-free radical agents, such as vitamin E and melatonin, can protect some special populations from EMR. This review presents an overview of the impacts of EMR from cellphones and Wi-Fi on sperm, some countermeasures, and prospects of EMR protection.

<https://www.ncbi.nlm.nih.gov/pubmed/32216233>

A REVIEW ON COMBINED BIOLOGICAL EFFECTS OF MICROWAVE AND OTHER PHYSICAL OR CHEMICAL AGENTS

Tan S, Tan H, Wang R, Peng R. A review on combined biological effects of microwave and other physical or chemical agents, *Int. J. Radiat. Res.* 2018; 16 (2): 139-153.

Abstract

With the development of science and technology, microwave has been used in many fields such as industry, military, medicine and communication. People are living in a lapped and dynamic electromagnetic environment. Concerns about potential hazards of microwave are getting increasing attention. The single biological effects of microwave were widely discussed which was considered harmful. Relevant safety standards had been formulated and applied. However, the real environment was more complex. Microwave was not the only factor that organisms might be affected. Other physical or chemical factors, such as ionizing radiation [IR] , ultraviolet [UV] , magnetic field and chemical drugs, often existed with the microwave radiation. Even the microwave itself could create combined exposure situation, because the environment consisted different frequency microwaves. Nuclear weapons and high-power radar could produce microwave and ionizing radiation. The ultraviolet ray and magnetic field generated by the instrument's operation could act on the human bodies along with the microwaves. The combination of radiofrequency therapy and chemotherapeutic agents was also commonly used in cancer therapy. Therefore, the combined biological effects of microwaves and other physical or chemical factors were very important. This review had covered the original articles in this aspect. In order to better understand the combined biological effects the comparative studies of different frequency microwaves were also included. Differences in biological effects were found among different frequency microwaves, and the combined biological effects contained both hazards and benefits. Findings in combined biological effects were very practical for rational uses of microwave technologies.

Excerpt

In summary, the studies of combined biological effects of microwave and multiple factors were focused on several aspects, such as multiple frequencies microwave, microwave and IR, microwave and magnetic field, microwave and UV, microwave and drugs. By now, most studies had confirmed the existence of combined biological effects, but failed to draw firm and unanimous conclusions. There were still many unsolved problems:

- 1) The experimental conditions in different papers were different, which made the results to be incomparable;
- 2) The research remained in exploration of existence of combined effects, there were blanks in dose-effect relationship research as well as mechanism research;
- 3) Many signaling pathways and molecules had been confirmed to participate in the injury process, but no sensitive biological indicators were found; 4. The diagnosis and protective measures for combined effects was incomplete.

In short, lots of beneficial explorations had been performed for combined biological effects of MW and multi- factors, but lots of effort still should be made in this field.

Open access paper: <http://ijrr.com/article-1-2244-en.pdf>

EFFECTS OF A SINGLE HEAD EXPOSURE TO GSM-1800 MHZ SIGNALS ON THE TRANSCRIPTOME PROFILE IN THE RAT CEREBRAL CORTEX: ENHANCED GENE RESPONSES UNDER PROINFLAMMATORY CONDITIONS

Lameth J, Arnaud-Cormos D, Lévêque P, Boillée S, Edeline JM, Mallat M. *Neurotox Res.* 2020 Mar 21. doi: 10.1007/s12640-020-00191-3.

Abstract

Mobile communications are propagated by electromagnetic fields (EMFs), and since the 1990s, they operate with pulse-modulated signals such as the GSM-1800 MHz. The biological effects of GSM-EMF in humans affected by neuropathological processes remain seldom investigated. In this study, a 2-h head-only exposure to GSM- 1800 MHz was applied to (i) rats undergoing an acute neuroinflammation triggered by a lipopolysaccharide (LPS) treatment, (ii) age-matched healthy rats, or (iii) transgenic hSOD1G93A rats that modeled a presymptomatic phase of human amyotrophic lateral sclerosis (ALS). Gene responses were assessed 24 h after the GSM head- only exposure in a motor area of the cerebral cortex (mCx) where the mean specific absorption rate (SAR) was estimated to be 3.22 W/kg. In LPS-treated rats, a genome-wide mRNA profiling was performed by RNA-seq analysis and revealed significant (adjusted p value < 0.05) but moderate (fold changes < 2) upregulations or downregulations affecting 2.7% of the expressed genes, including genes expressed predominantly in neuronal or in glial cell types and groups of genes involved in protein ubiquitination or dephosphorylation. Reverse transcription-quantitative PCR analyses confirmed gene modulations uncovered by RNA-seq data and showed that in a set of 15 PCR-assessed genes, significant gene responses to GSM-1800 MHz depended upon the acute neuroinflammatory state triggered in LPS-treated rats, because they were not observed in healthy or in hSOD1G93A rats. Together, our data specify the extent of cortical gene modulations triggered by GSM-EMF in the course of an acute neuroinflammation and indicate that GSM-induced gene responses can differ according to pathologies affecting the CNS.

<https://www.ncbi.nlm.nih.gov/pubmed/32200527>

EFFECT OF MOBILE PHONE RADIATION ON OXIDATIVE STRESS, INFLAMMATORY RESPONSE, AND CONTEXTUAL FEAR MEMORY IN WISTAR RAT

Singh KV, Gautam R, Meena R, Nirala JP, Jha SK, Rajamani P. Effect of mobile phone radiation on oxidative stress, inflammatory response, and contextual fear memory in Wistar rat. *Environ Sci Pollut Res Int.* 2020 Mar 24. doi: 10.1007/s11356-020-07916-z.

Abstract

In the present lifestyle, we are continuously exposed to radiofrequency electromagnetic field (RF-EMF) radiation generated mainly by mobile phones (MP). Among other organs, our brain and hippocampus in specific, is the region where effect of any environmental perturbation is most pronounced. So, this study was aimed to examine changes in major parameters (oxidative stress, level of pro-inflammatory cytokines (PICs), hypothalamic-pituitary-adrenal (HPA) axis hormones, and contextual fear conditioning) which are linked to hippocampus directly or indirectly, upon exposure to mobile phone radiofrequency electromagnetic field (MP- RF-EMF) radiation. Exposure was performed on young adult male Wistar rats for 16 weeks continuously (2 h/day) with MP-RF-EMF radiation having frequency, power density, and specific absorption rate (SAR) of 1966.1 MHz, 4.0 mW/cm², and 0.36 W/kg, respectively. Another set of animals kept in similar conditions without any radiation exposure serves as

control. Towards the end of exposure period, animals were tested for fear memory and then euthanized to measure hippocampal oxidative stress, level of circulatory PICs, and stress hormones.

We observed significant increase in hippocampal oxidative stress ($p < 0.05$) and elevated level of circulatory PICs viz. IL-1 β ($p < 0.01$), IL-6 ($p < 0.05$), and TNF- α ($p < 0.001$) in experimental animals upon exposure to MP- RF-EMF radiation. Adrenal gland weight ($p < 0.001$) and level of stress hormones viz. adrenocorticotrophic hormone (ACTH) ($p < 0.01$) and corticosterone (CORT) ($p < 0.05$) were also found to increase significantly in MP- RF-EMF radiation-exposed animals as compared with control. However, alteration in contextual fear memory was not significant enough. In conclusion, current study shows that chronic exposure to MP-RF-EMF radiation emitted from mobile phones may induce oxidative stress, inflammatory response, and HPA axis deregulation.

However, changes in hippocampal functionality depend on the complex interplay of several opposing factors that got affected upon MP-RF-EMF exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/32212071>

EFFECT OF ELECTROMAGNETIC RADIATION ON REDOX STATUS, ACETYLCHOLINE ESTERASE ACTIVITY AND CELLULAR DAMAGE CONTRIBUTING TO THE DIMINUTION OF THE BRAIN WORKING MEMORY IN RATS

Sharma S, Shukla S. Effect of electromagnetic radiation on redox status, acetylcholine esterase activity and cellular damage contributing to the diminution of the brain working memory in rats. J Chem Neuroanat. 2020 Mar 20:101784. doi: 10.1016/j.jchemneu.2020.101784.

Abstract

Behavioral impairments are the most pragmatic outcome of long-term mobile uses but the underlying causes are still poorly understood. Therefore, the Aim of the present study to determine the possible mechanism of mobile induced behavioral alterations by observing redox status, cholinesterase activity, cellular, genotoxic damage and cognitive alterations in rat hippocampus. This study was carried out on 24 male Wistar rats, randomly divided into four groups ($n = 6$ in each group): group I consisted of sham-exposed (control) rats, group II-IV consisted of rats exposed to microwave radiation (900 MHz) at different time duration 1 h, 2 h, and 4 h respectively for 90 days. After 90 days of exposure, rats were assessing learning ability by using T-Maze. A significantly increased level of malondialdehyde (MDA) with concomitantly depleted levels of superoxide dismutase (SOD), catalase (CAT) and redox enzymes (GSH, GPX, GR, GST, G-6PDH) indicated an exposure of mobile emitted EMR induced oxidative stress by the depleted redox status of brain cells. The depletion in the acetylcholinesterase (AChE) level reveals altered neurotransmission in brain cells. Resultant cellular degeneration was also observed in the radiation-exposed hippocampus. Conclusively, the present study revealed that microwave radiation induces oxidative stress, depleted redox status, and causes DNA damage with the subsequent reduction in working memory in a time-dependent manner. This study provides insight over the associative reciprocity between redox status, cellular degeneration and reduced cholinergic activity, which presumably leads to the behavioral alterations following mobile emitted electromagnetic radiation.

<https://www.ncbi.nlm.nih.gov/pubmed/32205214>

ASSESSMENT OF ELECTROMAGNETIC FIELDS, VIBRATION AND SOUND EXPOSURE EFFECTS FROM MULTIPLE TRANSCEIVER MOBILE PHONES ON OXIDATIVE STRESS LEVELS IN SERUM, BRAIN AND HEART TISSUE

Usman JD, Isyaku UM, Rabiou AM, Fasanmade AA. Assessment of electromagnetic fields, vibration and sound exposure effects from multiple transceiver mobile phones on oxidative stress levels in serum, brain and heart tissue. *Scientific African*. Vol 7. March 2020.

<https://doi.org/10.1016/j.sciaf.2020.e00271>.

Abstract

The present study evaluates oxidative stress markers in serum, brain and heart of albino Wistar rats after exposure to multiple transceiver mobile phone electromagnetic radiation, vibration and sound. Forty five (45) male albino Wistar rats weighing 140–180 g were randomly selected into nine groups (n = 5) viz; A serving as the control without mobile phone; groups B1, B2...E1, E2 were continuously exposed to electromagnetic field from double (1) and triple (2) transceiver mobile phone kept in various modalities with at least 10 min call per day within 9:00–21:00 h. Groups B1 and B2 were in silence mode, C1 and C2 in vibration, D1 and D2 in ring tone (sound), while E1 and E2 were in sound and vibration mode. After six weeks of exposure, the animals were sacrificed; serum, brain and heart were taken for oxidative stress assessment. Results showed that electromagnetic field radiation, vibration and sound from double and triple transceiver mobile phone cause decrease in the levels of glutathione peroxidase, superoxide dismutase, and malondialdehyde in the serum, heart and the brain. Catalase was observed to decrease only in the brain. Nitric oxide activities increased in the brain and heart of the treatment groups exposed to both phone types. Exposure to double or triple transceiver mobile phone radiation, vibration and sound causes oxidative stress to serum, brain and the heart.

Open access paper: <https://www.sciencedirect.com/science/article/pii/S2468227620300090>

ASSESSMENT OF GENOTOXICITY IN HUMAN CELLS EXPOSED TO MODULATED ELECTROMAGNETIC FIELDS OF WIRELESS COMMUNICATION DEVICES

Schuermann D, Ziemann C, Barekati Z, Capstick M, Oertel A, Focke F, Murbach M, Kuster N, Dasenbrock C, Schär P. *Genes* (Basel). 2020 Mar 25;11(4). pii: E347. doi: 10.3390/genes11040347.

Abstract

Modulated electromagnetic fields (wEMFs), as generated by modern communication technologies, have raised concerns about adverse health effects. The International Agency for Research on Cancer (IARC) classifies them as "possibly carcinogenic to humans" (Group 2B), yet, the underlying molecular mechanisms initiating and promoting tumorigenesis remain elusive. Here, we comprehensively assess the impact of technologically relevant wEMF modulations on the genome integrity of cultured human cells, investigating cell type-specificities as well as time- and dose-dependencies. Classical and advanced methodologies of genetic toxicology and DNA repair were applied, and key experiments were performed in two separate laboratories. Overall, we found no conclusive evidence for an induction of DNA damage nor for alterations of the DNA repair capacity in cells exposed to several wEMF modulations (i.e., GSM, UMTS, WiFi, and RFID). Previously reported observations of increased DNA damage after exposure of cells to GSM-modulated signals could not be reproduced.

Experimental variables, presumably underlying the discrepant observations, were investigated and are discussed. On the basis of our data, we conclude that the possible carcinogenicity of wEMF modulations cannot be explained by an effect on genome integrity through direct DNA damage. However, we cannot exclude non-genotoxic, indirect, or secondary effects of wEMF exposure that may promote tumorigenesis in other ways.

Conclusions

We investigated the genotoxic potential of modulated RF-EMF as used in wireless technology (UMTS, GSM, WiFi, and RFID) on cultured human cells. Classical and advanced genotoxicity testing and DNA repair assessment produced no conclusive evidence for a disturbance of DNA integrity or changes in the DNA repair capacity, following wEMF exposure. These overall negative results are in contrast to some previously reported positive findings. Investigating the underlying reasons for this discrepancy, we identified cell culture conditions and the CA methodology as likely relevant variables. In some experiments with UMTS exposure, we noticed small tendencies for wEMF exposure-associated changes in DNA damage levels and repair dynamics. In the absence of evidence for a direct DNA-damaging potential of wEMF, we interpret these to possibly be caused by an unspecific wEMF-induced cellular stress response. The nature of such an interaction between wEMF and cellular physiology, however, remains unclear and needs to be further investigated.

Open access paper: <https://www.mdpi.com/2073-4425/11/4/347>

THE EFFECT OF VITAMIN E AND C ON COMET ASSAY INDICES AND APOPTOSIS IN POWER PLANT WORKERS: A DOUBLE BLIND RANDOMIZED CONTROLLED CLINICAL TRIAL Mutat Res. 2020 Feb - Mar;850-851:503150. doi:10.1016/j.mrgentox.2020.503150.

Abstract

Extremely low frequency electromagnetic fields have been classified as a possible human carcinogen by the International Agency for Research on Cancer and this has raised some concern about its health effects on employees extensively exposed to these fields at thermal power plants. In this study, the effect of using vitamin E and C supplements have been examined on employees working at a thermal power plant. In this randomized controlled, double-blind clinical trial, 81 employees from different parts of the thermal power plant were enrolled between July and November 2017, and divided into four groups: Group 1 received vitamin E (400 units/day), Group 2: vitamin C (1000 mg/day), Group 3: vitamin E + C and Group 4: no intervention. DNA damage was measured in peripheral blood lymphocytes using comet assay and apoptosis, using flow cytometry. Based on the results, tail intensity and tail length in the vitamin E group, and all comet assay indices in the vitamin E + C and vitamin C groups (except DNA damage index) significantly decreased after the intervention, while the comet assay indices did not change significantly in the control group. None of the flow cytometry indices including early apoptosis, late apoptosis and necrosis changed after intervention in either group. The use of antioxidant vitamins such as E and C, can increase the activity of the non-enzymatic antioxidant defense system, and protect DNA from damage caused by exposure to extremely low frequency magnetic fields. But, taking these vitamins has no effect on apoptosis. It seems that consumption of vitamin E affected all investigated comet assay indices and can be probably considered as the best intervention.

<https://www.ncbi.nlm.nih.gov/pubmed/32247559>

EFFECT OF A 50-HZ ELECTROMAGNETIC FIELD AT 500 MT ON PARAMETERS RELATED WITH THE CARDIOVASCULAR SYSTEM IN RATS

Zhang Y, Li L, Liu X, Ding L, Wu X, et al. Examination of the Effect of a 50-Hz Front Public Health. 2020 Apr 7;8:87. doi: 10.3389/fpubh.2020.00087.

Abstract

Background: Whether electromagnetic field (EMF) exposure affects the function of the cardiovascular system is under debate. The present study aimed to investigate the effects of 500 μ T EMF exposure on the cardiovascular system in rats.

Methods: Forty-eight-week-old male Sprague-Dawley rats were randomly divided into two groups: the sham group and the exposure group. During 24-week EMF exposure (20 h per day), the blood pressure and pulse rate were recorded every 4 weeks. Before sacrifice, electrocardiography, echocardiography, and cardiac catheterization analysis were conducted to evaluate the cardiac function. Meanwhile, hematoxylin-eosin (HE) staining, Western blot, and real-time polymerase chain reaction (PCR) were performed to identify morphological and molecular changes indicative of cardiac remodeling.

Results: The heart rate, blood pressure, and pulse rate were not influenced by EMF exposure compared with the control group. In addition, HE staining showed no change in the morphology and arrangement of cardiomyocytes. Further, we found that the mRNA and protein levels of cardiac hypertrophy-related genes were not affected by EMF exposure. Finally, no significant difference was observed in cardiac function between the two groups by echocardiography and cardiac catheterization detection.

Conclusion: The 24-week exposure to EMF at 500 μ T did not have apparent effects on the cardiovascular system in rats, at least for the variables studied.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7154052/>

EFFECT OF STATIC MAGNETIC FIELD ON DNA SYNTHESIS: THE INTERPLAY BETWEEN DNA CHIRALITY AND MAGNETIC FIELD LEFT- RIGHT ASYMMETRY.

Yang X, Li Z, Polyakova T, Dejneka A, Zablotskii V, Zhang X. FASEB Bioadv. 2020 Mar 7;2(4):254-263. doi: 10.1096/fba.2019-00045.

Abstract

Interactions between magnetic fields (MFs) and living cells may stimulate a large variety of cellular responses to a MF, while the underlying intracellular mechanisms still remain a great puzzle. On a fundamental level, the MF - cell interaction is affected by the two broken symmetries: (a) left-right (LR) asymmetry of the MF and (b) chirality of DNA molecules carrying electric charges and subjected to the Lorentz force when moving in a MF. Here we report on the chirality-driven effect of static magnetic fields (SMFs) on DNA synthesis. This newly discovered effect reveals how the interplay between two fundamental features of symmetry in living and inanimate nature-DNA chirality and the inherent features of MFs to distinguish the left and right-manifests itself in different DNA synthesis rates in the upward and downward SMFs, consequently resulting in unequal cell proliferation for the two

directions of the field. The interplay between DNA chirality and MF LR asymmetry will provide fundamental knowledge for many MF-induced biological phenotypes.

Open access paper: <https://www.ncbi.nlm.nih.gov/pubmed/32259051>

CHANGE IN GEOMAGNETIC FIELD INTENSITY ALTERS MIGRATION-ASSOCIATED TRAITS IN A MIGRATORY INSECT

Wan G, Liu R, Li C, He J, Pan W, et al. Change in Geomagnetic Field Intensity Alters Migration-Associated Traits in a Migratory Insect. *Biol Lett.* 2020 Apr;16(4):20190940. 10.1098/rsbl.2019.0940. DOI: 10.1098/rsbl.2019.0940.

Abstract

Geomagnetic field (GMF) intensity can be used by some animals to determine their position during migration. However, its role, if any, in mediating other migration-related phenotypes remains largely unknown. Here, we simulated variation in GMF intensity between two locations along the migration route of a nocturnal insect migrant, the brown planthopper *Nilaparvata lugens*, that varied by approximately 5 μ T in field intensity. After one generation of exposure, we tested for changes in key morphological, behavioural and physiological traits related to migratory performance, including wing dimorphism, flight capacity and positive phototaxis. Our results showed that all three morphological and behavioural phenotypes responded to a small difference in magnetic field intensity. Consistent magnetic responses in the expression of the phototaxis-related *Drosophila*-like cryptochrome 1 (Cry1) gene and levels of two primary energy substrates used during flight, triglyceride and trehalose, were also found. Our findings indicate changes in GMF intensity can alter the expression of phenotypes critical for insect migration and highlight the unique role of magnetoreception as a trait that may help migratory insects express potentially beneficial phenotypes in geographically variable environments.

<https://pubmed.ncbi.nlm.nih.gov/32343935/>

GUIDELINES FOR LIMITING EXPOSURE TO ELECTROMAGNETIC FIELDS (100 KHZ TO 300 GHZ)

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Special Submission: March 11, 2020. DOI: 10.1097/HP.0000000000001210.

Abstract

Radiofrequency electromagnetic fields (EMFs) are used to enable a number of modern devices, including mobile telecommunications infrastructure and phones, Wi-Fi, and Bluetooth. As radiofrequency EMFs at sufficiently high power levels can adversely affect health, ICNIRP published Guidelines in 1998 for human exposure to time-varying EMFs up to 300 GHz, which included the radiofrequency EMF spectrum. Since that time, there has been a considerable body of science further addressing the relation between radiofrequency EMFs and adverse health outcomes, as well as significant developments in the technologies that use radiofrequency EMFs. Accordingly, ICNIRP has updated the radiofrequency EMF part of the 1998 Guidelines. This document presents these revised Guidelines, which provide protection for humans from exposure to EMFs from 100 kHz to 300 GHz.

Open access paper: <https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf>

FOR A DISCUSSION OF THE PROBLEMS WITH THESE GUIDELINES SEE: ICNIRP'S EXPOSURE GUIDELINES FOR RADIO FREQUENCY FIELDS ADVERSE EFFECTS OF WIRELESS RADIATION

Kostoff RN. Monograph. Adverse Effects of Wireless Radiation. School of Public Policy, Georgia Institute of Technology. 648 page monograph. 2019.

Abstract

This monograph identifies adverse effects of wireless radiation as reported in the premier biomedical literature. It shows that most of the laboratory experiments that have been performed are not designed to elicit the more severe adverse effects reflective of the real-life operating environment in which wireless radiation is embedded. The monograph includes a substantial bibliography of papers that present these adverse effects, and shows that what has been reported is the tip of the iceberg of the full spectrum of potential adverse effects from wireless radiation.

Open access paper: <http://hdl.handle.net/1853/61946>.

ELECTROHYPERSENSITIVITY AS A NEWLY IDENTIFIED AND CHARACTERIZED NEUROLOGIC PATHOLOGICAL DISORDER: HOW TO DIAGNOSE, TREAT, AND PREVENT IT

Belpomme D, Irigaray P. Electrohypersensitivity as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It. *Int J Mol Sci*. 2020 Mar 11;21(6). pii: E1915. doi: 10.3390/ijms21061915.

Abstract

Since 2009, we built up a database which presently includes more than 2000 electrohypersensitivity (EHS) and/or multiple chemical sensitivity (MCS) self-reported cases. This database shows that EHS is associated in 30% of the cases with MCS, and that MCS precedes the occurrence of EHS in 37% of these EHS/MCS-associated cases. EHS and MCS can be characterized clinically by a similar symptomatic picture, and biologically by low-grade inflammation and an autoimmune response involving autoantibodies against O-myelin. Moreover, 80% of the patients with EHS present with one, two, or three detectable oxidative stress biomarkers in their peripheral blood, meaning that overall these patients present with a true objective somatic disorder. Moreover, by using ultrasonic cerebral tomosphygmography and transcranial Doppler ultrasonography, we showed that cases have a defect in the middle cerebral artery hemodynamics, and we localized a tissue pulsometric index deficiency in the capsulo-thalamic area of the temporal lobes, suggesting the involvement of the limbic system and the thalamus. Altogether, these data strongly suggest that EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented. Because EHS is becoming a new insidious worldwide plague involving millions of people, we ask the World Health Organization (WHO) to include EHS as a neurologic disorder in the international classification of diseases.

Conclusions

In summary, we showed that there are presently sufficient clinical, biological, and radiological data for EHS to be acknowledged as a well-defined, objectively identified, and characterized pathological neurologic disorder. As a result, patients who self-report they suffer from EHS should be diagnosed and treated on the basis of presently available biological tests, including the detection of peripheral blood and urine biomarkers and the use of imaging techniques such as fMRI, TDU, and, when possible, UCTS. Moreover, because we showed for the first

time that EHS is frequently associated with MCS and that both clinico-biological entities may be associated with a common physiopathological mechanism for genesis, it clearly appears that they can be identified as a unique neurologic pathological syndrome whatever their causal origin. Moreover; as it was shown that MCS genesis may be attributed to toxic chemical exposure, and EHS genesis to potentially excessive EMF and/or chemical exposure; protective measures against these two environmental stressors should be taken. Whatever its causal origin and mechanism of action, EHS should therefore be from now on recognized as a new identified and characterized neurological pathological disorder. As it is already a real health plague potentially involving millions of people worldwide it should be acknowledged by WHO, and thus be included in the WHO ICD. As stated during the international scientific consensus meeting on EHS and MCS that we have organized in 2015 in Brussels, scientists unanimously asked WHO to urgently assume its responsibilities, by classifying EHS and MCS as separate codes in the ICD; so as to increase scientific awareness of these two pathological entities in the medical community and the general public, and to foster research and train medical practitioners to efficiently diagnose, treat, and prevent EHS and MCS—which in fact constitute a unique, well-defined, and identifiable new neurologic disease.

Open access paper: <https://www.mdpi.com/1422-0067/21/6/1915>

ADVERSE IMPACTS OF 5G DOWNLINKS ON HUMAN BODY

Nasim I, Kim S. Adverse Impacts of 5G Downlinks on Human Body. 2019 SoutheastCon. Huntsville, AL. 11-14 April 2019. DOI: 10.1109/SoutheastCon42311.2019.9020454

Abstract

The increasing demand for higher data rates and uninterrupted reliable service have made the frequency spectrum above 6 GHz a very promising candidate for future wireless communications because of its massive amount of raw bandwidth and extremely high data transfer capabilities. However, increasing concerns of communications at high frequencies on human health have gained international alarm that suggests more research before it is deployed successfully. In this context, this paper aims to investigate the human electromagnetic field (EMF) exposure from fifth-generation (5G) downlink communications and compare its impacts with the present cellular technologies considering the features that the 5G systems will likely adopt. Our simulation results suggest that while the impacts from 5G beamforming communications cross the regulatory borders at downlinks for a very short range between base stations (BSs) and user equipment (UE), the exposure level remains on a high throughout the entire network compared to the present systems. Also, this paper urges for more research on the exposure level from future communications to determine any possible threats below the existing guidelines. This paper also highlights the significance of considering SAR for the measurement of exposure compliance in downlinks.

Excerpt

... this paper urges the regulatory authorities to set SAR guidelines for 5G systems at far-field exposure also for frequencies above 6 GHz. Also, the minimum AP-UE [access point - user equipment] distance should be maintained at least 6 m [meters] for 5G and further space should be left for a conservative operation regarding human safety.

Conclusions

This paper has highlighted the significance of the human EMF exposure issue in the downlink of a cellular communications system. This paper measured the exposure level in terms of PD and SAR and compared them to those calculated in the 3.9G and 4G specifications. Distinguished from the prior art that studied uplinks only, this paper has found that the downlinks of a 5G can also yield a higher level of emissions in terms of SAR compared to concurrent cellular systems. Our results emphasized that this increase stems from more highly concentrated EMF energy per downlink RF beam due to the use of larger phased arrays within small cells of a 5G network. However, only skin effects are being taken into consideration for simplicity. This paper has also suggested the minimum AP-UE distance for human safety in cellular communications at high frequencies such as 28 GHz. To this end, this paper urges to investigate any possible threats at the exposure level shown in this work for future 5G systems before it is finally globalized.

<https://ieeexplore.ieee.org/document/9020454>

ELECTROMAGNETIC RADIATION DUE TO CELLULAR, WI-FI AND BLUETOOTH TECHNOLOGIES: HOW SAFE ARE WE?

Naren, Elhance A, Chamola V. Guizani M. Electromagnetic Radiation due to Cellular, Wi-Fi and Bluetooth technologies: How safe are we? IEEE Access. 4:1-21. 2019. DOI 10.1109/ACCESS.2020.2976434

Abstract

The electromagnetic radiation (EMR) emitted out of wireless communication modules in various electronic devices have been identified by researchers as biologically hazardous to humans as well as other living beings. Different countries have different regulations to limit the radiation density levels caused by these devices. The radiation absorbed by an individual depends on various factors such as the device they use, the proximity of use, the type of antenna, the relative orientation of the antenna on the device, and many more. Several standards exist which have tried to quantify the radiation levels and come up with safe limits of EMR absorption to prevent human harm. In this work, we determine the radiation concern levels in several scenarios using a handheld radiation meter by correlating the findings with several international standards, which are determined based on thorough scientific evidence. This study also analyzes the EMR from common devices used in day to day life such as smartphones, laptops, Wi-Fi routers, hotspots, wireless earphones, smartwatches, Bluetooth speakers and other wireless accessories using a handheld radio frequency radiation measurement device. The procedure followed in this paper is so presented that it can also be utilized by the general public as a tutorial to evaluate their own safety with respect to EMR exposure. We present a summary of the most prominent health hazards which have been known to occur due to EMR exposure. We also discuss some individual and collective human-centric protective and preventive measures that can be undertaken to reduce the risk of EMR absorption. This paper analyses radiation safety in pre-5G networks and uses the insight gained to raise valuable concerns regarding EMR safety in the upcoming 5G networks.

Conclusions

People should be made aware that the EMR from using day to day cellular, Wi-Fi and Bluetooth devices are harmful to human health. The levels of radiation observed in most cases such as phone calls, internet browsing on laptops and smartphones, using wireless routers and hotspots, Bluetooth smartwatches and smartphones are unsafe when compared with radiations limits determined by medical bodies. According to current medical literature, various adverse health effects from exposure to RF EMR have been well documented. For now, wireless technologies must be avoided as much as possible. New and innovative wired solutions which provide the same level of user-friendliness should be encouraged. Intervention of government and medical bodies with the main purpose of protecting human health is of utmost necessity to ensure good economic development without compromising the health of the population. Countries must adopt the guide-lines suggested by medical bodies which take into account both thermal and non-thermal effects of EMR. At present, all individuals must take preventive and protective measures to protect themselves from harmful EMR exposure.

Open access paper: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9016183>

A META-ANALYSIS OF IN VITRO EXPOSURES TO WEAK RADIOFREQUENCY RADIATION EXPOSURE FROM MOBILE PHONES (1990– 2015)

Halgamuge MN, Skafida E, Davis D. Available online 13 February 2020, 109227. <https://doi.org/10.1016/j.envres.2020.109227>.

Highlights

- Address the question of the impact of radiofrequency radiation on living organisms in vitro studies using abstract data from 300 peer-reviewed scientific publications (1990–2015) describing 1127 experimental observations.
- Establish impacts of the cumulative effect as measured by SAR * exposure time) to estimate the cumulative energy absorption of RF exposure for their analysis.
- Observe that more mature lymphocytes and glial cells are less reactive to RF, while less mature and less differentiated cells such as epithelium and spermatozoa are more sensitive to RF.
- Observe human cells are less affected by the radiofrequency radiation than rat/mouse cells.

Abstract

To function, mobile phone systems require transmitters that emit and receive radiofrequency signals over an extended geographical area exposing humans in all stages of development ranging from in-utero, early childhood, adolescents and adults. This study evaluates the question of the impact of radiofrequency radiation on living organisms in vitro studies. In this study, we abstract data from 300 peer-reviewed scientific publications (1990–2015) describing 1127 experimental observations in cell-based in vitro models. Our first analysis of these data found that out of 746 human cell experiments, 45.3% indicated cell changes, whereas 54.7% indicated no changes ($p < 0.001$). Realizing that there are profound distinctions between cell types in terms of age, rate of proliferation and apoptosis, and other characteristics and that RF signals can be characterized in terms of polarity, information content, frequency, Specific Absorption Rate (SAR) and power, we further refined our analysis to determine if there were some distinct properties of negative and positive findings

associated with these specific characteristics. We further analyzed the data taking into account the cumulative effect (SAR exposure time) to acquire the cumulative energy absorption of experiments due to radiofrequency exposure, which we believe, has not been fully considered previously. When the frequency of signals, length and type of exposure, and maturity, rate of growth (doubling time), apoptosis and other properties of individual cell types are considered, our results identify a number of potential non-thermal effects of radiofrequency fields that are restricted to a subset of specific faster-growing less differentiated cell types such as human spermatozoa (based on 19 reported experiments, p-value 0.002) and human epithelial cells (based on 89 reported experiments, p-value 0.0001). In contrast, for mature, differentiated adult cells of Glia (p 0.001) and Glioblastoma (p 0.0001) and adult human blood lymphocytes (p 0.0001) there are no statistically significant differences for these more slowly reproducing cell lines. Thus, we show that RF induces significant changes in human cells (45.3%), and in faster-growing rat/mouse cell dataset (47.3%). In parallel with this finding, further analysis of faster-growing cells from other species (chicken, rabbit, pig, frog, snail) indicates that most undergo significant changes (74.4%) when exposed to RF. This study confirms observations from the REFLEX project, Belyaev and others that cellular response varies with signal properties. We concur that differentiation of cell type thus constitutes a critical piece of information and should be useful as a reference for many researchers planning additional studies. Sponsorship bias is also a factor that we did not take into account in this analysis.

Conclusion

In this review, we perform a meta-analysis of data from 300 peer-reviewed scientific publications (1990-2015) with 1127 in vitro experimental observations carried out in the literature that discussed using different experimental techniques (cytogenetic, gene and protein expression analysis) and different cell types (cultured rodent, human cells and human blood lymphocytes) due to non-thermal radio-frequency electromagnetic exposure. In this paper, we directly differentiated the cumulative effect (SAR exposure time) to acquire the cumulative energy absorption of experiments due to RF exposure, which we believe, has not been fully considered previously. Several studies have reported, based on different experimental techniques that RF exposures comparable to those of a mobile phone induce a range of genetic and other damage including (cytogenetic, gene, and protein expression analysis). Non-thermal radiofrequency electromagnetic exposure in a range of cells/tissues that may not be associated with potentially harmful health consequences; in contrast, other studies have reported no apparent effects related to radiofrequency radiation. Our observation showed that 45.3% experiments concluded that an increase in such potential effects on cells exposed to radiofrequency radiation, while 54.7% showed no such effects (p = 0.001). Specific subtypes of cells show a much clearer cellular response. When radiofrequency, exposure and individual cell types are considered, potential non-thermal effects of radio-frequency radiation on cell types, such as human spermatozoa (based on 19 reported experiments, p-value = 0.002) and human epithelial cells (based on 89 reported experiments, p-value < 0.0001) may exist whereas for Glia (p = 0.001), Glioblastoma (p < 0.0001) and human blood lymphocytes (p < 0.0001) the evidence suggests that there are no statistically significant differences.

Fundamentally the validity of any exercise such as this depends on whether studies are carried out with parallel methods and levels of quality assurance and quality control for the biological

materials that are employed. The widely varying results we report here could well reflect failures of scientific rigor and consistency, as Portelli and Barnes (2013) [9] have suggested plague in vitro studies. Despite the lack of uniformity in responses, certain patterns are evident. It appears that more mature lymphocytes and glial cells are less reactive to RF, while less mature and less differentiated cells such as epithelium and spermatozoa are more sensitive to RF. In addition, it appears that frequencies that are higher and pulsed have more biological impact than those that are continuous and of lower frequency.

A simple glance at our findings could imply that human cells are less affected by the radiofrequency radiation than rat/mouse cells. However, due to the inconsistency of results, it may be safer to look at other possible explanation. One possibility is that the experimental procedure is not consistently followed throughout the majority of these studies, or it could be due to the experimental design guidelines not being able to account for all the variables we may or may not be aware of. Consequently, it allows an inconsistency set of results due to small fluctuation in different studies. Nevertheless, this study should be useful as a reference for many researchers supporting epidemiological studies and in vivo experiments using whole organism animal models.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935120301195>

MAIN REGULARITIES AND HEALTH RISKS FROM EXPOSURE TO NON-THERMAL MICROWAVES OF MOBILE COMMUNICATION

Belyaev I. 2019 14th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS). Nis Serbia. 23-25 Oct. 2019. DOI: 10.1109/TELSIKS46999.2019.9002324.

Abstract

Various responses to non-thermal microwaves (MW) from mobile communication including adverse health effects related to electrohypersensitivity, cancer risks, neurological effects, and reproductive impacts have been reported while some studies reported no such effects. This presentation provides an overview of the complex dependence of the MW effects on various physical and biological variables, which account for, at least partially, an apparent inconsistency in the published data. Among other variables, dependencies on carrier frequency, polarization, modulation, intermittence, electromagnetic stray fields, genotype, physiological traits, and cell density during exposure were reported. Nowadays, biological and health effects of 5G communication, which will use microwaves of extremely high frequencies (millimeter waves MMW, wavelength 1- 10 mm), are of significant public concern. It follows from available studies that MMW, under specific conditions of exposure at very low intensities below the ICNIRP guidelines, can affect biological systems and human health. Both positive and negative effects were observed in dependence on exposure parameters. In particular, MMW inhibited repair of DNA damage induced by ionizing radiation at specific frequencies and polarizations. To what extent the 5G technology and the Internet of Things will affect the biota and human health is definitely not known. However, based on possible fundamental role of MMW in regulation of homeostasis and almost complete absence of MMW in atmosphere due to effective absorption, which suggests the lack of adaptation to this type of radiation, the health effects of chronic MMW exposures may be more significant than for any other frequency range.

Conclusions

To what extent the 5G technology and the Internet of Things will affect the human health is definitely not known. However, based on possible fundamental role of MMW in regulation of homeostasis [72] and almost complete absence of MMW in atmosphere due to effective absorption, which suggests the lack of adaptation to this type of radiation, the health effects of chronic MMW exposures may be more significant than for any other frequency range. From the health perspectives, implementation of the 5G technology is premature. Extended research with chronic exposure of human cells, animals and man is needed to exclude potentially harmful 5G signals.

<https://ieeexplore.ieee.org/document/9002324>

A REAL-WORLD QUALITY ASSESSMENT STUDY IN SIX EXPOM-RF MEASUREMENT DEVICES

Eeftens M, Dongus S, Bürgler A, Röösli M, ACCEDERA team. Vol.182, March 2020, 109049. <https://doi.org/10.1016/j.envres.2019.109049>

Highlights

- We compared 6 ExpoM-RF personal measurement devices for radiofrequency electromagnetic fields (RF-EMF).
- The vast majority (84%) of variability in RF-EMF exposure levels was explained by the environment.
- Systematic differences between devices and calibrations were detectable, but relatively small.
- This supports the validity of studies which characterize personal and environmental RF-EMF using exposimeters.
- If systematic differences are corrected, we recommend adjusting for device ID and calibration session.

Abstract

Exposimeters measuring radiofrequency electromagnetic fields (RF-EMF) are commonly used to assess personal exposure to RF-EMF in real-life environments. They are usually calibrated in an anechoic chamber using single, well-defined signals such as the center frequency of each band, and standardized orientations, but it is not clear how different devices compare in the real environment where complex mixtures of signals from all directions are present. We thus tested the comparability of six ExpoM-RF exposimeters before and after calibration in an anechoic chamber by varying their position and orientation while repeatedly measuring 15 microenvironments (9 walking routes, 4 tram routes and 2 bus routes) on 6 different days. We modelled the geometric mean levels of RF-EMF as a function of orientation, position, device ID, whether the device was recently calibrated, correcting for the microenvironment in which each measurement took place. We found that systematic differences introduced by device ID, calibration, day of the week, orientation and position are relatively small compared to exposure differences between microenvironments. Any corrections (if desired) should include both device ID and calibration session, but would have a small impact considering the negligible differences between devices. This supports the validity of previous exposure measurement studies relying on ExpoM-RF devices, which did not correct for device ID. We further found that summarizing the exposure per microenvironment as geometric means results in better models than arithmetic means and medians, and recommend that further exposure assessment studies report observed levels as geometric means.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935119308461>

A NOVEL PILOT STUDY OF AUTOMATIC IDENTIFICATION OF EMF RADIATION EFFECT ON BRAIN USING COMPUTER VISION AND MACHINE LEARNING

Singh A, Singh N, Jinda T, Rosado-Muñoz, A, Kishore Dutta M. Vol. 57, March 2020, 101821. <https://doi.org/10.1016/j.bspc.2019.101821>.

Highlights

- This work presents automated identification of the effect of EMF radiations on brain.
- Changes in brain morphology due to EMF exposure were analyzed considering drosophila melanogaster as a specimen.
- The geometrical features were extracted from the microscopic segmented brain image of drosophila.
- Machine learning techniques were used for identification of EMF exposure on drosophila brain.

Abstract

Electromagnetic field (EMF) radiations from mobile phones and cell tower affect brain of humans and other organisms in many ways. Exposure to EMF could lead to neurological changes causing morphological or chemical changes in the brain and other internal organs. Cellular level analysis to measure and identify the effect of mobile radiations is an expensive and long process as it requires preparing the cell suspension for the analysis.

This paper presents a novel pilot study to identify changes in brain morphology under EMF exposure considering drosophila melanogaster as a specimen. The brain is automatically segmented, obtaining microscopic images from which discriminatory geometrical features are extracted to identify the effect of EMF exposure. The geometrical features of the microscopic segmented brain image of drosophila are analyzed and found to have discriminatory properties suitable for machine learning. The most prominent discriminatory features were fed to four different classifiers: support vector machine, naïve bayes, artificial neural network and random forest for classification of exposed / non-exposed microscopic image of drosophila brain. Experimental results indicate that all four classifiers provide good classification results up to 94.66% using discriminatory features selected by feature selection method. The proposed method is a novel approach to identify the effect of EMF exposure automatically and with low time complexity thus providing an efficient image processing framework based on machine learning.

<https://www.sciencedirect.com/science/article/abs/pii/S1746809419304021><https://www.sciencedirect.com/science/article/abs/pii/S1746809419304021>

THE RADIO-PROTECTIVE EFFECT OF ROSMARINIC ACID AGAINST MOBILE PHONE AND WI-FI RADIATION-INDUCED OXIDATIVE STRESS IN THE BRAINS OF RATS

Asl JF, Goudarzi M, Shoghi H. Pharmacol Rep. 2020 Mar 3. doi: 10.1007/s43440-020- 00063-9.

Abstract

BACKGROUND: *Rosmarinus officinalis* L. is an aromatic perennial herb from which rosmarinic acid (RA) can be extracted. This research was conducted to assess the effectiveness of RA against radio frequency (RF) radiation- induced oxidative stress due to 915 MHz (mobile phone) and 2450 MHz (Wi-Fi) frequencies in rats.

METHODS: The animals were separated into six groups, including group 1 receiving normal saline (NS), group 2 (NS/Wi-Fi) and group 4 (NS/mobile), which received NS plus 60 min/day of exposure to the electromagnetic radiation (EMR) for 1 month, group 3 (RA/Wi-Fi) and group 5 (RA/mobile) received RA (20 mg/kg/day, po) plus 60 min/day of EMR, and group 6 (RA) received only RA.

RESULTS: There was a significant elevation of protein carbonylation (PC), nitric oxide (NO) and malondialdehyde (MDA) and significant reduction in glutathione (GSH), glutathione peroxidase (GPx), total antioxidant capacity (TAC), superoxide dismutase (SOD) and catalase (CAT) in the RF radiation-exposed rats' brain compared to the control group. RA reduced the levels of NO, PC and MDA and it also elevated the TAC, GPx, SOD, CAT and GSH levels in the rats' brains in the RA/Wi-Fi and RA/mobile groups compared to the NS/Wi-Fi and NS/mobile groups, respectively.

CONCLUSION: It can be concluded that RA can be considered a useful candidate for protecting brain tissues against RF radiation-induced oxidative stress at 915 and 2450 MHz frequencies through ameliorative effects on the antioxidant enzyme activities and oxidative stress indices. <https://www.ncbi.nlm.nih.gov/pubmed/32128712>

THE EFFECTS OF MOBILE PHONE RADIOFREQUENCY RADIATION ON COCHLEAR STRIA MARGINAL CELLS IN SPRAGUE-DAWLEY RATS

Yang H, Zhang Y, Wang Z, Zhong S, Hu G, Zuo W. 2020 Feb 18. doi: 10.1002/bem.22255.

Abstract

To investigate the possible mechanisms for biological effects of 1,800 MHz mobile radiofrequency radiation (RFR), the radiation-specific absorption rate was applied at 2 and 4 W/kg, and the exposure mode was 5 min on and 10 min off (conversation mode). Exposure time was 24 h short-term exposure. Following exposure, to detect cell DNA damage, cell apoptosis, and reactive oxygen species (ROS) generation, the Comet assay test, flow cytometry, DAPI (4',6-diamidino-2-phenylindole dihydrochloride) staining, and a fluorescent probe were used, respectively. Our experiments revealed that mobile phone RFR did not cause DNA damage in marginal cells, and the rate of cell apoptosis did not increase ($P > 0.05$). However, the production of ROS in the 4 W/kg exposure group was greater than that in the control group ($P < 0.05$). In conclusion, these results suggest that mobile phone energy was insufficient to cause cell DNA damage and cell apoptosis following short-term exposure, but the cumulative effect of mobile phone radiation still requires further confirmation. Activation of the ROS system plays a significant role in the biological effects of RFR.

Conclusion

The RFR emitted from mobile phones was insufficient to cause cell DNA damage and cell apoptosis following short-term exposure, but intracellular ROS levels in the 4 W/kg exposure group were significantly increased than in the control group, indicating that activation of the ROS system plays a crucial role in the biological effects of RFR. The cumulative effect of mobile phone radiation requires investigation.

<https://www.ncbi.nlm.nih.gov/pubmed/32072661>

ASSESSMENT OF THE CELLPHONE RADIATION EFFECTS ON ANTI-OXIDATIVE AND RENAL PARAMETERS IN RAT

Eslami E, Fatahian S, Shahanipour K. Toxicology and Environmental Health Sciences. 11(4):278-282. Dec 2019.

Objective: In the present study an attempt is to assess the cellphones waves effects on the stress oxidative activities as well as renal parameters in rat.

Methods: 30 mature male Wister rats were divided into 3 groups of 10. Group 1 (control) was kept in normal laboratory conditions. Groups 2 and 3 were exposed with two and four cellphones in opposite sides of the cage, respectively. Blood samples were collected directly from the rat's heart 15 and 30 days post exposure and the activity of anti-oxidative factors including Glutathione Peroxidase, Superoxide Dismutase, Catalase, Glutathione Peroxidase, Paraoxonase and Malondialdehyde as well as renal parameters (Urea, Uric acid and Creatinine) were measured.

Results: Activity of catalase, superoxide dismutase and paraoxonase enzymes in all treated groups, 15 and 30 days post cellphone exposure were significantly increased in comparison with control. The activity of glutathione peroxidase enzyme in all treated groups, 15 and 30 days post cellphone exposure was decreased in comparison with control. Malondialdehyde and creatinine activity did not show any significant changes. Uric acid and urea were significantly increased in the group just exposed with four cellphones, 30 days post exposure.

Conclusion: According to the results, many changes were seen in biochemical parameters due to the cellphone exposure during a month. Therefore it can be concluded that radio frequency devices could be destructive and have many negative effects on the tissues and enzyme function.

<https://link.springer.com/article/10.1007/s13530-019-0414-4>

EFFECTS OF ACUTE EXPOSURE TO ULTRA-WIDEBAND PULSED ELECTROMAGNETIC FIELDS ON THE LIVER AND KIDNEYS OF MICE

Guo K, Zhang Y, Fang X, Fan P, Shang S, Fan F, Wu H, Man M, Xie Y, Lu X. *Electromagn Biol Med.* 2020 Mar 12:1- 14. doi: 10.1080/15368378.2020.1737806.

Abstract

The biosafety of ultra-wideband (UWB) pulses, which are characterized by simultaneously high power and a high bandwidth ratio, has gained increasing attention. Although there is substantial prior literature on the biological effects of UWB pulses on both cells and animals, an explicit, unequivocal and definite pattern of the corresponding biological responses remains elusive, and the systemic secondary consequences are also still not fully understood. In this study, we found that exposing mice to UWB pulses resulted in the alteration of several biochemical blood parameters, which further prompted us to investigate changes in the liver and kidneys of mice exposed to UWB pulses with different field intensities and different durations. The data demonstrated that exposure to UWB pulses significantly increased the levels of ALT and AST, increased oxidative stress, and could even induce the accumulation of lipid droplets in hepatocytes. The total number of pulses under the tested acute exposure regiment contributed most to the observed hepatic and renal dysfunction. Notably, the physiological and molecular changes recovered approximately 72 hours after exposure. These results imply the potential risk of acute exposure to UWB pulses, and highlight the meaningful targets for further long-term study of chronic exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/32164469>

DESIGN AND DOSIMETRIC ANALYSIS OF AN EXPOSURE FACILITY FOR INVESTIGATING POSSIBLE EFFECTS OF 2.45 GHZ WI-FI SIGNALS ON HUMAN SLEEP

Schmid G, Hirtl R, Bueno-Lopez A, Dorn H, Eggert T, Danker-Hopfe H. *Bioelectromagnetics.* 2020 Feb 27. doi: 10.1002/bem.22256.

Abstract

A new head exposure system for double-blind provocation studies investigating possible effects of 2.45 GHz Wi-Fi exposure on human sleep was developed and dosimetrically analyzed. The exposure system includes six simultaneously radiating directional antennas arranged along a circle (radius 0.6 m) around the test subject's head, and enables a virtually uniform head exposure, i.e. without any preferred direction of incidence, during sleep. The system is fully computer-controlled and applies a real wireless local area network (WLAN) signal representing different transmission patterns as expected in real WLAN scenarios, i.e. phases of "beacon only" as well as phases of different data transmission rates. Sham and verum are applied in a double-blind crossover study design and all relevant exposure data, i.e. forward and reverse power at all six antenna inputs, are continuously recorded for quality control. For a total antenna input power (sum of all antennas) of 220 mW, typical specific absorption rate (SAR) in cortical brain regions is approximately 1-2 mW/kg (mass average SAR over respective brain region), which can be seen as a realistic worst-case exposure level in real WLAN scenarios. Taking into account variations of head positions during the experiments, the resulting exposure of different brain regions may deviate from the given average SAR levels up to 10 dB. Peak spatial 10 g average SAR in all brain and all head tissues is between 1.5-3.5 and 10.4-25 mW/kg, respectively. <https://www.ncbi.nlm.nih.gov/pubmed/32104921>

ANTIBACTERIAL SUSCEPTIBILITY PATTERN OF THE PSEUDOMONAS AERUGINOSA AND STAPHYLOCOCCUS AUREUS AFTER EXPOSURE TO ELECTROMAGNETIC WAVES EMITTED FROM MOBILE PHONE SIMULATOR

Movahedi MM, Nouri F, Tavakoli Golpaygani A, Ataee L, Amani S, Taheri M. J Biomed Phys Eng. 2019 Dec 1;9(6):637-646. doi: 10.31661/jbpe.v0i0.1107.

Abstract

Background: The increasing use of telecommunication devices such as Wi-Fi modems and mobile phones in the recent years can change the cellular structure of microorganisms so the generation of electromagnetic waves has led to concern in the community whenever be exposed to these fields and may have harmful effects on human health.

Material and Methods: In this experimental study, standard strains of bacteria were prepared on Mueller-Hinton agar for bacterial growth to obtain 0.5 McFarland turbidity (1.5×10^8 CFU) of bacteria. Antibiotic susceptibility test using the Kirby-Bauer disk diffusion method was done. For Staphylococcus aureus and Pseudomonas aeruginosa, antibiotics susceptibility test was conducted. The test group was exposed to electromagnetic waves emitted by mobile phone simulator with a frequency of 900 MHz and the control group were not exposed.

Results: The results revealed that increasing duration of exposure to electromagnetic waves emitted by the mobile simulators with a frequency of 900 MHz especially after 24 h of exposure, can increase bacterial resistance in S. aureus, and P. aeruginosa.

Conclusion: Several factors can cause bacterial resistance against antibiotics. One of these factors is the electromagnetic waves emitted from mobile simulator with a frequency of 900 MHz, which can increase the permeability of the cell wall of bacteria.

<https://www.ncbi.nlm.nih.gov/pubmed/32039094>

DYNAMIC CHANGES IN CYTOSKELETON PROTEINS OF OLFACTORY ENSHEATHING CELLS INDUCED BY RADIOFREQUENCY ELECTROMAGNETIC FIELDS

Grasso R, Pellitteri R, Caravella SA, Musumeci F, Raciti G, Scordino A, Sposito G, Triglia A, Campisi A. J Exp Biol. 2020 Feb 10. pii: jeb.217190. doi: 10.1242/jeb.217190.

Abstract

Several evidences have suggested the ability of radio frequency electromagnetic fields to influence biological systems, even if the action mechanisms are not well understood. Only few data have reported about the effect of radio frequency electromagnetic fields on self-renewal of neural progenitor cells. A particular glial type, which shows characteristics of stem cells, are Olfactory Ensheathing Cells (OECs). Herein, we assessed the non-thermal effects induced on Olfactory Ensheathing Cells through radio frequency electromagnetic fields changing the envelope of the electromagnetic wave. Primary OEC cultures were exposed to continuous or amplitude modulated 900 MHz electromagnetic fields, in far field condition and at different exposition times (10, 15, 20 min). The expression of Olfactory Ensheathing Cells markers (S-100 and Nestin), cytoskeletal proteins (GFAP and Vimentin), apoptotic pathway activation by Caspase-3 cleavage and cell viability were evaluated. Our results highlight that 20 min of exposure to continuous or amplitude modulated 900 MHz electromagnetic fields induced a different and significant decrease in cell viability. In addition, according to the

electromagnetic fields waveform, diverse dynamic changes in the expression of the analysed markers in Olfactory Ensheathing Cells and activation of apoptotic pathway were observed. The data suggest that radio frequency electromagnetic fields might play different and important role in the self-renewal of OEC stem cells, which are involved in nervous system repair.

<https://www.ncbi.nlm.nih.gov/pubmed/32041804>

LIPID OXIDATION INDUCED BY RF WAVES AND MEDIATED BY FERRITIN IRON CAUSES ACTIVATION OF FERRITIN-TAGGED ION CHANNELS

Hernández-Morales M, Shang T, Chen J, Han V, Liu C. Cell Rep. 2020 Mar 10;30(10):3250-3260.e7. doi: 10.1016/j.celrep.2020.02.070.

Abstract

One approach to magnetogenetics uses radiofrequency (RF) waves to activate transient receptor potential channels (TRPV1 and TRPV4) that are coupled to cellular ferritins. The mechanisms underlying this effect are unclear and controversial. Theoretical calculations suggest that the heat produced by RF fields is likely orders of magnitude weaker than needed for channel activation. Using the FeRIC (Ferritin iron Redistribution to Ion Channels) system, we have uncovered a mechanism of activation of ferritin-tagged channels via a biochemical pathway initiated by RF disturbance of ferritin and mediated by ferritin-associated iron. We show that, in cells expressing TRPVFeRIC channels, RF increases the levels of the labile iron pool in a ferritin-dependent manner. Free iron participates in chemical reactions, producing reactive oxygen species and oxidized lipids that ultimately activate the TRPVFeRIC channels. This biochemical pathway predicts a similar RF-induced activation of other lipid-sensitive TRP channels and may guide future magnetogenetic designs.

<https://www.ncbi.nlm.nih.gov/pubmed/32160534>

Possible Mechanism for Synchronized Detection of Weak Magnetic Fields by Nerve Cells

Barnes F, Greenebaum B. Bioelectromagnetics. Published online Jan 28, 2020. <https://doi.org/10.1002/bem.22251>

Abstract

We propose that biological systems may detect static and slowly varying magnetic fields by the modification of the timing of firing of adjacent nerve cells through the local influence of the magnetic field generated by current from one cell's firing on its nearest neighbors. The time delay of an adjacent nerve cell pulse with respect to the initial clock nerve cell pulse could serve as a signal for sensing the magnitude and direction of the magnetic field in a direction perpendicular to the current flows in the cells. It has been shown that changes in static magnetic fields modify concentrations of reactive oxygen species, calcium, pH, the growth rates of fibrosarcoma cells, and membrane potentials. These are linked to changes in membrane potentials that can either inhibit or accelerate the firing rate of pacemaker or clock cells. This mechanism may have applications to animals' use of magnetic fields for navigation or other purposes, possibly in conjunction with other mechanisms.

<https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.22251>

ASSESSMENT OF LOW-FREQUENCY MAGNETIC FIELDS EMITTED BY DC FAST CHARGING COLUMNS

Trentadue G, Pinto R, Salvetti M, Zanni M, Pliakostathis K, Scholz H, Martini G. Bioelectromagnetics. 2020 Feb 11. doi: 10.1002/bem.22254.

Abstract

The expected imminent widespread use of electromobility in transport systems draws attention to the possible effects of human exposure to magnetic fields generated inside electric vehicles and during their recharge. The current trend is to increase the capacity of the battery inside the vehicles to extend the available driving range and to increase the power of recharging columns to reduce the time required for a full recharge. This leads to higher currents and potentially stronger magnetic fields. The Interoperability Center of the Joint Research Center started an experimental activity focused on the assessment of low-frequency magnetic fields emitted by five fast-charging devices available on the market in recharge and standby conditions. The aim of this study was to contribute to the development of a standard measurement procedure for the assessment of magnetic fields emitted by direct current charging columns. The spectrum and amplitudes of the magnetic field, as well as exposure indices according to guidelines for the general public and occupational exposure, were recorded by means of a magnetic field probe analyzer. The worst-case scenario for instantaneous physical direct and indirect effects was identified. Measurements within the frequency range of 25 Hz-2 kHz revealed localized magnetic flux density peaks above 100 μ T at the 50 Hz frequency in three out of five chargers, registered in close proximity during the recharge. Beyond this distance, exposure indices were recorded showing values below 50% of reference levels.

<https://www.ncbi.nlm.nih.gov/pubmed/32043629>

NATURAL ELF FIELDS IN THE ATMOSPHERE AND IN LIVING ORGANISMS

Price C, Williams E, Elhalel G, Sentman D. Natural ELF fields in the atmosphere and in living organisms. Int J Biometeorol. 2020 Feb 8. doi: 10.1007/s00484-020-01864-6.

Abstract

Most electrical activity in vertebrates and invertebrates occurs at extremely low frequencies (ELF), with characteristic maxima below 50 Hz. The origin of these frequency maxima is unknown and remains a mystery. We propose that over billions of years during the evolutionary history of living organisms on Earth, the natural electromagnetic resonant frequencies in the atmosphere, continuously generated by global lightning activity, provided the background electric fields for the development of cellular electrical activity. In some animals, the electrical spectrum is difficult to differentiate from the natural background atmospheric electric field produced by lightning. In this paper, we present evidence for the link between the natural ELF fields and those found in many living organisms, including humans.

<https://www.ncbi.nlm.nih.gov/pubmed/32034466>

RELATIONSHIP BETWEEN DISTANCE TO OVERHEAD POWER LINES AND CALCULATED FIELDS IN TWO STUDIES

Amoon AT, Swanson J, Vergara X, Kheifets LI. J Radiol Prot. 2020 Feb 17. doi: 10.1088/1361-6498/ab7730.

Abstract

There is some evidence that both distance from transmission lines and measured or calculated magnetic fields are associated with childhood leukemia. Because distance is a key component when calculating the magnetic field generated by power lines, distance from lines and calculated fields based on lines tend to be highly correlated. Socioeconomic status (SES) and dwelling type are also associated with magnetic field exposure. We used exposure data from two large studies of childhood leukemia and other cancers, in the US and the UK, to describe a relationship between distance and magnetic fields across the population within 100 meters (m) of power lines as a whole and evaluate potential modifiers such as SES and type of dwelling. There were 387 subjects living within 100 m of an overhead power line. There was no significant difference in mean calculated fields nor distance to 200+ kV lines within 100 m by study. Within the range where the power line field is expected to be significant compared to other sources, which we take as 100 m, distance to high voltage lines predicted MF variation in both studies better than other functions of distance tested in both linear and logistic regression. There were no differences between high and low SES nor dwelling types (single-family home vs other). In conclusion, we found that calculated fields do appear to diminish linearly with increasing distance from overhead power lines, up to 100 m, particularly those 200+ kV and above. These results are stronger in the UK study. Within 100 m, distance to high voltage lines continues to be highly correlated with calculated magnetic fields and each can be a proxy for the other.

<https://www.ncbi.nlm.nih.gov/pubmed/32066122>

THE INVERSE RELATION BETWEEN MITOCHONDRIAL TRANSMEMBRANE POTENTIAL AND PROTEINS A-HELIX IN NEURONAL-LIKE CELLS UNDER STATIC MAGNETIC FIELD AND THE ROLE OF VDAC

Calabrò E, Magazù S, Currò M, Ientile R. Electromagn Biol Med. 2020 Mar 9:1-7. doi: 10.1080/15368378.2020.1737808.

Abstract

In this study, a correlation between cell channel α -helices displacement and the mitochondrial transmembrane potential after exposure of 3, 7, 15 and 24 h of neuronal-like cells to a uniform magnetic field at the intensity of 2 mT was shown. Fourier Transform Infrared (FTIR) Spectroscopy and fluorescence techniques were used to analyze the secondary structure of protein content and mitochondrial transmembrane potential, respectively. The main result of this study was represented by a significant inverse relation between the mitochondrial transmembrane potential and the intensity of the Amide I band that can be associated with time exposure. Given that mitochondrial transmembrane potential should be related to the gating state of voltage-dependent anion channel (VDAC) in mitochondrial membrane, this result could have a relevant role in medicine. Indeed, VDAC's irregular behavior can be associated with several varieties of mitochondria-associated pathologies and various forms of cancer and neurodegeneration.

<https://www.ncbi.nlm.nih.gov/pubmed/32149540>

RADIOFREQUENCY INTERFERENCE IN THE CLINICAL LABORATORY

Badizadegan ND, Greenberg S, Lawrence H, Badizadegan K. Am J Clin Pathol. 2019 Apr 2;151(5):522-528. doi: 10.1093/ajcp/aqy174.

Abstract

OBJECTIVES: Radiofrequency interference (RFI) is a known medical device safety issue, but there are no documented cases of interference resulting in erroneous laboratory results.

METHODS: We investigated unexpected failure of a hematology analyzer resulting in erroneous WBC counts. Hardware failure was initially suspected, but temporal association with increased power output from a nearby antenna prompted investigation for RFI.

RESULTS: Power output from an antenna located approximately 4 feet from the analyzer was increased to ensure sufficient signal for emergency communications in the building. Interference from the antenna resulted in aberrant side scatter and abnormal WBC counts. Powering down the antenna returned the instrument to normal working conditions.

CONCLUSIONS: We have shown RFI as the root cause of erroneous WBC counts in a hematology analyzer. We propose that RFI should be on the list of potential interfering mechanisms when clinical laboratory instruments generate inconsistent or unreliable results.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6445342/>

ELECTRIC AND MAGNETIC SENSES IN MARINE ANIMALS, AND POTENTIAL BEHAVIORAL EFFECTS OF ELECTROMAGNETIC SURVEYS

Nyqvist D, Durif C, Johnsen MG, De Jong K, Forland TN, Sivle LD. Mar Environ Res. 2020 Mar;155:104888. doi: 10.1016/j.marenvres.2020.104888.

Abstract

Electromagnetic surveys generate electromagnetic fields to map petroleum deposits under the seabed with unknown consequences for marine animals. The electric and magnetic fields induced by electromagnetic surveys can be detected by many marine animals, and the generated fields may potentially affect the behavior of perceptive animals. Animals using magnetic cues for migration or local orientation, especially during a restricted time-window, risk being affected by electromagnetic surveys. In electrosensitive animals, anthropogenic electric fields could disrupt a range of behaviors. The lack of studies on effects of the electromagnetic fields induced by electromagnetic surveys on the behavior of magneto- and electrosensitive animals is a reason for concern. Here, we review the use of electric and magnetic fields among marine animals, present data on survey generated and natural electromagnetic fields, and discuss potential effects of electromagnetic surveys on the behavior of marine animals.

<https://www.ncbi.nlm.nih.gov/pubmed/32072990>

A SENSE OF PLACE: PINK SALMON USE A MAGNETIC MAP FOR ORIENTATION

Putman NF, Williams CR, Gallagher EP, Dittman AH. J Exp Biol. 2020 Feb 6. pii: jeb.218735. doi: 10.1242/jeb.218735.

Abstract

The use of "map-like" information from Earth's magnetic field for orientation has been shown in diverse taxa, but questions remain regarding the function of such maps. We used a "magnetic displacement" experiment to demonstrate that juvenile pink salmon (*Oncorhynchus gorbuscha*) use magnetic cues to orient. The experiment was designed to simultaneously explore whether their magnetic map is used to direct fish (i) homeward, (ii) toward the center of their broad oceanic range, or (iii) along their oceanic migratory route. The headings adopted by these navigationally naïve fish coincided remarkably well with the direction of the juveniles' migration inferred from historical tagging and catch data. This suggests that the large-scale movements of pink salmon across the North Pacific may be driven largely by their innate use of geomagnetic map cues. Key aspects of the oceanic ecology of pink salmon and other marine migrants might therefore be predicted from magnetic displacement experiments.

<https://www.ncbi.nlm.nih.gov/pubmed/32029460>

ON THE BIOPHYSICAL MECHANISM OF SENSING UPCOMING EARTHQUAKES BY ANIMALS

Panagopoulos DJ, Balmori A, Chrousos GP. Sci Total Environ. 2020 Jan 29;717:136989. doi: 10.1016/j.scitotenv.2020.136989.

Abstract

It is documented that a few days or weeks before major Earthquakes (EQs) there are changes in animal behavior within distances up to 500 km from the seismic epicenter. At the same time Seismic Electric Signals (SES), geomagnetic and ionospheric perturbations, are detected within similar distances. SES consist of single unipolar pulses, and/or groups of such pulses called "SES activities" with an average frequency between successive pulses on the order of ~0.01 Hz and electric field intensity on the order of ~10⁻⁵-10⁻⁴ V/m (Frazer-Smith et al., 1990; Rikitake, 1998; Varotsos et al., 1993, 2011, 2019; Hayakawa et al., 2013; Grant et al., 2015). We show that the SES activities can be sensed by living organisms through the "Ion Forced-Oscillation Mechanism" for the action of Electromagnetic Fields (EMFs) on cells, according to which polarized EMFs can cause irregular gating of electro-sensitive ion channels on the cell membranes with consequent disruption of the cell electrochemical balance (Panagopoulos et al., 2000, 2002, 2015). This can be sensed by sensitive animals as discomfort in cases of weak and transient exposures, and may even lead to DNA damage and serious health implications in cases of intense exposure conditions (as in certain cases of man-made EMF exposures). Moreover, we show that the geomagnetic and ionospheric perturbations cannot be sensed through this mechanism. The same mechanism has explained meteoropathy, the sensing of upcoming thunderstorms by sensitive individuals, through the action of the EMFs of lightning discharges (Panagopoulos and Balmori, 2017). The present study shows that centuries-long anecdotal rumors of animals sensing intense upcoming EQs and displaying unusual behavior, lately documented by systematic studies, are now explained for the first time on the basis of the electromagnetic nature of all living organisms, and the electromagnetic signals emitted prior to EQs.

<https://www.ncbi.nlm.nih.gov/pubmed/32070887>

GRAY WHALES STRAND MORE OFTEN ON DAYS WITH INCREASED LEVELS OF ATMOSPHERIC RADIO-FREQUENCY NOISE

Granger J, Walkowicz L, Fitak R, Johnsen S. Curr Biol. 2020 Feb 24;30(4):R155-R156. doi: 10.1016/j.cub.2020.01.028.

Abstract

Evidence from live gray whale strandings suggests that their navigation may be disrupted by increased radio frequency noise generated by solar storms, suggesting the potential for magnetoreception in this species.

<https://www.ncbi.nlm.nih.gov/pubmed/32097638>

ADVERSE HEALTH EFFECTS OF 5G MOBILE NETWORKING TECHNOLOGY UNDER REAL-LIFE CONDITIONS

Kostoff RN, Heroux P, Aschner M, Tsatsakis A. Adverse health effects of 5G mobile networking technology under real-life conditions. Toxicology Letters. Published online Jan 25, 2020. <https://doi.org/10.1016/j.toxlet.2020.01.020>.

Highlights

- Identifies wide-spectrum of adverse health effects of non-ionizing non-visible radiation
- Most laboratory experiments were not designed to identify the more severe adverse effects reflective of real-life conditions
- Many experiments do not include the real-life pulsing and modulation of the carrier signal
- Vast majority of experiments do not account for synergistic adverse effects of other toxic stimuli with wireless radiation
- 5G mobile networking technology will affect not only the skin and eyes, but will have adverse systemic effects as well

Abstract

This article identifies adverse effects of non-ionizing non-visible radiation (hereafter called wireless radiation) reported in the premier biomedical literature. It emphasizes that most of the laboratory experiments conducted to date are not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate. Many experiments do not include pulsing and modulation of the carrier signal. The vast majority do not account for synergistic adverse effects of other toxic stimuli (such as chemical and biological) acting in concert with the wireless radiation. This article also presents evidence that the nascent 5 G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have adverse systemic effects as well.

https://www.sciencedirect.com/science/article/abs/pii/S037842742030028X?fbclid=IwAR2-J0fi_XJVnJ-pFvfmlBtvkJVd0mVCjLgia89IKv6lpNrCFDQmizoSDZU

APPEALS THAT MATTER OR NOT ON A MORATORIUM ON THE DEPLOYMENT OF THE FIFTH GENERATION, 5G, FOR MICROWAVE RADIATION

Hardell L, Nyberg R. [Comment] Molecular and Clinical Oncology. Published online January 22, 2020.

Abstract

Radiofrequency (RF) radiation in the frequency range of 30 kHz-300 GHz is classified as a 'possible' human carcinogen, Group 2B, by the International Agency for Research on Cancer (IARC) since 2011. The evidence has since then been strengthened by further research; thus, RF radiation may now be classified as a human carcinogen, Group 1. In spite of this, microwave radiations are expanding with increasing personal and ambient exposure. One contributing factor is that the majority of countries rely on guidelines formulated by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a private German non-governmental organization. ICNIRP relies on the evaluation only of thermal (heating) effects from RF radiation, thereby excluding a large body of published science demonstrating the detrimental effects caused by non-thermal radiation. The fifth generation, 5G, for microwave radiation is about to be implemented worldwide in spite of no comprehensive investigations of the potential risks to human health and the environment. In an appeal sent to the EU in September, 2017 currently >260 scientists and medical doctors requested for a moratorium on the deployment of 5G until the health risks associated with this new technology have been fully investigated by industry-independent scientists. The appeal and four rebuttals to the EU over a period of >2 years, have not achieved any positive response from the EU to date. Unfortunately, decision makers seem to be uninformed or even misinformed about the risks. EU officials rely on the opinions of individuals within the ICNIRP and the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), most of whom have ties to the industry. They seem to dominate evaluating bodies and refute risks. It is important that these circumstances are described. In this article, the warnings on the health risks associated with RF presented in the 5G appeal and the letters to the EU Health Commissioner since September, 2017 and the authors' rebuttals are summarized. The responses from the EU seem to have thus far prioritized industry profits to the detriment of human health and the environment.

<https://www.spandidos-publications.com/10.3892/mco.2020.1984>

Excerpt

In conclusion, this article demonstrates that the EU has given mandate to a 13-member, non-governmental private group, the ICNIRP, to decide upon the RF radiation guidelines. The ICNIRP, as well as SCENIHR, are well shown not to use the sound evaluation of science on the detrimental effects of RF radiation, which is documented in the research which is discussed above (9,10,21-24,54,55). These two small organizations are producing reports which seem to deny the existence of scientific published reports on the related risks. It should perhaps be questioned whether it is in the realm of protecting human health and the environment by EU and whether the safety of EU citizens and the environment can be protected by not fully understanding the health-related risks.

Open access paper:

<https://www.spandidos-publications.com/10.3892/mco.2020.1984/download>

LIMITING LIABILITY WITH POSITIONING TO MINIMIZE NEGATIVE HEALTH EFFECTS OF CELLULAR PHONE TOWERS PEARCE JM. LIMITING LIABILITY WITH POSITIONING TO MINIMIZE NEGATIVE HEALTH EFFECTS OF CELLULAR PHONE TOWERS. ENVIRONMENTAL RESEARCH. AVAILABLE ONLINE 29 NOVEMBER 2019, 108845.

Highlights

- Cellular phone networks demand widespread human exposure to radio-frequency radiation (RFR).
- Cellular phone base stations density & power output increasing global human RFR exposure.
- Already enough medical-scientific evidence to warrant long-term liability concerns.
- To protect cell phone tower firms, companies should seek to minimize human RFR exposure.

Abstract

The use of cellular phones is now ubiquitous through most of the adult global population and is increasingly common among even young children in many countries (e.g. Finland, where the market for smart phones is nearly saturated). The basic operation of cellular phone networks demands widespread human exposure to radio-frequency radiation (RFR) with cellular phone base stations providing cellular coverage in most areas. As the data needs of the population increase from the major shift in the source of Internet use from personal computers to smart phones, this coverage is widely predicted to increase. Thus, both the density of base stations and their power output is expected to increase the global human RFR exposure. Although direct causation of negative human health effects from RFR from cellular phone base stations has not been finalized, there is already enough medical and scientific evidence to warrant long-term liability concerns for companies deploying cellular phone towers. In order to protect cell phone tower firms from the ramifications of the failed paths of other industries that have caused unintended human harm (e.g. tobacco) this Current Issue summarizes the peer-reviewed literature on the effects of RFR from cellular phone base stations. Specifically the impacts of siting base stations are closely examined and recommendations are made for companies that deploy them to minimize their potential future liability.

<https://www.ncbi.nlm.nih.gov/pubmed/31791710>

Excerpts

A review article of the health effects near base stations concluded that deployment of base stations should be kept as efficient as possible to minimize exposure of the public to RFR and should not be located less than 500m from the population, and at a height of 50m (Levitt and Lai, 2010)....

There are several first steps a cellular phone company can take to minimize human exposure particularly of the most vulnerable populations. First, voluntarily restrictions can be made on the placement of cellular phone base stations within 500m of schools and hospitals....

The second technical hurdle is more challenging. Ideally, all cell phone users would have coverage while minimizing the population density near cellular phone base stations (thus minimizing health impacts)

The cell phone industry should also consider cell splitting, small cell deployment, beam and null steering antennae as possible technical means for reducing RF exposure. Moreover, more research on cognitive radio should also be conducted, so that the overall RF exposure is reduced....

Finally, exposed companies should consider funding large-scale epidemiological studies with personal dosimeters for strict dose measurement and straight-forward tissue exposure. By quantifying the human medical threat themselves, more appropriate long-term planning can be made to minimize the risk of liability from unintended human harm due to cellular phone base station siting.

CANCER STATISTICS, 2020: BRAIN AND OTHER NERVOUS SYSTEM CANCER INCIDENCE AND DEATH RATES

Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA: A Cancer Journal for Clinicians. doi: 10.3322/caac.21590.

Cancer incidence

The American Cancer Society estimates that there will be 23,890 new cases of brain & other nervous system (ONS) cancers this year in the U.S. and 18,020 people will die from these types of cancer (Table 1). Leukemia is the most common childhood (birth to 19 years of age) cancer, accounting for 28% of cases, followed by brain & ONS cancers (26%), greater than one-quarter of which are benign/borderline malignant (Table 12). In adolescents, brain & ONS cancers are most common (21%), greater than one-half of which are benign/borderline malignant, followed closely by lymphoma (20%). (p. 18)

Cancer deaths

Death rates increased over the past decade for brain & ONS cancers (p. 13). Brain & ONS cancers are the first leading cause of cancer death among men aged younger than 40 years and women aged younger than 20 years. These cancers are the fourth leading cause of cancer death among women aged 20 to 39 years and the fifth leading cause of cancer death among men aged 40 to 59 years (Table 8).

Open access paper: <https://acsjournals.onlinelibrary.wiley.com/doi/full/10.3322/caac.21590>

AN EXPERIMENTAL STUDY ON EFFECTS OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS ON SLEEP IN HEALTHY ELDERLY MALES AND FEMALES: GENDER MATTERS!

Danker-Hopf H, Dorn H, Sauter C, Schmid G, Eggert T. Environmental Research. 183, April 2020, 109181 <https://doi.org/10.1016/j.envres.2020.109181>

Highlights

- First paper to investigate gender specific RF-EMF effects in elderly subjects.
- RF-EMF affects approximately 10% of the sleep variables directly.
- RF-EMF affects approximately 12% of the sleep variables differently in men and women.
- Women are more affected than men.
- None of the observed effects is indicative of a disturbed sleep.

Abstract

Background Results from human experimental studies investigating possible effects of radiofrequency electromagnetic fields (RF-EMF) on sleep are heterogeneous. So far, there is no study on possible sex- differences in RF-EMF effects.

Objectives The present study aimed at analyzing differences in RF-EMF effects on the macrostructure of sleep between healthy elderly males and females.

Methods With a double-blind, randomized, sham-controlled cross-over design effects of two RF-EMF exposures (GSM900 and TETRA) on sleep were investigated in samples of 30 elderly healthy male and 30 healthy elderly female volunteers. Participants underwent each of the three exposure conditions on three occasions following an individually randomized order resulting in a total of nine study nights per participant. Exposure was delivered for 30 min prior to sleep and for the whole night (7.5 h) by a head worn antenna specifically designed for the projects. The peak spatial absorption rate averaged over time in head tissues (psSAR10g) was 6 W/kg for TETRA and 2 W/kg for GSM900. Thirty variables characterising the macrostructure of sleep and arousals as well as four subjective sleep variables were considered for statistical analyses.

Results Multivariate analyses revealed that exposure to GSM900 and/or TETRA resulted in a significant reduction in arousals, a shorter latency to sleep stage N3, and a shorter self-reported time awake after sleep in both males and females. Exposure effects depending on sex (significant interactions) were observed. Latency to sleep stage R was shorter in females and tended to be longer in males under both exposures. Latency to stage N3 was shorter in females under TETRA exposure and almost not affected in males. The time awake within the sleep period under TETRA exposure was shorter in females and only slightly longer in males. Under GSM exposure, the self-rated total sleep time tended to be longer in females and to be shorter in males. Finally, the number of awakenings was lower only in females and tended to be higher in males under GSM exposure.

Discussion With regard to RF-EMF effects on human sleep it seems that gender matters since GSM900 and TETRA led to significantly more exposure effects in females. Regardless of gender, none of the observed changes is indicative of a sleep disturbing effect of RF-EMF exposure. Observed effects might be mediated by skin related thermoregulatory mechanisms.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935120300736>

DIMENSIONLESS COEFFICIENTS FOR ASSESSING HUMAN EXPOSURE TO RADIO-FREQUENCY ELECTROMAGNETIC FIELDS INDOORS AND OUTDOORS IN URBAN AREAS

Paniagua JM, Rufo M, Jiménez A, Antolín A. Dimensionless coefficients for assessing human exposure to radio- frequency electromagnetic fields indoors and outdoors in urban areas. *Environmental Research*. 183, April 2020, 109188.

Highlights

- Residential areas were measured indoors and outdoors with a personal exposimeter.
- Different protocols were used for indoor and outdoor measurements.
- Electric field was systematically detected in the FM and downlink mobile phone bands.
- Median exposure quotient was 2.5×10^{-6} outdoors and 1.6×10^{-6} indoors.
- Exposure quotient: FM radio > downlink > DECT and WIFI.

Abstract

The main objective of this work was to evaluate human exposure to electromagnetic fields in a city of about one hundred thousand inhabitants, both inside and outside dwellings, using exposure quotients. To this end, a personal exposure meter was used, collecting data in different frequency bands, including radio and television broadcasting, mobile telephony, cordless telephones, and wireless communication networks. The indoor measurements were made with the exposure meter in a static position. Those outdoor were made by walking around the building with the exposure meter held by the operator. The median electric field was 0.200 V/m outdoors and 0.102 V/m indoors. The median of the ICNIRP exposure quotients for multiple-frequency sources was 25×10^{-6} outside and 16×10^{-6} inside. The proximity of the operator's body caused the readings of the electric field in the FM band to be overestimated by a factor of 1.35, and in the mobile telephony bands by factors from 0.76 to 1.02. The standard deviation of the measurements repeated inside a dwelling over five days was of the order of the exposure meter's standard uncertainty of calibration, but the spatial dispersion at the scale of a dwelling and of the city was much greater. The two main contributors to the exposure were FM radio followed by the “downlink” mobile telephony bands. Inside the dwellings, the DECT and WIFI bands contributed less. Exposure quotients are dimensionless parameters that characterize exposure, and reflect the relative weight of each service to that exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/32032813>

SPATIAL AND TEMPORAL ASSESSMENT OF RADIOFREQUENCY ELECTROMAGNETIC FIELDS EMITTED BY SMART METERS AND SMART METER BANKS IN URBAN ENVIRONMENTS

Aerts S, Van den Bossche M, Vergara X, Odie S, Verloock L, Martens L, WoutJ. *Environmental Research*. 183. Apr 2020. 109196.

Highlights

- We present a method to assess spatiotemporal RF-EMF exposure to AMI smart meters.
- Measurements of smart meter(s) (banks) were performed in a densely populated area.
- Maximum field levels at 0.3 m were 13 V/m (1 m) and 38 V/m (>20 m).
- Duty cycles were between 0.01% (1 m) and 14% (81-m bank).
- The maximum time-averaged exposure level was 9.43% of the ICNIRP reference level.

Abstract

This paper describes radiofrequency (RF) electromagnetic field (EMF) measurements in the vicinity of single and banks of advanced metering infrastructure (AMI) smart meters. The measurements were performed in a meter testing and distribution facility as well as in-situ at five urban locations. The measurements consisted of gauging the RF environment at the place of assessment, evaluating the worst-case electric-field levels at various positions around the assessed AMI meter configuration (spatial assessment), which ranged from a single meter to a bank of 81 m, and calculating the duty cycle of the system, i.e. the fraction of time that the AMI meters were actually transmitting (12-h temporal assessment). Both in-situ and in the meter facility, the maximum field levels at 0.3 m from the meter configurations were 10–13 V/m for a single meter and 18–38 V/m for meter banks with 20–81 m. Furthermore, 6-min average duty cycles of 0.01% (1 m) up to 13% (81-m bank) were observed. Next, two general statistical models (one for a single meter and one for a meter bank) were constructed to predict the electric-field strength as a function of distance to any configuration of the assessed AMI meters. For all scenarios, the measured exposure levels (at a minimum distance of 0.3 m) were well below the maximum permissible exposure limits issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the U.S. Federal Communications Commission (FCC), and the Institute of Electrical and Electronics Engineers (IEEE). Indeed, the worst-case time-average exposure level at a distance of 0.3 m from an AMI installation was 5.39% of the FCC/IEEE and 9.43% of the ICNIRP reference levels.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935120300888>

PULSED HIGH-POWER MICROWAVES DO NOT IMPAIR THE FUNCTIONS OF SKIN NORMAL AND CANCER CELLS IN VITRO: A SHORT- TERM BIOLOGICAL EVALUATION

Mumtaz S, Bhartiya P, Kaushik N, Adhikari M, Lamichhane P, Lee S-J, Kaushik NK, Choi EH. J Advance Research. 22: 47-55. Mar 2020.

Highlights

- Pulsed high power microwave (MW) at a frequency 3.5 GHz was generated.
- MW did not induce cell death in skin fibroblast normal cells and melanoma cells.
- MW did not alter the morphology of melanoma cells.
- Gene expression related to ATP synthesis and proliferation can get altered by MW.
- MW selectively stimulated viability and proliferation of only melanoma cells.

Abstract

Over the past few decades, microwave (MW) radiation has been widely used, and its biological effects have been extensively investigated. However, the effect of MW radiation on human skin biology is not well understood. We study the effects of pulsed high-power microwaves (HPMs) on melanoma (G361 and SK-Mel-31) and normal human dermal fibroblast (NHDF) cells. A pulsed power generator (Chundoong) was used to generate pulsed HPMs (dominant frequency: 3.5 GHz). For treatment 1, 5, 15, and 45 shots are given to cells in which the electromagnetic energy of 0.6 J was delivered to the cells at each trigger shot. Cell viability, proliferation rate, apoptosis, cell death, metabolic activity, and oxygen-free radical regulation were evaluated after the MW exposure at low and high doses. MW exposure increased the viabilities and proliferation rates of both melanoma cell lines in a dose-dependent manner, while no significant effects on the fibroblast cells were observed.

We found an elevated level of ATP and mitochondrial activity in melanoma cells. Also, it was observed that MW exposure did not affect cell death in melanoma and fibroblast cells. A polymerase chain reaction analysis indicated that the MWs induced dose-dependent proliferation markers without affecting the cell cycle and apoptotic genes in the melanoma cells. Our findings show the differential effects of the MW radiation on the melanoma cells, compared to those on the fibroblast cells.

Conclusion

This study reveals that the MW exposure led to increased cell growth and proliferation specific to melanoma after 24 h, which could be attributed to the increased mitochondrial activity by the increased ATP level. The MW exposure did not affect the normal fibroblast cells at the considered doses, while it altered the melanoma cell physiology in a cell-type specific manner. Therefore, MW exposure may be utilized with mitotic inhibitory chemotherapeutic drugs for melanoma cells and should be considered while analyzing melanoma cells in vitro. Further investigations are required to study the cellular signaling upon MW exposure.

Open access paper: <https://doi.org/10.1016/j.jare.2019.11.007>

RF-INDUCED TEMPERATURE INCREASE IN A STRATIFIED MODEL OF THE SKIN FOR PLANE-WAVE EXPOSURE AT 6-100 GHZ

Christ A, Samaras T, Neufeld E, Kuster N. Radiat Prot Dosimetry. 2020 Jan 16. pii: ncz293. doi: 10.1093/rpd/ncz293.

Abstract

This study assesses the maximum temperature increase induced by exposure to electromagnetic fields between 6 and 100 GHz using a stratified model of the skin with four or five layers under plane wave incidence. The skin model distinguishes the stratum corneum (SC) and the viable epidermis as the outermost layers of the skin. The analysis identifies the tissue layer structures that minimize reflection and maximize the temperature increase induced by the electromagnetic field. The maximum observed temperature increase is 0.4°C for exposure at the present power density limit for the general population of 10 W m⁻². This result is more than twice as high as the findings reported in a previous study. The reasons for this difference are identified as impedance matching effects in the SC and less conservative thermal parameters. Modeling the skin as homogeneous dermis tissue can underestimate the induced temperature increase by more than a factor of three.

<https://www.ncbi.nlm.nih.gov/pubmed/31950182>

EFFECTS OF ELECTROMAGNETIC FIELDS FROM (4G) LONG-TERM EVOLUTION ON AWAKE ELECTROENCEPHALOGRAPH IN HEALTHY HUMANS

Nakatani-Enomoto S, Yamazaki M, Nishiura K, Enomoto H, Ugawa Y. Neurosci Res. 2020 Jan 25. pii: S0168-0102(20)30036-5. doi: 10.1016/j.neures.2020.01.010.

Abstract

Mobile phones are indispensable for daily life, and the adverse effects of the electromagnetic field (EMF) emitted by mobile phones have been a great concern. We studied the effects of long-term evolution (LTE) -like EMF for 30 min on an awake electroencephalogram (EEG). Thirty-eight healthy volunteers, aged 20 to 36 years old, participated in this study. The maximum local SAR (specific absorption rate) averaged over 10-g mass was 2.0 W/kg. The EEG

was recorded before and after real or sham exposures. The effects of exposure conditions (real or sham) and the recording time (before, during, and after exposure) on each EEG power spectrum of θ , α , and β frequency ranges were analyzed. The θ and α band waves were enhanced after both exposure conditions. These results may be explained by the participants' drowsiness during the EEG recording in both exposures. We conclude that an LTE-like exposure for 30 min in this study showed no detectable harmful effects on awake EEGs in healthy humans.

<https://www.ncbi.nlm.nih.gov/pubmed/31991204>

INVESTIGATION OF SAR (SPECIFIC ABSORPTION RATE) IN DIFFERENT HEAD MODELS PLACED IN SHIELDED SPACE

Psenakova Z, Benova M, Mydlova J. 2019 IEEE 20th International Conference on Computational Problems of Electrical Engineering (CPEE).15-18 Sept. 2019.

Abstract

This article deals with effects of electromagnetic (EM) fields to different types of numerical models of human head. There are differences between specific absorption rate (SAR) near human head model inside shielded space like in elevator or non-shielded space (open area). In the presented approach, the investigation is focused on modelling of EM field proceeded on the finite integration method. The simulations were carried out for specific scenario where a person/passenger was placed in the shielded space using a cellular phone. The results were evaluated in terms of the SAR values – the determination of EM energy absorption inside the human head. The dipole antenna with a frequency of 900 MHz was designed and working as radio frequency source. In the proposed matching method, two models of human head - SAM homogenous human head model and AustinMan model - were chosen to model three different distances of the cellular phone from the human head surface.

Both have the dielectric properties determined to the evaluated frequency of source. The numerical results have shown that the obtained maximal SAR values in shielded/enclosure (such as the elevator) is higher than are maximum values determined according to maximum SAR in European standards limit. Additionally, the obtained SAR values are higher than the results achieved by the open space simulations.

Conclusions

In this paper, the study of the electromagnetic energy absorption changes caused to the human head models in different situations-open and shielded space was proposed. The near-field exposure results from have shown that the SAR values vary for the antenna distance and space, where is the antenna placed as well as to the use of human head model. The changes of EM fields relate to the above-mentioned process – occurrence of EM fields reflection from the surface of iron shielded space. This reflected wave interferes with the primary wave from the radiation source, resulting in increased wave amplitude. In a shaded environment, this affects the object by absorbing direct waves from the source in the tissue as well as reflected waves, resulting in a higher SAR value.

In some cases of our simulation scenarios, the SAR values results are not within the limits for public radio- frequency EM field exposure by ICNIRP. However, it could be caused by setting

the specific parameters of our simulations – such as dielectric parameters of materials, number of voxels, boundary conditions in each space and model of human head. On the other hand, the cases presented in this paper, represent a risk for long-term exposure of human body, especially of human head, to EM field.

In this article we would like to show differences between open space and shielded space, which could be some vehicles like train, car and another shielded spaces with low signal from base station like underground park places or elevators. Mobile phone has highest power in this types of spaces and places, which was proven in our simulations. [12]

<https://ieeexplore.ieee.org/document/8949133>

VARIATION IN REPORTED HUMAN HEAD TISSUE ELECTRICAL CONDUCTIVITY VALUES

McCann H, Pisano G, Beltrachini L. Brain Topogr. 2019 Sep;32(5):825-858. doi: 10.1007/s10548-019-00710-2.

Abstract

Electromagnetic source characterisation requires accurate volume conductor models representing head geometry and the electrical conductivity field. Head tissue conductivity is often assumed from previous literature, however, despite extensive research, measurements are inconsistent. A meta-analysis of reported human head electrical conductivity values was therefore conducted to determine significant variation and subsequent influential factors. Of 3121 identified publications spanning three databases, 56 papers were included in data extraction. Conductivity values were categorised according to tissue type, and recorded alongside methodology, measurement condition, current frequency, tissue temperature, participant pathology and age. We found variation in electrical conductivity of the whole-skull, the spongiform layer of the skull, isotropic, perpendicularly- and parallelly-oriented white matter (WM) and the brain-to-skull-conductivity ratio (BSCR) could be significantly attributed to a combination of differences in methodology and demographics. This large variation should be acknowledged, and care should be taken when creating volume conductor models, ideally constructing them on an individual basis, rather than assuming them from the literature. When personalised models are unavailable, it is suggested weighted average means from the current meta-analysis are used. Assigning conductivity as: 0.41 S/m for the scalp, 0.02 S/m for the whole skull, or when better modelled as a three-layer skull 0.048 S/m for the spongiform layer, 0.007 S/m for the inner compact and 0.005 S/m for the outer compact, as well as 1.71 S/m for the CSF, 0.47 S/m for the grey matter, 0.22 S/m for WM and 50.4 for the BSCR.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6708046/>

A THEORETICAL STUDY ON THE BIOPHYSICAL MECHANISMS BY WHICH TUMOR TREATING FIELDS AFFECT TUMOR CELLS DURING MITOSIS

Li X, Yang F, Rubinsky B. A Theoretical Study on the Biophysical Mechanisms by Which Tumor Treating Fields Affect Tumor Cells during Mitosis. IEEE Trans Biomed Eng. 2020 Jan 13. doi: 10.1109/TBME.2020.2965883.

Abstract

OBJECTIVE: A theoretical study on the mechanisms through which Tumor Treating Fields (TTFields) affect dividing tumor cells.

METHODS: Numerical analysis was used to revisit two previously proposed mechanisms and introduce a third. We examine the previous hypotheses that: a) TTFields generate a moment that affects microtubule assembly during early mitosis, and b) dielectrophoretic (DEP) forces cause neutral particles to move toward the cleavage furrow during the telophase stage. We further introduce a new hypothesis that TTFields modify cell membrane potential in dividing tumor cells.

RESULTS: a) The Brownian energy is several orders of magnitude larger than the moment induced by TTFields on tubulin dimers. b) Adding Stokes drag forces to DEP forces shows that the motion of the particles in the cytoplasm is very slow, approximately 0.003 $\mu\text{m/s}$, and therefore, unless the duration of the telophase is long enough there will be no substantial effect from the DEP forces. c) The Schwan equation shows that electric fields at the frequencies of clinical TTFields can cause a 10% - 17% change in tumor cell membrane potential.

CONCLUSION: Our studies find limited support for the previously suggested hypotheses and suggest that the TTFields effect on cell membrane potential by affecting ion channels could be a mechanism of tumor cell death.

SIGNIFICANCE: Previously suggested mechanisms of tumor cell death from TTFields are found lacking. The effect of TTFields on the tumor cell membrane potential warrants further research.

<https://www.ncbi.nlm.nih.gov/pubmed/31940516>

A CRITICAL REVIEW AND SYNTHESIS OF CLINICAL AND NEUROCOGNITIVE EFFECTS OF NONINVASIVE NEUROMODULATION ANTIDEPRESSANT THERAPIES.

McClintock SM, Kallioniemi E, Martin DM, Kim JU, Weisenbach SL, Abbott CC. A Critical Review and Synthesis of Clinical and Neurocognitive Effects of Noninvasive Neuromodulation Antidepressant Therapies. Focus (Am Psychiatr Publ). 2019 Jan;17(1):18-29. doi: 10.1176/appi.focus.20180031.

Abstract

There is a plethora of current and emerging antidepressant therapies in the psychiatric armamentarium for the treatment of major depressive disorder. Noninvasive neuromodulation therapies are one such therapeutic category; they typically involve the transcranial application of electrical or magnetic stimulation to modulate cortical and subcortical brain activity. Although electroconvulsive therapy (ECT) has been used since the

1930s, with the prevalence of major depressive disorder and treatment-resistant depression (TRD), the past three decades have seen a proliferation of noninvasive neuromodulation antidepressant therapeutic development. The purpose of this critical review was to synthesize information regarding the clinical effects, neurocognitive effects, and possible mechanisms of action of noninvasive neuromodulation therapies, including ECT, transcranial magnetic stimulation, magnetic seizure therapy, and transcranial direct current stimulation.

Considerable research has provided substantial information regarding their antidepressant and neurocognitive effects, but their mechanisms of action remain unknown. Although the four therapies vary in how they modulate neurocircuitry and their resultant antidepressant and neurocognitive effects, they are nonetheless useful for patients with acute and chronic major depressive disorder and TRD. Continued research is warranted to inform dosimetry, algorithm for administration, and integration among the noninvasive neuromodulation therapies and with other antidepressant strategies to continue to maximize their safety and antidepressant benefit.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6493152/>

THE ROLE OF RADIATION INDUCED OXIDATIVE STRESS AS A REGULATOR OF RADIO-ADAPTIVE RESPONSES

Sisakht M, Darabian M, Mahmoodzadeh A, Bazi A, Shafiee SM, Mokarram P, Khoshdel Z. The role of radiation induced oxidative stress as a regulator of radio-adaptive responses. *Int J Radiat Biol.* 2020 Jan 24;1-40. doi: 10.1080/09553002.2020.1721597.

Abstract

Purpose: Various sources of radiation including radiofrequency, electromagnetic radiation (EMR), low- dose X- radiation, low-level microwave radiation and ionizing radiation (IR) are indispensable parts of modern life. In the current review, we discussed the adaptive responses of biological systems to radiation with a focus on the impacts of radiation-induced oxidative stress (RIOS) and its molecular downstream signaling pathways.

Materials and methods: A comprehensive search was conducted in Web of Sciences, PubMed, Scopus, Google Scholar, Embase, and Cochrane Library. Keywords included Mesh terms of "radiation", "electromagnetic radiation", "adaptive immunity", "oxidative stress", and "immune checkpoints". Manuscript published up until December 2019 were included.

Results: RIOS induces various molecular adaptors connected with adaptive responses in radiation exposed cells. One of these adaptors includes p53 which promotes various cellular signaling pathways. RIOS also activates the intrinsic apoptotic pathway by depolarization of the mitochondrial membrane potential and activating the caspase apoptotic cascade. RIOS is also involved in radiation-induced proliferative responses through interaction with mitogen-activated protein kinases (MAPks) including p38 MAPK, ERK, and c-Jun N-terminal kinase (JNK).

Protein kinase B (Akt)/phosphoinositide 3-kinase (PI3K) signaling pathway has also been reported to be involved in RIOS-induced proliferative responses. Furthermore, RIOS promotes genetic instability by introducing DNA structural and epigenetic alterations, as well as attenuating DNA repair mechanisms. Inflammatory transcription factors including

macrophage migration inhibitory factor (MIF), nuclear factor κ B (NF- κ B), and signal transducer and activator of transcription-3 (STAT-3) play major role in RIOS-induced inflammation.

Conclusion: In conclusion, RIOS considerably contributes to radiation induced adaptive responses. Other possible molecular adaptors modulating RIOS-induced responses are yet to be divulged in future studies.

<https://www.ncbi.nlm.nih.gov/pubmed/31976798>

NATIONAL OBSERVATORY OF ELECTROMAGNETIC FIELDS: NATIONAL TELEMETRIC NETWORK FOR THE MEASUREMENT OF HIGH- FREQUENCY ELECTROMAGNETIC FIELDS IN GREECE

Karastergios I, Gialofas A, Karabetsos E. Radiat Prot Dosimetry. 2020 Feb 5. pii: ncz301. doi: 10.1093/rpd/ncz301.

Abstract

At the end of 2015, the operation of the National Observatory of Electromagnetic Fields (established in 2012) has started. The National Observatory of Electromagnetic Fields is a network of 500 fixed (480 broadband and 20 frequency selective) and 13 mobile (vehicle mounted frequency selective) measurement stations throughout Greece that continuously monitor the electromagnetic field levels from all kinds of antenna stations in the frequency range 100kHz-7GHz. The results of this national monitoring network, which is operated and controlled by the Greek Atomic Energy Commission (EEAE), are presented through an interactive web portal (<https://paratiritirioemf.eeae.gr>), in which data are constantly updated with the latest station measurements.

This paper presents the operational aspects and the measurement results of the first 3 years of operation (2016- 2018). The measurement results revealed that all values were well below the reference levels for general public exposure, as defined by the Greek legislation.

<https://www.ncbi.nlm.nih.gov/pubmed/32022239>

Conclusions

The scope of this study is to present the NOEF's measurement data of the broadband measurement stations for the first 3 years of its operation. The measurement sample consists of 489 annual average and maximum values from all frequency bands of the broadband monitoring stations, 100kHz–7GHz, and the three sub-bands, 925–960 MHz, 1805–1880 MHz and 2110–2170 MHz.

It is concluded that 100% of the annual average and maximum values, from all four aforementioned frequency bands, are lower than 10 V/m (equivalent to 0.2653 W/m²), which is well below the Greek reference levels for general public exposure. It should be noted that the established Greek safety limits for general public exposure in the vicinity of antenna stations are set in general to 70% of the 1999 EU Council's Recommendation and the 1998 ICNIRP guidelines for basic restrictions and reference level values and to 60% of them for stations located closer than 300 meters from the perimeter of schools, kindergartens,

hospitals or eldercare facilities. The comparison of the NOEF's measurements data is performed with the 60% of the EU Recommendation reference levels in all cases, as this is the strictest Greek exposure limit.

Also, 91% of the annual average values of the 100kHz–7GHz frequency band are lower than 2 V/m (or 0.0106 W/m²), while 92% of the annual average values for both 925–960 MHz–1805–1880 MHz sub-bands are below 1 V/m (or 0.00265 W/m²), and 91% of the annual average values of the 2110–2170 MHz sub-band are below 1 V/m (or 0.00265 W/m²).

Regarding the annual maximum values, the statistics are similar; 80% of the annual maximum values of the 100kHz–7GHz frequency band are below 2 V/m (or 0.0106 W/m²); 83% of the annual maximum values of the 925–960 MHz frequency band are below 1 V/m (or 0.00265 W/m²); 79% of the annual maximum values of the 1805–1880 MHz frequency band are below 1 V/m (or 0.00265 W/m²); 80% of the annual maximum values of the 2110–2170 MHz frequency band are below 1 V/m (or 0.00265 W/m²).

It is to be noted that, as expected, at the lower value intervals of electrical field strength, there is a higher concentration of average values than at the higher value intervals.

Also, the standard deviation values of the annual average values are below 0.5 V/m for the majority of the measurement locations. This is due to the normal daily fluctuations of the telecommunication networks traffic which results to variations of the measured electromagnetic fields levels.

Moreover, at locations with higher-than-normal standard deviation values, a change of the electromagnetic fields background levels has been observed within the 3-year period of the study which was verified with in situ measurements with handheld frequency selective EMF measuring equipment.

It should also be mentioned that the aforementioned results show higher exposure levels when compared to the results from the international radiofrequency exposure surveys(13) that mostly concern ground-level measurements. This is expected since all the NOEF's fixed measuring stations are installed on rooftops, and so, measurement results represent 'worst-case' general public exposure conditions. Rooftop measurements are also performed by the telemetric networks mentioned in (7, 8) and Table 1. Hence, the NOEF's results are similar to those of the abovementioned telemetric networks.

APOPTOTIC EFFECT OF 1800 MHZ ELECTROMAGNETIC RADIATION ON NIH/3T3 CELLS

Li DY, Song JD, Liang ZY, Oskouei K, Xiao XQ, Hou WZ, Li JT, Yang YS, Wang ML, Murbach M. Apoptotic Effect of 1800 MHz Electromagnetic Radiation on NIH/3T3 Cells. *Int J Environ Res Public Health*. 2020 Jan 28;17(3). pii: E819. doi: 10.3390/ijerph17030819.

Abstract

To investigate the effect of 1800 MHz electromagnetic radiation (EMR) on apoptosis, we exposed NIH/3T3 cells at 1800 MHz with a specific absorption rate (SAR) of 2 W/kg intermittently for 12, 24, 36, and 48 h. After exposure, Cell Counting Kit-8 (CCK-8) and flow cytometry were used to detect cell viability and apoptosis; the expression of p53, a molecule

with the key role in apoptosis, was measured by real-time qPCR, western blot, and immunofluorescence; and images of the structure of the mitochondria, directly reflecting apoptosis, were captured by electron microscopy. The results showed that the viability of cells in the 12, 36, and 48 h exposure groups significantly decreased compared with the sham groups; after 48 h of exposure, the percentage of late apoptotic cells in the exposure group was significantly higher. Real-time qPCR results showed that p53 mRNA in the 48 h exposure group was 1.4-fold of that in the sham group; significant differences of p53 protein fluorescence expression were observed between the exposure groups and the sham groups after 24 h and 48 h. The mitochondrial swelling and vesicular morphology were found in the electron microscopy images after 48 h exposure. These findings demonstrated 1800 MHz, SAR 2 W/kg EMR for 48 h may cause apoptosis in NIH/3T3 cells and that this apoptosis might be attributed to mitochondrial damage and upregulation of p53 expression.

Open access paper: <https://www.mdpi.com/1660-4601/17/3/819>

ELECTROMAGNETIC FIELD MODULATES AGGREGATION PROPENSITY OF AMYLOID PEPTIDES

Todorova N, Bentvelzen A, Yarovsky I. Electromagnetic field modulates aggregation propensity of amyloid peptides. *J Chem Phys.* 2020 Jan 21;152(3):035104. doi: 10.1063/1.5126367.

Abstract

Nonthermal effects of the electromagnetic (EM) field in the radio and microwave frequency ranges on basic biological matter are difficult to detect and thus remain poorly understood. In this work, all-atom nonequilibrium molecular dynamics simulations were performed to investigate the molecular mechanisms of an amyloidogenic peptide response to nonionizing radiation of varying field characteristics. The results showed that the EM field induced peptide conformations dependent on the field frequency and strength. At the high field strength (0.7 V/nmrms), the peptide explored a wider conformational space as the frequency increased from 1.0 to 5.0 GHz. At the intermediate strength fields (0.07-0.0385 V/nmrms), the frequencies of 1.0 and 2.5 GHz resulted in the peptide being trapped in specific conformations, with 1.0 GHz enabling both fibril-forming and fibril-inhibiting conformations, while 2.5 GHz led to formation of mostly fibril-forming conformations. In contrast, the 5.0 GHz frequency caused increased peptide dynamics and more extended conformations with fibril-enabling aromatic side-chain arrangement akin to the structures formed under ambient conditions. All the simulated frequencies at low strength fields (0.007-0.0007 V/nmrms) resulted in the formation of amyloid-prone hairpin conformations similar to those formed under the weak static electric field and ambient conditions. These results suggest that specific ranges of EM field parameters produce peptide conformations unfavorable for formation of amyloid fibrils, a phenomenon that can be exploited in treatment and prevention of amyloid diseases. Alternatively, EM field parameters can be selected to modulate the formation of well-ordered peptide assemblies as a rational design strategy for engineering biocompatible materials.

Open access paper: <https://aip.scitation.org/doi/10.1063/1.5126367>

COMPARISON OF STATISTIC METHODS FOR CENSORED PERSONAL EXPOSURE TO RF-EMF DATA

Najera A, Ramirez-Vazquez R, Arribas E, Gonzalez-Rubio J. Comparison of statistic methods for censored personal exposure to RF-EMF data. *Environ Monit Assess.* 2020 Jan 2;192(2):77. doi: 10.1007/s10661-019-8021-z.

Abstract

Several studies have characterized personal exposure to RF-EMF, which allows possible effects on health to be studied. All equipment has a detection limit, below which we obtain nondetects or censored data. This problem is a challenge for researchers as it makes the analysis of such data complex. We suggest reconsidering the statistical protocols of the nondetects analysis by comparing four different methods. Three of them substitute censored data using different approaches: regression on order of statistics (ROS) to simulate data below the detection limit (Method 1), substituting nondetect values by the detection limit divided by 2 (Method 2), a naïve calculation (Method 3) using the detection limit as a valid measurement. The fourth method consists of considering censored data to be missing values (Method 4). This article examines how these methods affect the quantification of personal exposure. We considered data from 14 frequency bands from FM to WiMax measured in Albacete (Spain) for 76 days every 10 s by a personal exposimeter (PEM) Satimo EME Spy 140. Methods 3 and 2 gave similar mean and median values to Method 1, but both underestimated the mean values when high nondetects records occurred, which conditioned the physical description of the real situation. The mean values calculated by Method 4 differed from those obtained by Method 1 but were similar when the percentage of nondetects was below 20%. Our comparison suggests that nondetects can be neglected when the percentage of censored data is low to provide a more realistic physical situation.

<https://www.ncbi.nlm.nih.gov/pubmed/31897614>

RADIO-FREQUENCY ELECTROMAGNETIC FIELD EXPOSURE OF WESTERN HONEY BEES

Thielens A, Greco MK, Verloock L, Martens L, Joseph W. Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees. *Sci Rep.* 2020 Jan 16;10(1):461. doi: 10.1038/s41598-019-56948-0.

Abstract

Radio-frequency electromagnetic fields (RF-EMFs) can be absorbed in all living organisms, including Western Honey Bees (*Apis Mellifera*). This is an ecologically and economically important global insect species that is continuously exposed to environmental RF-EMFs. This exposure is studied numerically and experimentally in this manuscript. To this aim, numerical simulations using honey bee models, obtained using micro-CT scanning, were implemented to determine RF absorbed power as a function of frequency in the 0.6 to 120 GHz range. Five different models of honey bees were obtained and simulated: two workers, a drone, a larva, and a queen. The simulations were combined with in-situ measurements of environmental RF-EMF exposure near beehives in Belgium in order to estimate realistic exposure and absorbed power values for honey bees. Our analysis shows that a relatively small shift of 10% of environmental incident power density from frequencies below 3 GHz to higher frequencies will lead to a relative increase in absorbed power of a factor higher than 3.

Conclusions

Exposure of Western Honey Bees (*apis mellifera*) to radio-frequency (RF) electromagnetic fields was studied using a combination of in-situ exposure measurements near bee hives in Belgium and numerical simulations. The simulations use the finite-difference time-domain technique to determine the electromagnetic fields in and around five honey bee models exposed to plane waves at frequencies from 0.6 GHz up to 120 GHz. These simulations lead to a quantification of the whole-body averaged absorbed radio-frequency power (Pabs) as a function of frequency. The average Pabs increases by factors 16 to 121, depending on the considered phantom, when the frequency is increased from 0.6 GHz to 6 GHz for a fixed incident electric field strength. A relatively small decrease in Pabs is observed for all studied honey bees between 12 and 120 GHz. RF exposure measurements were executed on ten sites near five different locations with bee hives in Belgium. These measurements resulted in an average total incident RF field strength of 0.06 V/m, which was in excellent agreement with literature. This value was used to assess Pabs for those honey bees at those measurement sites. A realistic Pabs is estimated to be between 0.1 and 0.7 nW for the studied honey bee models. Assuming that 10% of the incident power density would shift to frequencies higher than 3 GHz would lead to an increase of this absorption between 390–570%. Such a shift in frequencies is expected in future networks.

Open access paper: <https://www.nature.com/articles/s41598-019-56948-0>

Testing of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields

Li ZQ, Zhang Y, Wan YM, Zhou Q, Liu C, Wu HX, Mu YZ, He YF, Rauniyar R, Wu XN. Testing of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields. *J Radiat Res.* 2020 Jan 11. pii: rrz097. doi: 10.1093/jrr/rrz097.

Abstract

The objective of the study was to explore the effects of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields. Pregnant female rats were exposed to radiofrequency fields beginning on the 21st day of pregnancy. The indicators of physiological and behavioral development were observed and measured in the offspring rats: Y maze measured at 3-weeks postnatal, open field at 7-weeks postnatal, and the expression of N-methyl-D-aspartate receptors (NMDARs) measured by reverse transcription-PCR in the hippocampus at 9-weeks postnatal. The body weight of the 1800 MHz group and the 1800 MHz + WiFi group showed a downward trend. The eye opening time of newborn rats was much earlier in the WiFi group than in the control group. Compared to the control group, the overall path length of the 1800 MHz + WiFi group was shortened and the stationary time was delayed. The path length of the WiFi group was shortened and the average velocity was increased in the error arm. The 1800 MHz + WiFi group displayed an increased trend in path length, duration, entry times and stationary time in the central area. In both the 1800 MHz + WiFi and WiFi groups, NR2A and NR2B expression was down-regulated, while NR2D, NR3A and NR3B were up-regulated. Moreover, NR1 and NR2C in the WiFi group were also up-regulated. Prenatal exposure to 1800 MHz and WiFi radiofrequency may affect the behavioral and cognitive development of offspring rats, which may be associated with altered mRNA expression of NMDARs in the hippocampus

<https://www.ncbi.nlm.nih.gov/pubmed/31927574>

RADIOPROTECTION IN PRENATAL CARE USING A NONWOVEN FABRIC WITH ELECTROMAGNETIC SHIELDING PROPERTY

Sahmelikoglu, AG, Karakas S, Tellioglu AM, Acer, N, Bilgen M. Radioprotection in prenatal care using a nonwoven fabric with electromagnetic shielding property. *Erciyes Medical Journal*. 41(4):444-449. Dec 2019.

Abstract

Objective: Electromagnetic shielding fabrics (EMSFs) have been marketed by several manufacturers within the past few years. However, their efficacies in protecting living organisms against the harmful effects of EM noise have yet to be established. The aim of the present study was to accomplish this task with novel in vivo experiments where fetal development and the pathological consequences of wearing protective fabric against EM radiation during pregnancy were investigated.

Materials and Methods: Nine pregnant rats were equally divided into three groups. Sham controls were kept unexposed, but the remaining six were subjected to EM radiation at 900 MHz for 1 h daily throughout the pregnancy. However, three of the rats were protected by a nonwoven fabric manufactured locally and characterized previously. After birth, the kidneys of newborns were extracted and evaluated by histopathology. Histometry data were analyzed statistically.

Results: EM exposure affected the kidney structure and morphology as revealed by the disruption of glomerular basement membrane continuity, increased Bowman capsule and proximal tubule sizes (from 15.01 +/- 2.56 μ m to 29.94 +/- 4.42 μ m), and thickened cortex and medulla (from 261.13 +/- 4.10 μ m to 284.57 +/- 10.93 μ m for cortex and from 594.25 +/- 23.48 μ m to 732.61 +/- 20.46 μ m for medulla). However, the effects were significantly attenuated in those kidneys placed behind the fabric.

Conclusion: EMSF effectively protects the fetal kidney against EM radiation at 900 MHz during the developmental phase and possibly at other frequencies and for other organs. It is advisable to wear such fabrics during pregnancy when EM pollution is of significant concern.

Open access paper:

https://www.journalagent.com/erciyesmedj/pdfs/EMJ_41_4_444_449.pdf

RADIO FREQUENCY-INDUCED SUPEROXIDE ACCUMULATION AFFECTED THE GROWTH AND VIABILITY OF SACCHAROMYCES CEREVISIAE (BAKER'S YEAST)

Li Q, Tian M, Teng J, Gao P, Tang BQ, Wu H. Radio frequency-induced superoxide accumulation affected the growth and viability of *Saccharomyces cerevisiae*. *Int Microbiol*. 2020 Jan 2. doi: 10.1007/s10123-019-00111-2.

Abstract

With the development of the electric technologies, the biological effects of electromagnetic fields (EMF) were widely studied. However, the results remain controversial and the biophysical mechanisms are still unknown. To our knowledge, little studies pay attention to the radio frequency (RF) of 2.6-5 MHz. In the present study, we investigated the effect of these radio frequencies on the growth and cell viability of *Saccharomyces cerevisiae* at very

low power density below 0.1 mT. The result appeared to be time-dependent. The growth of the yeast cells was obviously affected by the RF-EMF with a 43.5% increase when exposed for 30 h, and the growth-promoting effect decreased along with the radiation time and eventually turned to an inhibiting effect retarding growth by 20.7% at 89 h. The cell viability was improved to 70.1% at 8 h and reduced by 33.5% at 28 h. The superoxide accumulated in exposed cells as radiation time increased which may lead to the inhibition of viability and growth of the cells. However, the efficient frequency, power density, and exposure dosage await further investigation. Nevertheless, the wave band studied in this research is effective to produce biological effect, and therefore, it may provide an optional new radio frequency which is valuable for the development and utilization in therapy technique and medical use.

<https://www.ncbi.nlm.nih.gov/pubmed/31898034>

IN VITRO STUDY OF EFFECTS OF ELF-EMF ON TESTICULAR TISSUES OF ROE

Koziorowska A, Depciuch J, Kozioł K, Nowak S, Lach K. Anim Reprod Sci. 2020 Feb;213:106258. doi: 10.1016/j.anireprosci.2019.106258.

Abstract

Electromagnetic fields (EMF) are classified as an environmental factor affecting living organisms. The aim of the study was to evaluate the effect of EMF at different frequencies (50 and 120 Hz), durations of treatment (2 and 4 h) and with the magnetic induction of 8 m T on testicular tissues of roe deer (*Capreolus capreolus*) in vitro by comparison with the control samples. Fourier Transform Raman Spectroscopy (FT-Raman) and Fourier Transform Infrared Spectroscopy (FTIR) were utilized in this study to identify the chemical changes in the testicular tissues. The FTIR and FT-Raman spectroscopy methods were used to evaluate differences in spectra of the treated tissues compared to the control group. The results from the analysis of the spectra indicated there were characteristic differences in the testicular tissue compared with the control samples. There was identification of peaks attributed to different biochemical components. Comparing the spectra for different frequencies and treatment times, there was a greater intensity of peaks originating from most of the functional groups in the tissues evaluated. With the FTIR spectra, there were five of 15 peaks, while with the FT-Raman spectra, there were six of ten peaks that were shifted. For FTIR and FT-Raman analyzed spectral ranges, results from the PCA analysis indicate there was no similarity between control groups (2 and 4 h) and samples treated with EMF at a frequency of 120 Hz for 2 and 4 h. In conclusion, therefore, EMF is an environmental factor affecting the testis of roe deer.

<https://www.ncbi.nlm.nih.gov/pubmed/31987319>

EFFECTS OF LONG-TERM EXPOSURE TO LOW-POWER 915 MHZ UNMODULATED RADIATION ON PHASEOLUS VULGARIS L.

Surducan V, Surducan E, Neamtu C, Mot AC, Ciorîță A. Effects of Long-Term Exposure to Low-Power 915 MHz Unmodulated Radiation on Phaseolus vulgaris L. Bioelectromagnetics. 2020 Feb 6. doi: 10.1002/bem.22253.

Abstract

The morphophysiological response of Phaseolus vulgaris L. to low-power electromagnetic radiation was investigated in order to assess the potential harmful effects of long-term continuous exposure. The plants were grown in two separate electromagnetic field (EMF) shielded rooms, in a controlled, greenhouse-like environment. One batch was continuously irradiated during the growth period (from sowing to maturity) and the other one was used as a reference. An unmodulated signal at 915 MHz (the central frequency between the uplink and downlink of the GSM900 mobile communications band) was used, with a maximum power density of 10 mW/m² measured near the plants. The plants were analyzed using ultraviolet-visible, statistical, morphometric, and electron microscopy methods. Significant differences were observed regarding the height of the plants, number of inflorescences, and chlorophyll and carotenoid content, all closely connected with the ultrastructural changes observed in the leaves. The irradiated batch grew higher (19% increase in plant height, 20% increase in stem and leaves' dry mass), with 18% fewer inflorescences, and extremely long roots (34% increase in dry mass). The ultrastructure of the irradiated leaves showed irregular cells and a higher content of plastoglobules in the chloroplasts. All results indicate that the irradiated plants suffered significant morphological modifications during their long-term exposure to the specific EM radiation.

<https://www.ncbi.nlm.nih.gov/pubmed/32030775>

NOTES ON PARLIAMENT HEARING IN TALLINN, ESTONIA JUNE 4, 2019 AS REGARDS THE DEPLOYMENT OF THE FIFTH GENERATION, 5G, OF WIRELESS COMMUNICATION

Hardell L. World Academy of Sciences Journal. November 18, 2019 pp. 1-8. <https://doi.org/10.3892/wasj.2019.28>

Abstract

The fifth generation (5G) for wireless communication is about to be deployed worldwide in spite of no thorough studies being made on the potential risks to human health and the environment. The implementation seems to be driven mainly by business interests, not considering mounting public anxiety on the associated risks. In Estonia, an appeal on a moratorium was signed by 1,122 subjects, forcing a hearing in the Social Affairs Commission and the Environment Commission of Estonian Parliament on June 4, 2019. The hearing lasted for 1 h and 40 min. The whole hearing may be found on the web. It clearly demonstrated that decision-making bodies base their decisions and act on expert statements that tend to be biased and formed by a cartel of members instead of their own science-based evaluation. Thus, the hearing revealed a lack of knowledge among the Commission members on the risks involved with the use of 5G wireless communication that is exemplified herein. This may create negative consequences for human health and the environment in the future.

Open access paper:

<https://www.spandidos-publications.com/10.3892/wasj.2019.28/download>

DISCUSSION ON SPATIAL AND TIME AVERAGING RESTRICTIONS WITHIN THE ELECTROMAGNETIC EXPOSURE SAFETY FRAMEWORK IN THE FREQUENCY RANGE ABOVE 6 GHZ FOR PULSED AND LOCALIZED EXPOSURES

Neufeld E, Samaras T, Kuster N. Discussion on Spatial and Time Averaging Restrictions Within the Electromagnetic Exposure Safety Framework in the Frequency Range Above 6 GHz for Pulsed and Localized Exposures. *Bioelectromagnetics*. 2019 Dec 30. doi: 10.1002/bem.22244.

Abstract

Both the current and newly proposed safety guidelines for local human exposure to millimeter-wave frequencies aim at restricting the maximum local temperature increase in the skin to prevent tissue damage. In this study, we show that the application of the current and proposed limits for pulsed fields can lead to a temperature increase of 10°C for short pulses and frequencies between 6 and 30 GHz. We also show that the proposed averaging area of 4 cm², that is greatly reduced compared with the current limits, does not prevent high-temperature increases in the case of narrow beams. A realistic Gaussian beam profile with a 1 mm radius can result in a temperature increase about 10 times higher than the 0.4°C increase the same averaged power density would produce for a plane wave. In the case of pulsed narrow beams, the values for the time and spatial-averaged power density allowed by the proposed new guidelines could result in extreme temperature increases. <https://www.ncbi.nlm.nih.gov/pubmed/31885092>

Excerpts

.... In this letter, we look at limits, such as those currently proposed or recently approved for the revised ICNIRP guidelines and IEEE standard, and investigate whether such limits are consistent with the stated goals of the exposure safety frameworks of preventing excessive heating in the case of pulsed and/or localized radiation. In cases when they are not consistent, we discuss how consistency can be achieved. In line with the abovementioned safety standards and exposure guidelines, the presented analysis focuses exclusively on the magnitude of the tissue temperature increase as a risk factor and does not consider other aspects, such as the thermoelastic effect related to the rapidity of temperature increase.....

In conclusion, the results presented above demonstrate that, in the case of very short pulses, pulse-duration- independent limits imposed on transmitted energy density (fluence) alone cannot preclude the induction of high-temperature increases in the skin. Pulse-duration-dependent limits should be applied also for pulses less than 1 s and possibly less than 30 GHz as well. Even though the amplifiers of the currently developed consumer devices will not allow the full exploitation of the limits of the guidelines, the guidelines should not implicitly rely on this, as they will be used to develop exposure assessment standards with the aim of ensuring safety of any future technology, e.g. IEC/IEEE 63195 [2018]. Accordingly, either assumption must be explicitly stated in the guidelines, or the limits should be adapted to be intrinsically safe. In the absence of limitations applied to the peak-to-average power ratio of pulses, it is possible to deliver to the body large amounts of energy within a very short time interval. For millimeter-wave frequencies, where the absorption is superficial, this results in fast and dramatic temperature rises, as the step response function is proportional to the rapidly rising rather than the commonly encountered for deeper heating. As far as spatial averaging is concerned, it has been shown that an averaging area smaller than 4 cm² should be introduced in order to avoid peak PDs in narrow beams [Neufeld and Kuster, 2018] that

overheat the tissues. With increasing beam radius, e.g. at larger distances from the antenna(s), the tolerable averaging area increases rapidly, provided that there are no sharp exposure peaks.

Duration-independent limits on the fluence of pulses are not suitable. They should either be replaced by duration-dependent fluence limits for pulses or by limits on the (temporal) peak exposure. In both cases, the limits should be set after taking narrow-beam exposures into consideration. These limits will depend on the chosen spatial and temporal averaging schemes and the maximum temperature increase deemed acceptable. Forward-looking knowledge about the technical needs and priorities of the industry could allow for selecting the balance between thresholds (averaging time and area, peak-to-average ratio, PD) to minimally impact the technological potential using the same limit-setting framework.

SPECIAL ISSUE: "ELECTRIC, MAGNETIC, AND ELECTROMAGNETIC FIELDS IN BIOLOGY AND MEDICINE: FROM MECHANISMS TO BIOMEDICAL APPLICATIONS"

Scarfì MR, Mattsson M-O, Simkó M, Zeni O. Editorial. Special Issue: "Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications." *Int. J. Environ. Res. Public Health* 2019, 16(22): 4548; <https://doi.org/10.3390/ijerph16224548>

1. Special Issue Rationale - The last decades have seen a huge increase in applications and devices using and emitting non-ionizing radiation, otherwise referred to as "electromagnetic fields" (EMF). This includes, e.g., the distribution and use of electricity and information and communication technologies. Present and foreseeable future technologies employ different parts of the electromagnetic (EM) spectrum, from static electric and magnetic fields, via low frequency fields to high frequency EMF encompassing millimeter waves and THz fields. Thus, humans are exposed to various electric, magnetic, and EMF in the course of everyday life. In addition, these kinds of non- ionizing radiation are also successfully employed in biomedical applications, for both diagnostic and therapeutic purposes, causing exposure in specific occupational environments. As a consequence, public and scientific concern with respect to the possible adverse health effects of EMF occurring after exposure to levels below those inducing known acute effects has been rising. A large body of literature dealing with experimental as well as clinical and population-based investigations into the biological and health effects of such fields has yielded inconsistent and often conflicting information. Moreover a comprehensive understanding of the mechanisms of interaction remains to be elucidated. Therefore, there is great interest in evaluating the induced biological responses from the point of view of the associated interaction mechanisms.

2. About the Papers of This Special Issue - The call for articles on "Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications" resulted in a total of 14 accepted manuscripts: 10 regular papers, one communication and three review papers. On the whole, the following issues were addressed:

(1) EMF Exposure Assessment - In the characterization of human exposure to EMF, children's exposure to extremely low frequency (ELF) magnetic fields has been a matter of debate since several meta-analyses reported on an increased risk of childhood leukemia's for daily average exposure above 0.4 μ T without any causal relationship. This issue was covered in two papers

by the same research group. Bonato et al. [1] propose a new method for the characterization of children's exposure, which relies on personal measurements and employs a stochastic approach based on segmentation that resulted in the identification of the parameters most affecting the level of children's exposure. Tognola et al. [2], characterized a real-life ELF exposure scenario by applying a machine learning approach on personal exposure measurements from 977 children in France. The impact of only outdoor sources of exposure was considered.

The measurements of personal exposure to radiofrequency (RF) EMF is a challenging task in epidemiological studies and was covered in two papers and one review article. Zeleke et al. [3] recorded and analyzed measurements of personal RF-EMF exposure levels from a wide range of frequency bands from 63 participants over a range of 27.4 ± 4.5 h. Liu et al. [4] investigated the applicability of an efficient whole-body individual modelling method for the assessment of RF exposure in the case of patient exposure under MRI examination. Chiamarello et al. [5] presented an overview of the papers published in the last ten years and address RF-EMF exposure assessment from different sources in indoor environments.

(2) Biological Effects of EMF Exposure and Health Risk Evaluation - An in vitro study by Sannino et al. [6] indicated a possible involvement of DNA repair mechanisms in the RF- induced adaptive response, a phenomenon by which pre-exposure of different cell cultures to RF fields under specific conditions is capable of reducing the damage induced by subsequent treatment with genotoxic agents.

Three studies report on the results of in vivo investigations carried out on laboratory animals. In particular, Guo et al. [7] investigated the effects of one-month exposure to a 220 MHz pulsed modulated RF field at the power density of 50 W/m² on the sperm quality in male adult rats, which was found to be impaired by the exposure. These exposure conditions were chosen by the authors since they are realistic under certain occupational conditions in which workers are exposed to high intensity RF fields.

The Medaka fish was chosen in the paper by Sun et al. [8] to address the effect of long term (entire development period) static magnetic field exposure at the mT level on embryo development and behavioral response. Development was not affected whereas swimming velocity was reduced in the exposed group.

Sienkiewicz and van Rongen [9] reviewed the evidence on the effects of exposure to RF fields, mostly associated with mobile phone technology, on the cognitive behavior of laboratory animals. Vornoli et al. [10] reviewed the currently available evidence from in vivo studies on carcinogenicity and reproductive toxicity studies in order to summarize the contribution of experimental research to the prevention of the adverse effects of RF radiation on human health.

Two studies were carried out on human volunteers. In Loughran et al. [11], the influence of RF-EMF on electroencephalogram (EEG) readings was investigated in 36 healthy adults participating in a randomized, double-blind provocation study with the aim to find out if a thermal mechanism is involved in nervous system responses to RF-EMF. Indeed, the results suggest such an involvement.

Vecsei et al. [12] studied the effects of acute exposure from long term evolution (LTE) mobile phone EMF on the thermal pain threshold in healthy young adults and no effects of exposure were seen.

A couple of other relevant papers are collected in this special issue that address the topic of the extrapolation of the outcome of animal studies to humans [13], and the identification and description of methods using non- ionizing radiation (NIR) such as EMF and optical radiation in Swedish health care [14]. Specifically, Kodera and Hirata computationally estimated the thermal time constants of temperature elevation in human head and rat models exposed to dipole antennas at 3–10 GHz [13], while Hansson Mild and coworkers identified three applications in Swedish health care (magnetic resonance imaging (MRI), transcranial magnetic stimulation (TMS), and electrosurgery) where acute effects at existing exposure levels could not be ruled out [14].

Open access paper: <https://www.mdpi.com/1660-4601/16/22/4548/htm>

GENETIC SUSCEPTIBILITY MAY MODIFY THE ASSOCIATION BETWEEN CELL PHONE USE AND THYROID CANCER: A POPULATION- BASED CASE-CONTROL STUDY IN CONNECTICUT

Luo J, Li H, Deziel NC, Huang H, Zhao N, Ma S, Nie X, tUdelsman R, Zhang Y. Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut. *Environmental Research*. Available online 6 December 2019, 109013. <https://doi.org/10.1016/j.envres.2019.109013>.

Highlights

- 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.
- Genetic susceptibility may modify the association between cell phone use and thyroid cancer.

Abstract

Emerging studies have provided evidence on the carcinogenicity of radiofrequency radiation (RFR) from cell phones. This study aims to test the genetic susceptibility on the association between cell phone use and thyroid cancer. Population-based case-control study was conducted in Connecticut between 2010 and 2011 including 440 thyroid cancer cases and 465 population-based controls with genotyping information for 823 single nucleotide polymorphisms (SNPs) in 176 DNA genes. We used multivariate unconditional logistic regression models to estimate the genotype-environment interaction between each SNP and cell phone use and to estimate the association with cell phone use in populations according to SNP variants. Ten SNPs had $P < 0.01$ for interaction in all thyroid cancers. In the common homozygote groups, no association with cell phone use was observed. In the variant group

(heterozygotes and rare homozygotes), cell phone use was associated with an increased risk for rs11070256 (odds ratio (OR): 2.36, 95% confidence interval (CI): 1.30–4.30), rs1695147 (OR: 2.52, 95% CI: 1.30–4.90), rs6732673 (OR: 1.59, 95% CI: 1.01–2.49), rs396746 (OR: 2.53, 95% CI: 1.13–5.65), rs12204529 (OR: 2.62, 95% CI: 1.33–5.17), and rs3800537 (OR: 2.64, 95% CI: 1.30–5.36) with thyroid cancers. In small tumors, increased risk was observed for 5 SNPs (rs1063639, rs1695147, rs11070256, rs12204529 and rs3800537), In large tumors, increased risk was observed for 3 SNPs (rs11070256, rs1695147, and rs396746). Our result suggests that genetic susceptibilities modify the associations between cell phone use and risk of thyroid cancer. The findings provide more evidence for RFR carcinogenic group classification.

<https://www.sciencedirect.com/science/article/abs/pii/S0013935119308102>

WIRELESS WEARABLES AND IMPLANTS: A DOSIMETRY REVIEW

Guido K, Kiourti A. Bioelectromagnetics. Wireless Wearables and Implants: A Dosimetry Review. 2020 Jan;41(1):3-20. doi: 10.1002/bem.22240.

Abstract

Wireless wearable and implantable devices are continuing to grow in popularity, and as this growth occurs, so too does the need to consider the safety of such devices. Wearable and implantable devices require the transmitting and receiving of electromagnetic waves near and through the body, which at high enough exposure levels may damage proximate tissues. The specific absorption rate (SAR) is the quantity commonly used to enumerate exposure levels, and various national and international organizations have defined regulations limiting exposure to ensure safe operation. In this paper, we comprehensively review dosimetric studies reported in the literature up to the year 2019 for wearables and implants. We discuss antenna designs for wearables and implants as they relate to SAR values and field and thermal distributions in tissue, present designs that have made steps to reduce SAR, and then review SAR considerations as they relate to applied devices. As compared with previous review papers, this paper is the first review to focus on dosimetry aspects relative to wearable and implantable devices.

<https://www.ncbi.nlm.nih.gov/pubmed/31854006>

Conclusions

This paper presents a comprehensive overview of the dosimetry aspects relevant to wearable and implantable antennas. Placing radiators close to or within the body poses challenges for both radiation efficiency and device safety. The primary indicator of dosimetry for such increasingly prevalent devices, SAR, manifests as a temperature increase within body tissues. When SAR peaks outside of the safe limits outlined by the IEEE, ICNIRP, and FCC, damage to the surrounding tissues, usually those located closest to the device, can occur. As such, designers of wearable and implantable devices are taking steps to reduce SAR levels while maintaining the radiation characteristics of the antenna. Both designers of wearable devices and designers of implantable devices share many of the methods used to reduce SAR, such as metamaterials and other ground plane alterations, and all methods seek to reduce peak areas of the electric field. As these devices continue to grow in popularity, designers must not only consider the safety of their own device but also the combined safety of the other devices that may be implemented on/in the same person.

RF EXPOSURE DUE TO MOBILE DEVICES OPERATED CLOSE TO THE HUMAN BODY

Fernández-Rodríguez C, Bulla G, de Salles AA. RF Exposure Due to Mobile Devices Operated Close to the Human Body. Proceedings of the 49th European Microwave Conference. Paris, France. 1-3 October 2019. pp. 264-267.

Abstract

The SAR (Specific Absorption Rate) simulations due to mobile devices operated in close range to the human head and body are described in this paper. The FDTD (Finite- Difference Time-Domain) numerical method together with realistic children, adolescents and adults' models are employed to estimate the 1 g and the 10 g SAR in different biological tissues. Typical mobile phones, laptops, tablets and virtual reality glasses were considered and the alternatives to reduce the SAR are discussed. The need of new dosimetric parameters and skin and nervous system models for 5G and millimetric waves exposure are also addressed.

VII. DISCUSSION AND CONCLUSIONS

The SAR for some typical mobile phones, laptops, tablets and virtual reality glasses were simulated and results were compared to the available recommended exposure guidelines. It was observed that when some of these devices are operated very close to the head or body the simulated results can be above the exposure limits. This is particularly the case for the children models and for particular tissues (e.g. hippocampus and cerebellum). Then the methods to determine regulatory compliance for wireless devices should be re-examined.

Antennas now used in portable devices are monopole, helix, PIFA or other planar structures (generally without ground plane) and they radiate the EMF almost to all directions. Since these devices can be operated close to the head or body, directional antennas radiating the EMF to the direction opposite to the head and body should be developed in order to reduce the SAR in these tissues. This can also contribute to reduce antenna input impedance mismatching when the device is operated close to the body. New antenna techniques including a back plane, electromagnetic band gap (EBG) and artificial magnetic conductor (AMC) could be adequate alternatives aiming to reduce the SAR in the user's head and body. There is also an urgent need for research to evaluate the risks to the eye from use of cell phones in virtual reality applications.

Also, in the near future the use of mm-waves (e.g. 26 GHz and above) will be widespread to carry new services on the 5 G network. Then, the need for new quantities of interest, metrics and exposure limits adequate for these frequencies, as well as modelling new structures, such as the skin and the nervous system, are suggested.

It is very important to remark that the recommendations and the standards usually adopted in different countries only consider the health effects of short time exposure. However, the mobile phones, notebooks, tablets and virtual reality glasses may be used for long time very close to the user's body. Then the long-time health effects must be taken into consideration in order to evaluate the health risks. Meanwhile the Precautionary Principle should be adopted in order to reduce health risks.

<https://ieeexplore.ieee.org/document/8910925>

MONITORING THE RISK OF THE ELECTRIC COMPONENT IMPOSED ON A PILOT DURING LIGHT AIRCRAFT OPERATIONS IN A HIGH- FREQUENCY ELECTROMAGNETIC FIELD

Michałowska J, Tofil A, Józwik J, Pytka J, Legutko S, Siemiątkowski Z, Łukaszewicz A. Monitoring the Risk of the Electric Component Imposed on a Pilot During Light Aircraft Operations in a High-Frequency Electromagnetic Field. *Sensors* (Basel). 2019 Dec 14;19(24). pii: E5537. doi: 10.3390/s19245537.

Abstract

High-frequency electromagnetic fields can have a negative effect on both the human body and electronic devices. The devices and systems utilized in radio communications constitute the most numerous sources of electromagnetic fields. The following research investigates values of the electric component of electromagnetic field intensification determined with the ESM 140 dosimeter during the flights of four aircrafts-Cessna C152, Cessna C172, Aero AT3 R100, and Robinson R44 Raven helicopter-from the airport in Depułtycze Krolewskie near Chelm, Poland. The point of reference for the obtained results were the normative limits of the electromagnetic field that can affect a pilot in the course of a flight. The maximum value registered by the dosimeter was $E = 3.307 \text{ V/m}$ for GSM 1800 frequencies.

Excerpt

Although the results obtained confirm that the measured values of the electromagnetic fields in the tested aircraft did not exceed the permissible values, there is a risk related to the high load on the pilot's body, especially the instructor, who performed a significant number of flights per day. As such, the radiation doses add up and this may cause premature fatigue and other negative effects on the instructor's mental condition.

Bearing in mind the need to increase the level of flight operations safety, it is reasonable to undertake research and development activities to develop a system for monitoring electromagnetic radiation and its impact on pilots during a flight. The authors' idea is an onboard electromagnetic field monitoring system, shown schematically in Figure 23.

Open access paper: <https://www.mdpi.com/1424-8220/19/24/5537>

WHOLE-BODY EXPOSURES TO RADIOFREQUENCY-ELECTROMAGNETIC ENERGY CAN CAUSE DNA DAMAGE IN MOUSE SPERMATOOZOA VIA AN OXIDATIVE MECHANISM

Houston BJ, Nixon B, McEwan KE, Martin JH, King BV, Aitken RJ, De Iuliis GN. Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse spermatozoa via an oxidative mechanism. *Sci Rep*. 2019 Nov 25;9(1):17478. doi: 10.1038/s41598-019-53983-9.

Abstract

Artificially generated radiofrequency-electromagnetic energy (RF-EME) is now ubiquitous in our environment owing to the utilization of mobile phone and Wi-Fi based communication devices. While several studies have revealed that RF-EME is capable of eliciting biological stress, particularly in the context of the male reproductive system, the mechanistic basis of this biophysical interaction remains largely unresolved. To extend these studies, here we exposed unrestrained male mice to RF-EME generated via a dedicated waveguide (905 MHz, 2.2 W/kg) for 12 h per day for a period of 1, 3 or 5 weeks. The testes of exposed mice exhibited

no evidence of gross histological change or elevated stress, irrespective of the RF-EME exposure regimen. By contrast, 5 weeks of RF- EME exposure adversely impacted the vitality and motility profiles of mature epididymal spermatozoa. These spermatozoa also experienced increased mitochondrial generation of reactive oxygen species after 1 week of exposure, with elevated DNA oxidation and fragmentation across all exposure periods. Notwithstanding these lesions, RF-EME exposure did not impair the fertilization competence of spermatozoa nor their ability to support early embryonic development. This study supports the utility of male germ cells as sensitive tools with which to assess the biological impacts of whole-body RF-EME exposure.

Open access paper: <https://www.nature.com/articles/s41598-019-53983-9>

PRENATAL EFFECTS OF A 1,800-MHZ ELECTROMAGNETIC FIELD ON RAT LIVERS

Tumkaya L, Yilmaz A, Akyildiz K, Mercantepe T, Yazici ZA, Yilmaz H. Prenatal Effects of a 1,800-MHz Electromagnetic Field on Rat Livers. *Cells Tissues Organs*. 2019 Dec 4:1-9. doi: 10.1159/000504506.

Abstract

The use of devices, including mobile phones, generating electromagnetic fields (EMF) is widespread and is progressively increasing. It has also been shown that EMF may have detrimental effects. This is the first study to investigate the postnatal biochemical and histological effects of prenatal exposure of rat livers to 1,800-MHz EMF at different time intervals in uteroplacental life. The 3 EMF groups of rats were exposed to 1,800-MHz EMF for 6, 12, or 24 h daily for 20 days. Unexposed rats served as control group. All rats were subjected to anesthesia, and on postnatal day 60, the livers were excised, and blood was collected for histological and biochemical analyses. Malondialdehyde levels were significantly higher in the exposed groups than the unexposed controls ($p < 0.05$). In contrast, EMF-exposed groups had lower liver tissue glutathione levels than controls ($p < 0.05$). Serum Ca^{2+} , alanine transaminase, and aspartate aminotransferase levels were higher in EMF-exposed groups than controls ($p < 0.05$). In addition, liver tissue total oxidant status levels were increased ($p < 0.05$), and liver tissue total antioxidant status levels were decreased ($p < 0.05$) compared to the control group. Furthermore, in the EMF groups, extensive vacuolation and degeneration of the hepatocytes in the portal area, as well as those surrounding the sinusoids, were evident. Affected hepatocytes had polygonally shaped nuclei and vacuolic cytoplasm imparting eosinophilic staining. Loss of cellular membrane integrity and invaginations, as well as picnotic nuclei, was prominent. This study has shown that intrauterine liver damage caused by 1,800-MHz EMF exposure persists into puberty in rats.

<https://www.ncbi.nlm.nih.gov/pubmed/31801129>

Excerpt

Three of the pregnant rats served as untreated controls, while the others were exposed to mobile phone radiation, which was adjusted to talking and Wi-Fi mode, for 6-, 12-, and 24-h/day for 20 consecutive days [Çetin et al., 2014; Meral et al., 2014; Ragy and Ragy, 2015; Schmid and Kuster, 2015; Mugunthan et al., 2016; Bahreyni Toossi et al., 2018; Ertilav et al., 2018]. The emitter of the EMF device (Anritsu MG3670 B type, Japan), which generates 1,800-MHz frequency radiation, was placed centrally under the cage [Bedir et al., 2018]. The SAR (specific absorption rate) value was calculated according to the study by Qin et al. [2012],

which was 0.12 W/kg. Eight newborn rats were allocated to each group. The newborn rats were not exposed to EMF. They were reared for 2 months under the aforementioned conditions.

DOES EXPOSURE OF SMART PHONES DURING PREGNANCY AFFECT THE OFFSPRING'S OVARIAN RESERVE? A RAT MODEL STUDY

Calis P, Seymen M, Soykan Y, Delen K, Aral BS, Take Kaplanoglu G, Karcaaltincaba D. Does Exposure of Smart Phones during Pregnancy Affect the Offspring's Ovarian Reserve? A Rat Model Study.

Fetal Pediatr Pathol. 2019 Dec 10:1-11. doi: 10.1080/15513815.2019.1692112.

Abstract

Objective: We investigated the effect of prenatal exposure to smart phone radiation and the protective effect of omega-3 on ovarian reserve of offspring. **Methods:** 24 pregnant Wistar albino rats were divided into four groups. Group-I received neither radiofrequency (RF) radiation nor omega-3, group-II received RF, group-III received RF radiation and 300 mg omega-3 and group-IV received RF radiation and 600 mg Omega-3 till birth. At 42 days, bilateral oophorectomy was performed on all female offspring for follicle count and immunohistochemical staining (GDF9, FOXO1 and TUNEL). **Results:** Group-II had significantly lower mean number of primordial ($p = 0.006$), secondary follicles ($p = 0.003$) and a higher atresia score. Group-III variables were comparable with group-I variables. Group-IV had statistically higher median number of atretic follicles than group-I ($p = 0.023$). **Conclusions:** Ovarian reserve of offspring diminished with RF exposure during pregnancy. Omega-3 supplementation during pregnancy may reduce the potential premature ovarian failure. <https://www.ncbi.nlm.nih.gov/pubmed/31820670>

Excerpts

RF exposure in the experiment resulted in a whole body average SAR of 0.23 W/kg with an ERMS field of 17.25 V/m. This SAR value could be accepted as non-thermal SAR level for RF radiation, because it is known that 4 W/kg SAR leads to 1 °C increase in the temperature of the exposed tissue. RF exposure was applied at the same time of the day at whole pregnancy for 1 hour/day.

In conclusion, RF appears to negatively alter ovarian reserve in a rat model when exposed throughout pregnancy. However, low dose of Omega-3 supplementation might be a preventive strategy to minimize atresia in such cases. Before extrapolating those results to clinical practice, current findings should be confirmed with human data.

BIOCHEMICAL, IMMUNOHISTOCHEMICAL AND MORPHOMETRICAL INVESTIGATION OF THE EFFECT OF THYMOQUINONE ON THE RAT TESTIS FOLLOWING EXPOSURE TO A 900-MHZ ELECTROMAGNETIC FIELD

Yahyazadeh A, Altunkaynak BZ, Kaplan S. Biochemical, immunohistochemical and morphometrical investigation of the effect of thymoquinone on the rat testis following exposure to a 900-MHz electromagnetic field. *Acta Histochem.* 2019 Nov 26:151467. doi: 10.1016/j.acthis.2019.151467.

Abstract

Long-term use of cell phones emitting electromagnetic fields (EMFs) have raised concerns regarding public health in recent year. We aimed to investigate the possible effects of 900 MHz EMF exposure (60 min/day for 28 days) on the rat testis. Another objective was to determine whether the deleterious effect of EMF radiation would be reduced by the administration of thymoquinone (TQ) (10 mg/kg/day). Twenty-four male adult Wistar albino rats were randomly selected, then assigned into four groups as follow Control, EMF, TQ and EMF + TQ. Testicular samples were analyzed using histological, stereological, biochemical and immunohistochemical techniques. Total numbers of primary spermatocytes and spermatids as well as Leydig cells were significantly decreased in the EMF group compared to the Control group ($p < 0.05$). In the EMF + TQ group, the total number of primary spermatocytes was significantly increased compared to the EMF group ($p < 0.05$). Superoxide dismutase (SOD) activity was significantly increased in the EMF group compared to the Control group ($p < 0.05$). Also, serum testosterone levels and wet weight of testes were significantly decreased in the EMF group compared to the Control group ($p < 0.05$). Our findings suggested that exposure to a 900 MHz EMF had adverse effects on rat testicular tissue and that the administration of TQ partially mitigated testicular oxidative damages caused by EMF radiation.

<https://www.ncbi.nlm.nih.gov/pubmed/31784235>

EFFECTS OF CO-EXPOSURE TO 900 MHZ RADIOFREQUENCY ELECTROMAGNETIC FIELDS AND HIGH-LEVEL NOISE ON SLEEP, WEIGHT, AND FOOD INTAKE PARAMETERS IN JUVENILE RATS

Bosquillon de Jenlis A, Del Vecchio F, Delanaud S, Bach V, Pelletier A *Environ Pollut.* 2019 Oct 25:113461. doi: 10.1016/j.envpol.2019.113461.

Abstract

OBJECTIVE: Electrohypersensitive people attribute various symptoms to exposure of radiofrequency electromagnetic fields (RF-EMF); sleep disturbance is the most frequently cited. However, laboratory experiments have yielded conflicting results regarding sleep alterations. Our hypothesis was that exposure to RF-EMF alone would lead to slight or non-significant effects but that co-exposure to RF-EMFs and other environmental constraints (such as noise) would lead to significant effects.

METHODS: 3-week-old male Wistar rats (4 groups, $n = 12$ per group) were exposed for 5 weeks to continuous RF-EMF (900 MHz, 1.8 V/m, SAR = 30 mW/kg) in the presence or absence of high-level noise (87.5 dB, 50- 20000 Hz) during the rest period. After 5 weeks of exposure, sleep (24 h recording), food and water intakes, and body weight were recorded with or without RF-EMF and/or noise. At the end of this recording period, sleep was scored during the 1 h resttime in the absence of noise and of RF-EMF exposure.

RESULTS: Exposure to RF-EMF and/or noise was associated with body weight gain, with hyperphagia in the noise-only and RF-EMF + noise groups and hypophagia in the RF-EMF-only group. Sleep parameters recording over 24 h highlighted a higher frequency of active wakefulness in the RF-EMF-only group and a lower non-rapid eye movement/rapid eye movement sleep ratio during the active period in the noise-only group. There were no differences in sleep duration in either group. During the 1-h, constraint-free sleep recording, sleep rebound was observed in the noise-only group but not in the RF-EMF-only and RF-EMF + noise groups.

CONCLUSION: Our study showed effects of RF-EMF, regardless of whether or not the animals were also exposed to noise. However, the RF-EMF + noise group presented no exacerbation of those effects. Our results did not support the hypothesis whereby the effects of RF-EMF on physiological functions studied are only visible in animals exposed to both noise and RF-EMF.

<https://www.ncbi.nlm.nih.gov/pubmed/31706765>

IMPACT OF CEREBRAL RADIOFREQUENCY EXPOSURES ON OXIDATIVE STRESS AND CORTICOSTERONE IN A RAT MODEL OF ALZHEIMER'S DISEASE

Bouji M, Lecomte A, Gamez C, Blazy K, Villégier AS. J Alzheimers Dis. 2019 Nov 25. doi: 10.3233/JAD-190593.

Abstract

BACKGROUND: Alzheimer's disease (AD) is the most common type of neurodegenerative disease leading to dementia. Several studies suggested that mobile phone radiofrequency electromagnetic field (RF-EMF) exposures modified AD memory deficits in rodent models.

OBJECTIVE: Here we aimed to test the hypothesis that RF-EMF exposure may modify memory through corticosterone and oxidative stress in the Samaritan rat model of AD.

METHODS: Long-Evans male rats received intracerebroventricular infusion with ferrous sulphate, amyloid-beta 1-42 peptide, and buthionine-sulfoximine (AD rats) or with vehicle (control rats). To mimic cell phone use, RF-EMF were exposed to the head for 1 month (5 days/week, in restraint). To look for hazard thresholds, high brain averaged specific absorption rates (BASAR) were tested: 1.5 W/Kg (15 min), 6 W/Kg (15 min), and 6 W/Kg (45 min). The sham group was in restraint for 45 min. Endpoints were spatial memory in the radial maze, plasmatic corticosterone, heme oxygenase-1 (HO1), and amyloid plaques.

RESULTS: Results indicated similar corticosterone levels but impaired memory performances and increased cerebral staining of thioflavine and of HO1 in the sham AD rats compared to the controls. A correlative increase of cortical HO1 staining was the only effect of RF-EMF in control rats. In AD rats, RF-EMF exposures induced a correlative increase of hippocampal HO1 staining and reduced corticosterone.

DISCUSSION: According to our data, neither AD nor control rats showed modified memory after RF-EMF exposures. Unlike control rats, AD rats showed higher hippocampal oxidative stress and reduced corticosterone with the higher BASAR. This data suggests more fragility related to neurodegenerative disease toward RF-EMF exposures.

<https://www.ncbi.nlm.nih.gov/pubmed/31796670>

MICROWAVES FROM MOBILE PHONE INDUCE REACTIVE OXYGEN SPECIES BUT NOT DNA DAMAGE, PRELEUKEMIC FUSION GENES AND APOPTOSIS IN HEMATOPOIETIC STEM/PROGENITOR CELLS

Durdik M, Kosik P, Markova E, Somsedikova A, Gajdosechova B, Nikitina E, Horvathova E, Kozics K, Davis D, Belyaev I. Microwaves from mobile phone induce reactive oxygen species but not DNA damage, preleukemic fusion genes and apoptosis in hematopoietic stem/progenitor cells. *Sci Rep.* 2019 Nov 7;9(1):16182. doi: 10.1038/s41598-019-52389-x.

Abstract

Exposure to electromagnetic fields (EMF) has been associated with the increased risk of childhood leukemia, which arises from mutations induced within hematopoietic stem cells often through preleukemic fusion genes (PFG). In this study we investigated whether exposure to microwaves (MW) emitted by mobile phones could induce various biochemical markers of cellular damage including reactive oxygen species (ROS), DNA single and double strand breaks, PFG, and apoptosis in umbilical cord blood (UCB) cells including CD34+ hematopoietic stem/progenitor cells. UCB cells were exposed to MW pulsed signals from GSM900/UMTS test-mobile phone and ROS, apoptosis, DNA damage, and PFG were analyzed using flow cytometry, automated fluorescent microscopy, imaging flow cytometry, comet assay, and RT-qPCR. In general, no persisting difference in DNA damage, PFG and apoptosis between exposed and sham-exposed samples was detected. However, we found increased ROS level after 1 h of UMTS exposure that was not evident 3 h post-exposure. We also found that the level of ROS rise with the higher degree of cellular differentiation. Our data show that UCB cells exposed to pulsed MW developed transient increase in ROS that did not result in sustained DNA damage and apoptosis.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6838175/>

IMMUNOTROPIC EFFECTS IN CULTURED HUMAN BLOOD MONONUCLEAR CELLS EXPOSED TO A 900 MHZ PULSE-MODULATED MICROWAVE FIELD

Szymański Ł, Sobiczewska E, Cios A, Szymanski P, Ciepielak M, Stankiewicz W. Immunotropic effects in cultured human blood mononuclear cells exposed to a 900 MHz pulse-modulated microwave field. *J Radiat Res.* 2019 Dec 12. pii: rrz085. doi: 10.1093/jrr/rrz085.

Abstract

The specific biological effect of electromagnetic field (EMF) remains unknown even though devices present in our daily lives, such as smartphones and Wi-Fi antennae increase the environmental level of electromagnetic radiation. It is said that the human immune system is able to react to discrete environmental stimuli like EMF. To investigate the effect of 900 MHz microwave stimulation on the immune system our research aimed to analyze lymphocyte proliferation and observe and assess the basic immunoregulatory activities using a newly developed and improved anechoic chamber. Samples of mononuclear cells (PBMC) isolated from the blood of healthy donors were exposed to 900 MHz pulse-modulated radiofrequency radiation (20 V/m, SAR 0.024 W/kg) twice (15 min each) or left without irradiation (control group). Subsequently, the control and exposed cells were set up to determine several parameters characterizing T cell immunocompetence and monocyte immunogenic activity. Although the microcultures of PBMC exposed to radiofrequency radiation demonstrated higher immunogenic activity of monocytes (LM index) and T-cell response to concanavalin A

than control cultures after first exposure, this parameter decreased after a second stimulation. Saturation of the interleukin-2 (IL-2) receptor rose significantly after the second day of exposure. On the other hand, response to mitogen dropped after EMF stimulation. The results suggest that PBMC are able to overcome stress caused by mitogens after stimulation with 900 MHz radiation.

<https://www.ncbi.nlm.nih.gov/pubmed/31832654>

COMPARATIVE CYTO- AND GENOTOXICITY OF 900 MHZ AND 1800 MHZ ELECTROMAGNETIC FIELD RADIATIONS IN ROOT MERISTEMS OF ALLIUM CEPA

Kumar A, Kaur S, Chandel S, Singh HP, Batish DR, Kohli RK. Comparative cyto- and genotoxicity of 900 MHz and 1800 MHz electromagnetic field radiations in root meristems of Allium cepa. Ecotoxicol Environ Saf. 2019 Nov 4;188:109786. doi: 10.1016/j.ecoenv.2019.109786.

Abstract

In the last few decades, tremendous increase in the use of wireless electronic gadgets, particularly the cell phones, has significantly enhanced the levels of electromagnetic field radiations (EMF-r) in the environment. Therefore, it is pertinent to study the effect of these radiations on biological systems including plants. We investigated comparative cytotoxic and DNA damaging effects of 900 and 1800 MHz EMF-r in Allium cepa (onion) root meristematic cells in terms of mitotic index (MI), chromosomal aberrations (CAs) and single cell gel electrophoresis (comet assay). Onion bulbs were subjected to 900 and 1800 MHz (at power densities 261 ± 8.50 mW m⁻² and 332 ± 10.36 mW m⁻², respectively) of EMF-r for 0.5 h, 1 h, 2 h, and 4 h. Root length declined by 13.2% and 12.3%, whereas root thickness was increased by 46.7% and 48.3% after 4 h exposure to 900 MHz and 1800 MHz, respectively. Cytogenetic studies exhibited clastogenic effect of EMF-r as depicted by increased CAs and MI. MI increased by 36% and 53% after 2 and 4 h exposure to 900 MHz EMF-r, whereas it increased by 41% and 67% in response to 1800 MHz EMF-r. Aberration index was increased by 41%-266% and 14%-257% during 0.5-4 h of exposure to 900 MHz and 1800 MHz, respectively, over the control. EMF-r exposure decreased % head DNA (DNAH) and increased % tail DNA (DNAT) and olive tail moment (OTM) at both 900 and 1800 EMF-r. In 4 h exposure treatments, head DNA (%) declined by 19% and 23% at 900 MHz and 1800 MHz, respectively. DNAT and OTM were increased by 2.3 and 3.7 fold upon exposure to 900 MHz EMF-r over that in the control, whereas 2.8 and 5.8 fold increase was observed in response to 1800 MHz EMF-r exposure for 4 h and the difference was statistically significant. The study concludes that EMF-r in the communication range (900 and 1800 MHz) adversely affect root meristems in plants and induce cytotoxic and DNA damage. EMF-r induced DNA damage was more pronounced at 1800 MHz than that at 900 MHz.

<https://www.ncbi.nlm.nih.gov/pubmed/31698176>

COMMENTS ON THE "EVALUATION OF THE GENOTOXICITY OF CELL PHONE RADIOFREQUENCY RADIATION IN MALE AND FEMALE RATS AND MICE FOLLOWING SUBCHRONIC EXPOSURE"

Vijayalaxmi, Foster KR, Miyakoshi J, Verschaeve L. Comments on the "Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure" by Smith-Roe et al. [online, open access, Environmental and Molecular Mutagenesis, 2019]. Environ Mol Mutagen. 2019 Dec 27. doi: 10.1002/em.22353.

No abstract <https://www.ncbi.nlm.nih.gov/pubmed/31883146>

ENVIRONMENTAL RADIOFREQUENCY ELECTROMAGNETIC FIELD LEVELS IN A DEPARTMENT OF PEDIATRICS

Besset D, Selmaoui B, Tourneux P, Leke A, Delanaud S, de Seze R, Stephan Blanchard E. Environmental radiofrequency electromagnetic field levels in a department of pediatrics. Environ Res. 2019 Nov 6:108894. doi: 10.1016/j.envres.2019.108894.

Abstract

Preterm neonates constitute a vulnerable population that is highly sensitive to its environment. Given the increased use of wireless communication devices (mobile and digital enhanced cordless telecommunications, WiFi networks, etc.), neonates hospitalized in a department of pediatrics are potentially exposed to radiofrequency electromagnetic fields (RF-EMF). Strikingly, data on RF-EMF levels in pediatric units have not previously been published. The objective of the present study was thus to quantify the RF-EMF levels in a 34-bed tertiary department of pediatrics with a neonatal critical care unit (NCCU) and a neonatal intensive care unit (NICU). To this end, we used triaxle antenna dosimeters to map the RF-EMF levels in the environment and to measure spot emissions from medical devices. In a first set of experiments, RF-EMF levels at 144 points in the staff area and in the children's rooms in the NCCU and NICU were evaluated over a 24-h period. In a second set of measurements performed in a Faraday chamber, we measured the RF-EMF levels emitted by the medical devices to which neonates are potentially exposed in the department of pediatrics. The RF-EMF levels were significantly higher in the NCCU than in the NICU ($p < 0.05$). Although the two units did not differ significantly with regard to the average maximum values, the single greatest value recorded in the NCCU (6 V/m GSM + UMTS 900 (UL) frequency band, in the staff area) was more than twice that recorded in the NICU (3.70 V/m in the UMTS 2100 (UL) frequency band, in the children's rooms). The NCCU and NICU did not differ significantly with regard to the time during which the RF-EMF level at each measurement point was more than two standard deviations above its mean. The RF-EMF level was significantly higher during the day than during the night ($p < 0.001$). The various medical devices used in the NICU did not emit detectable amounts of RF. Overall, RF-EMF levels in the NCCU and NICU were very low. It is probable that the RF-EMFs measured here were primarily generated by the parents' and staff members' activities, rather than by medical devices. However, a combination of low-level, chronic exposure with transient, elevated peak values in a vulnerable population of preterm neonates may be of particular concern. In a department of pediatrics, decreasing preterm neonates' exposure to RF-EMFs should primarily involve a limitation on the use of wireless communication devices by staff members and parents.

<https://www.ncbi.nlm.nih.gov/pubmed/31740038>

PATIENTS WITH PACEMAKERS OR DEFIBRILLATORS DO NOT NEED TO WORRY ABOUT E-CARS: AN OBSERVATIONAL STUDY

Lennerz C, Horlbeck L, Weigand S, Grebmer C, Blazek P, Brkic A, Semmler V, Haller B, Reents T, Hessling G, Deisenhofer I, Lienkamp M, Kolb C, O'Connor M. *Technol Health Care*. 2019 Nov 8. doi: 10.3233/THC-191891.

Abstract

BACKGROUND: Electric cars are increasingly used for public and private transportation and represent possible sources of electromagnetic interference (EMI). Potential implications for patients with cardiac implantable electronic devices (CIED) range from unnecessary driving restrictions to life-threatening device malfunction. This prospective, cross-sectional study was designed to assess the EMI risk of electric cars on CIED function.

METHODS: One hundred and eight consecutive patients with CIED presenting for routine follow-up between May 2014 and January 2015 were enrolled in the study. The participants were exposed to electromagnetic fields generated by the four most common electric cars (Nissan Leaf, Tesla Model S, BMW i3, VW eUp) while roller-bench test-driving at Institute of Automotive Technology, Department of Mechanical Engineering, Technical University, Munich. The primary endpoint was any abnormalities in CIED function (e.g. oversensing with pacing-inhibition, inappropriate therapy or mode-switching) while driving or charging electric cars as assessed by electrocardiographic recordings and device interrogation.

RESULTS: No change in device function or programming was seen in this cohort which is representative of contemporary CIED devices. The largest electromagnetic field detected was along the charging cable during high current charging (116.5 μ T). The field strength in the cabin was lower (2.1-3.6 μ T).

CONCLUSIONS: Electric cars produce electromagnetic fields; however, they did not affect CIED function or programming in our cohort. Driving and charging of electric cars is likely safe for patients with CIEDs.

Open access paper: <https://content.iospress.com/articles/technology-and-health-care/thc191891>

EVALUATION OF WI-FI RADIATION EFFECTS ON ANTIBIOTIC SUSCEPTIBILITY, METABOLIC ACTIVITY AND BIOFILM FORMATION BY ESCHERICHIA COLI 0157H7, STAPHYLOCOCCUS AUREUS AND STAPHYLOCOCCUS EPIDERMIS

Said-Salman IH, Jebali FA, Yusef HH, Mustafa ME. *J Biomed Phys Eng*. 2019 Oct 1;9(5):579-586. doi: 10.31661/jbpe.v0i0.1106.

Abstract

Background: The radiation emitted from electromagnetic fields (EMF) can cause biological effects on prokaryotic and eukaryotic cells, including non-thermal effects.

Objective: The present study evaluated the non-thermal effects of wireless fidelity (Wi-Fi) operating at 2.4 GHz part of non-ionizing EMF on different pathogenic bacterial strains (*Escherichia coli* 0157H7, *Staphylococcus aureus*, and *Staphylococcus epidermis*). Antibiotic

resistance, motility, metabolic activity and biofilm formation were examined.

Material and Methods: In this case-control, a Wi-Fi router was used as a source of microwaves and also bacterial cells were exposed to Wi-Fi radiation continuously for 24 and 48 hours. The antibiotic susceptibility was carried out using a disc diffusion method on Müller Hinton agar plates. Motility of *Escherichia coli* 0157H7 was conducted on motility agar plates. Cell metabolic activity and biofilm formation were performed using 3-(4, 5- Dimethylthiazol-2yl)-2, 5-diphenyltetrazolium bromide (MTT) assay and crystal violet quantification, respectively.

Results: The exposure to Wi-Fi radiation altered motility and antibiotic susceptibility of *Escherichia coli* 0157H7. However, there was no effect Wi-Fi radiation on antibiotic susceptibility of *Staphylococcus aureus* and *Staphylococcus epidermis*. On the other hand, the exposed cells, as compared to the unexposed control, showed an increased metabolic activity and biofilm formation ability in *Escherichia coli* 0157H7, *Staphylococcus aureus* and *Staphylococcus epidermis*.

Conclusion: These results proposed that Wi-Fi exposure acted on bacteria in stressful manner by increasing antibiotic resistance and motility of *Escherichia coli* 0157H7, as well as enhancing biofilm formation by *Escherichia coli* 0157H7, *Staphylococcus aureus* and *Staphylococcus epidermis*. The findings may have implications for the management of serious diseases caused by these infectious bacteria.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6820025/>

THE EFFECT OF WI-FI ELECTROMAGNETIC WAVES ON NEURONAL RESPONSE PROPERTIES IN RAT BARREL CORTEX

Sistani S, Fatemi I, Shafeie SA, Kaeidi A, Azin M, Shamsizadeh A. The effect of Wi-Fi electromagnetic waves on neuronal response properties in rat barrel cortex. *Somatosens Mot Res.* 2019 Nov 13:1-6. doi: 10.1080/08990220.2019.1689116.

Abstract

There is a growing number of studies on the possible biological effects of Wi-Fi radiations on nervous system. In this study we investigated the effect of Wi-Fi exposure on single neuron responses to natural stimuli by using whisker to barrel pathway. This study was done on 29 male Wistar rats. Neuronal spontaneous activity and ON and OFF responses to displacement of principal whisker (PW), adjacent whisker (AW) and combination of PW- AW stimulation (as natural stimuli) were recorded in barrel cortex of anaesthetised rats. A D-link Wi-Fi device was used for 1 h exposure to 2.4 GHz microwaves in data mode (18.2 dBm and 44% for power and duty cycle). A condition test ratio (CTR) was calculated for assessing neuronal integrative properties. Wi-Fi radiations decreased CTR for ON responses. However, neuronal spontaneous activity and ON and OFF responses were not significantly changed following exposure to Wi-Fi signals. The results of this study demonstrated that exposure to Wi-Fi radiation could modulate integrative responses to natural stimuli in barrel cortex.

<https://www.ncbi.nlm.nih.gov/pubmed/31718372>

THE EFFECT OF PRENATAL EXPOSURE TO 2.4 GHZ RADIO FREQUENCY ON THE HISTOLOGY AND EXPRESSION OF THE OSTEOCALCIN AND RUNX2 GENE OF THE FORELIMB IN AN NMRI MOUSE

Amandokht Saghezchi S, Azad N, Heidari R, Jajarmi V, Abdi S, Abaszadeh HA, Sadjadpour SS, Neikoei N, Heidari MH, Abdollahifar MA. The Effect of Prenatal Exposure to 2.4 GHz Radio Frequency on the Histology and Expression of the osteocalcin and RUNX2 Gene of the Forelimb in an NMRI Mouse. *J Lasers Med Sci*. 2019 Fall;10(4):283-289. doi: 10.15171/jlms.2019.46.

Abstract

Introduction: Today the use of electromagnetic waves has dramatically increased in modern industrial societies. This study aimed to investigate the effect of prenatal exposure to 2.4 GHz wireless frequency on forelimb development in an NMRI mouse in vivo.

Methods: A total of 21 female mice weighing 25-30 g were included in the present study. They were randomly assigned to 3 groups, namely control (n=7), sham (n=7), and experimental (n=7). After mating, the experimental group was exposed to 2.4 GHz radio frequency at a distance of 20-30 cm from the device, 4 h/d until the delivery. The sham group was placed at a distance of 20-30 cm from the device every day without exposure to electromagnetic waves, and the control group had a pregnancy period without any stress and electromagnetic wave exposure. After giving birth, the forelimbs were isolated from the infants and examined by stereological studies and RT-PCR for the evaluation of osteocalcin and RUNX2 gene expression.

Results: Although, at first glance, there was no macroscopic teratogen effect in forelimbs in all groups, via a stereological method, we showed that bone and cartilage volume decreased in the experimental group compared to the other groups. We also found that the experimental group had lower expression of the osteocalcin and RUNX2 gene than the control and sham groups did. However, there were no significant differences between the control and sham groups in terms of bone and cartilage volume and gene expression.

Conclusion: Although teratogen effect of prenatal exposure to 2.4 GHz radio frequency on forelimbs was not demonstrated macroscopically, further studies showed negative effects on the forelimb bone, cartilage volume, and gene expression.

The exposure apparatus was a wireless router (CISCO, EA6300V1, China) that applied 2.4 GHz wireless frequency for 21 days and 4 h/d.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6885904/>

EFFECT OF OCCUPATIONAL EXPOSURE TO RADAR RADIATION ON CANCER RISK: A SYSTEMATIC REVIEW AND META-ANALYSIS

Variani AS, Saboori S, Shahsavari S, Saeed Yari S, Zaroushani V. Effect of Occupational Exposure to Radar Radiation on Cancer Risk: A Systematic Review and Meta-Analysis. Asian Pac J Cancer Prev. 20 (11): 3211-3219. 2019 Nov 1. DOI: 10.31557/APJCP.2019.20.11.3211.

Abstract

Objective: Microwave radiation is one of the most growing environmental workplace factors that exposes too many workers in the various workplaces. Regard to concerns about cancer incidence in these workers and lack of systematic or meta-analytic studies about this object, so, we conducted a meta-analysis to acquire an understanding of the association between cancer risk and occupational exposure to radar radiation.

Methods: A systematic search was carried out on case-control, cohort and clinical control trial studies that published in the Cochrane Library, PubMed, ISI Web of Science, Scopus and Google scholar databases that accomplished from March 2017 to March 2018 and updated on 30 September, 2018 in English and Persian articles without time limit in publication date. Keywords were selected based on PICO principle and collected from MeSH database. After removal of duplicated studied, taking into inclusion and exclusion criteria, the process of screening was carried out and data were extracted after preparation of the full text of included articles. Article collection was completed by manually searching for a reference list of eligible studies. For quality assessment of included studies, Newcastle-Ottawa scale was used.

Results: a total of 533 studies was found in the first step of literature search, only 6 were included with 53,008 sample size according to inclusion and exclusion criteria. Estimated pooled random effects size analysis showed no significant increasing effect of occupational exposure to radar radiation on mortality rate (MR=0.81, 95%CI: 0.78, 0.83) and relative risk (RR=0.87, 95%CI: 0.75, 0.99, P <0.0001) of cancer with a significant heterogeneity between the selected studies.

Conclusions: In conclusion, the results of this meta-analysis study have shown no significant increase in overall mortality ratio and cancer risk ratio from occupational exposure to the radar frequency of workers. But, these results are not conclusive. As regards to some limitation such as fewer numbers of included studies, lack of data about exposure characterizations and demographic characterizations in this meta-analysis, this result is not certain and conclusive. It is recommended to conduct future studies.

Open access paper:

<http://journal.waocp.org/?sid=Entrez:PubMed&id=pmid:&key=2019.20.11.3211>

SCOPING REVIEW OF THE POTENTIAL HEALTH EFFECTS OF EXPOSURE TO EXTREMELY LOW-FREQUENCY ELECTRIC AND MAGNETIC FIELDS

Habash M, Gogna P, Krewski D, Habash RWY. Scoping Review of the Potential Health Effects of Exposure to Extremely Low-Frequency Electric and Magnetic Fields. *Crit Rev Biomed Eng.* 2019;47(4):323-347. doi: 10.1615/CritRevBiomedEng.2019030211.

Abstract

Previous studies suggest that extremely low-frequency (ELF) electric and magnetic fields (EMFs) may impact human health. However, epidemiologic studies have provided inconsistent results on the association between exposure to ELF EMFs and various health outcomes. This scoping review reports on primary investigations that were published during the ten-year period of 2007-2017 on the association between ELF EMFs and cancer, cardiovascular disease (CVD), reproductive health effects, and neurodegenerative diseases. We identified a total of 361 articles from two bibliographic databases (PubMed and EMBASE). Of these, 39 articles (19 cancer studies, two CVD studies, nine reproductive health studies, and ten neurodegenerative disease studies [with one repeated for two outcomes]) met inclusion criteria. Articles identified in this study focus on three different types of exposure: occupational (22 studies), residential (15 studies), and electric blanket (two studies). This review suggests that ELF EMFs may be associated with neurodegenerative diseases, specifically Alzheimer's disease; however, limited evidence was found to suggest that ELF EMFs are associated with several types of cancer, CVD, and reproductive outcomes. Additional epidemiological studies in large study populations with improved exposure assessments are needed to clarify current inconclusive relationships.

<https://www.ncbi.nlm.nih.gov/pubmed/31679262>

MATERNAL CUMULATIVE EXPOSURE TO EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS, PREMATURITY AND SMALL FOR GESTATIONAL AGE: A POOLED ANALYSIS OF TWO BIRTH COHORTS

Migault L, Garlantézec R, Piel C, Marchand-Martin L, Orazio S, Cheminat M, Zaros C, Carles C, Cardis E, Ancel PY, Charles MA, de Seze R, Baldi I, Bouvier G. Maternal cumulative exposure to extremely low frequency electromagnetic fields, prematurity and small for gestational age: a pooled analysis of two birth cohorts. *Occup Environ Med.* 2020 Jan;77(1):22-31. doi: 10.1136/oemed-2019-105785.

Abstract

BACKGROUND: Data on the effects of extremely low frequency electromagnetic fields (ELF-EMF) on pregnancy outcomes are inconclusive.

OBJECTIVE: To study the relation between maternal cumulative exposure to ELF-EMF during pregnancy and the risk of prematurity or small for gestational age (SGA) in a pooled analysis of two French birth cohorts.

METHODS: Elfe and Epipage2 are both population-based birth cohorts initiated in 2011 and included 18 329 and 8400 births, respectively. Health data and household, mother and child characteristics were obtained from medical records and questionnaires at maternity and during follow-up. A job exposure matrix was used to assess cumulative exposure to ELF-EMF during three periods: (1) until 15 weeks of gestation, (2) until 28 weeks of gestation and (3)

until 32 weeks of gestation. Analyses were restricted to single live births in mainland France and to mothers with documented jobs (N=19 894). Adjusted logistic regression models were used.

RESULTS: According to the period studied, 3.2%-4% of mothers were classified as highly exposed. Results were heterogeneous. Increased risks of prematurity were found among low exposed mothers for the three periods, and no association was observed among the most exposed (OR1=0.92 (95% CI 0.74 to 1.15); OR2=0.98 (95% CI 0.80 to 1.21); OR3=1.14 (95% CI 0.92 to 1.41)). For SGA, no association was observed with the exception of increased risk among the low exposed mothers in period 2 and the most exposed in period 3 (OR=1.25 (95% CI 1.02 to 1.53)).

CONCLUSION: Some heterogeneous associations between ELF-EMF exposure and prematurity and SGA were observed. However, due to heterogeneity (ie, their independence regarding the level of exposure), associations cannot be definitely explained by ELF-EMF exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/31831625>

LOW FREQUENCY MAGNETIC FIELDS INSIDE CARS

Pääkkönen R, Korpinen L. LOW FREQUENCY MAGNETIC FIELDS INSIDE CARS. Radiat Prot Dosimetry. 2019 Nov 7. pii: ncz248. doi: 10.1093/rpd/ncz248.

Abstract

Magnetic fields were compared inside passenger seats of electric, petrol and hybrid cars. While driving about 5 km in an urban environment, values were recorded and compared between car types. The magnetic flux densities of the cars were less than 2.6 μ T. The magnitudes of the magnetic fields of petrol cars and hybrid cars were about the same and slightly lower for electric cars. Based on our measurements, values were less than 3% of the guidelines given for the general population or people using pacemakers.

<https://www.ncbi.nlm.nih.gov/pubmed/31702768>

EVALUATION IN HUMANS OF ELF-EMF EXPOSURE ON CHROMOGRANIN A, A MARKER OF NEUROENDOCRINE TUMORS AND STRESS

Touitou Y, Lambrozo J, Mauvieux B, Riedel M. Evaluation in humans of ELF-EMF exposure on chromogranin A, a marker of neuroendocrine tumors and stress. Chronobiol Int. 2019 Nov 4;1-8. doi: 10.1080/07420528.2019.1683857.

Abstract

Chromogranin A (CgA), which is a major protein in adrenal chromaffin cells and adrenergic neurons, is a clinically relevant endocrine and neuroendocrine tumor marker including pheochromocytomas, neuroblastomas, and related neurogenic tumors. In this study, we looked at the effect in humans of chronic daily exposure to a 50-Hz magnetic field. We examined in 15 men (38.0 ± 0.9 years) the effects of chronic daily exposure to a 50-Hz magnetic field for 1-20 yrs both at home and at work. EMDEX II dosimeters were used to record magnetic field all day long every 30 s. for 1 week. The weekly geometric mean of the individual exposures ranged from 0.1 to 2.6 μ T. Blood samples were taken hourly between

20:00 h and 08:00 h. CgA patterns of exposed subjects were compared to age-matched controls. The results of exposed subjects were compared with those for 15 unexposed men who served as controls and whose individual exposure was ten times lower ranging from 0.004 to 0.092 μ T. This work shows that in the control group the serum CgA levels exhibited a nighttime peak with a progressive decline of the serum concentrations and a nadir in the morning. Both the profile and the serum concentrations of CgA, a marker of neuroendocrine tumors and stress, did not appear to be impaired in the subjects chronically exposed over a long period (up to 20 yrs) to magnetic fields though a trend toward lower levels were found at the highest exposure (>0.3 μ T). This does not rule out, however, that the potential deleterious risk of ELF-EMF on frail populations such as children and the elderly may be greater at low exposure and should hence be documented, at least for their residential exposure.

<https://www.ncbi.nlm.nih.gov/pubmed/31682468>

GENDER AND AGE DIFFERENCES IN THE SUPPRESSIVE EFFECT OF A 50 HZ ELECTRIC FIELD ON THE IMMOBILIZATION-INDUCED INCREASE OF PLASMA GLUCOCORTICOID IN MICE

Harakawa S, Hori T, Nedachi T, Suzuki H. Gender and Age Differences in the Suppressive Effect of a 50 Hz Electric Field on the Immobilization-Induced Increase of Plasma Glucocorticoid in Mice. *Bioelectromagnetics*. 2019 Dec 12. doi: 10.1002/bem.22238.

Abstract

We developed an experimental system to characterize the suppressive effect of extremely low-frequency (ELF) electric fields (EFs) on the stress response. We assessed differences in the EF effects by age and gender. Control, EF-alone, immobilization-alone, and co-treated groups were subjected to an EF (50 Hz, 10 kV/m). Co-treated mice were exposed to the EF for 60 min, with immobilization during the latter half. Our results indicate that the suppressive effects of ELF EFs on the stress response in immobilized mice occur regardless of gender or age. As stress plays an important role in the onset and progression of various diseases, these findings may have broad implications for understanding the efficacy of EFs in animal, and perhaps human, health

<https://www.ncbi.nlm.nih.gov/pubmed/31833072>

AN EXTREMELY LOW FREQUENCY MAGNETIC FIELD AND GLOBAL CEREBRAL ISCHEMIA AFFECT PITUITARY ACTH AND TSH CELLS IN GERBILS

Rauš Balind SManojlović-Stojanoski M, Šošić-Jurjević B, Selaković V, Milošević V, Petković B. An Extremely Low Frequency Magnetic Field and Global Cerebral Ischemia Affect Pituitary ACTH and TSH Cells in Gerbils. *Bioelectromagnetics*. 2019 Dec 11. doi: 10.1002/bem.22237.

Abstract

The neuroendocrine system can be modulated by a magnetic field and cerebral ischemia as external and internal stressors, respectively. This study deals with the separate or combined effects of an extremely low frequency (ELF) magnetic field (50 Hz, average magnetic field of 0.5 mT) for 7 days and global cerebral ischemia for 10 min on the morpho-functional features of pituitary adrenocorticotrophic (ACTH) and thyrotrophic (TSH) cells in 3- month-old gerbils. To determine the immediate and delayed effects of the applied stressors, measurements were made on the 7th and 14th days after the onset of the experiment. The ELF magnetic

field and 10-min global cerebral ischemia, separately and particularly in combination, decreased ($P < 0.05$) the volume density of ACTH cells, while only in combination were intracellular ACTH content and plasma ACTH concentration increased ($P < 0.05$) on day 7. The ELF magnetic field elevated serum TSH concentration on day 7 and intracellular TSH β content on day 14 ($P < 0.05$). Also, 10-min global cerebral ischemia alone increased serum TSH concentration ($P < 0.05$), while in combination with the ELF magnetic field it elevated ($P < 0.05$) intracellular TSH β content on day 14. In conclusion, an ELF magnetic field and/or 10-min global cerebral ischemia can induce immediate and delayed stimulation of ACTH and TSH synthesis and secretion.

<https://www.ncbi.nlm.nih.gov/pubmed/31828821>

CT2A CELL VIABILITY MODULATED BY ELECTROMAGNETIC FIELDS AT EXTREMELY LOW FREQUENCY UNDER NO THERMAL EFFECTS

García-Minguillán O, Prous R, Ramirez-Castillejo MDC, Maestú C. CT2A Cell Viability Modulated by Electromagnetic Fields at Extremely Low Frequency under No Thermal Effects. *Int J Mol Sci*. 2019 Dec 24;21(1). pii: E152. doi: 10.3390/ijms21010152.

Abstract

The effects produced by electromagnetic fields (EMFs) on human beings at extremely low frequencies (ELFs) have been investigated in the past years, across in vitro studies, using different cell lines. Nevertheless, the effects produced on cells are not clarified, and the cellular mechanisms and cell-signaling processes involved are still unknown. This situation has resulted in a division among the scientific community about the adequacy of the recommended level of exposure. In this sense, we consider that it is necessary to develop long-term exposure studies and check if the recommended levels of EMFs are under thermal effects. Hence, we exposed CT2A cells to different EMFs at different ELFs at short and long times. Our results showed frequency dependence in CT2A exposed during 24 h to a small EMF of 30 μ T equal to those originated by the Earth and frequency dependence after the exposure during seven days to an EMF of 100 μ T at different ELFs. Particularly, our results showed a remarkable cell viability decrease of CT2A cells exposed to EMFs of 30 Hz. Nevertheless, after analyzing the thermal effects in terms of HSP90 expression, we did not find thermal damages related to the differences in cell viability, so other crucial cellular mechanism should be involved.

Open access paper: <https://www.mdpi.com/1422-0067/21/1/152>

MAGNETIC FIELDS TRUMP OXYGEN IN CONTROLLING THE DEATH OF ERYTHRO-LEUKEMIA CELLS

Li Y, Héroux P. Magnetic fields trump oxygen in controlling the death of erythro-leukemia Cells. *Applied Sciences*, 6 December 2019.

Abstract

Expansions in power and telecommunications systems have created a new electromagnetic environment. Here, we compare the death rate of human cancer cells in vitro in the pre-industrial electromagnetic environment of the past (“Zero Field”) with that of an electromagnetic environment typical of contemporary human exposures (“Incubator Field”). A cell incubator provides magnetic fields comparable to those in the current human environment. Steel shields divert those same fields away from cell preparations in the “pre-

industrial” assays. Large changes in oxygen levels are provided by nitrogen or atmospheric gas over the cell cultures. Human cancer cells are then separated according to three categories: necrotic, early apoptotic, or late apoptotic. The results are compiled for two variables, magnetic field and oxygen, in 16 different situations (“Transitions”) likely to occur in the human body under present living conditions. We find that magnetic fields are a more powerful determinant of cell death than oxygen, and induce death by different mechanisms. This has important implications for the reproducibility of in vitro biological experiments focusing on cell survival or metabolism, and for public health. The rate and mechanisms of cell death are critical to many chronic human ailments such as cancer, neurological diseases, and diabetes.

Open access paper: <https://www.mdpi.com/2076-3417/9/24/5318>

REVIEW. THE INFLUENCE OF BIOACTIVE MOBILE TELEPHONY RADIATION AT THE LEVEL OF A PLANT COMMUNITY – POSSIBLE MECHANISMS AND INDICATORS OF THE EFFECTS

Czerwiński M, Januszkiewicz L, Vian A, Lázaro A. Review. The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects. *Ecological Indicators*. 108, January 2020, 105683. <https://doi.org/10.1016/j.ecolind.2019.105683>.

Highlights

- There are various indicators of microwave radiation impact on herbaceous vegetation.
- The best indicators are some parameters of vegetation canopy or individual plants.
- Specific plant functional groups may be indicators of long-term community processes.
- Other organisms interacting with plants, e.g. pollinators, should also be considered.
- The selection of indicators depends on the propagation of radiation in the canopy.

Abstract

Environmental exposure to radiofrequency electromagnetic fields (RF-EMFs) from mobile telephony has rapidly increased in the last two decades and this trend is expected to continue. The effects of this exposure at plant community level are unknown and difficult to assess in a scientifically appropriate manner. Such an assessment can be scientifically adequate if a studied plant community is completely new and control-impact radiation treatment is used.

In this review we aimed to predict ecological effects and identify indicators of the impact of bioactive RF-EMFs at the mobile telephony frequency range on plant communities. We considered the scenario where a plant community was exposed to radiation generated by a base transmitting station antenna mounted on a nearby mast. This plant community can be represented by mesic meadow, ruderal or arable weed community, or other herbaceous, moderately productive vegetation type. We concentrated primarily on radiation effects that can be recorded for a year since the exposure started. To predict them we used physical theories of radiowave propagation in vegetation and the knowledge on plants physiological responses to RF-EMF. Our indicators can be used for the detection of the impact of RF-EMFs on vegetation in a control-impact experiment.

The identified indicators can be classified into the following groups: (1) canopy parameters; (2) plant characteristics to be measured in the field or laboratory in a number of individuals that represent the populations of selected species; (3) community weighted means/medians

(CWMs) of plant traits and strategies; (4) the abundance of other organisms that interact with plants and can influence their fitness or population size. The group of canopy parameters includes mean height, vertical vegetation structure and dry weight of above-ground standing phytomass. Plant characteristics requiring biometric sampling in the field are plant height, the number of fruits and seeds, as well as seed viability. The group of plant traits that are calculated as CWMs covers seed releasing height, seed dispersal mode, SLA, leaf orientation, month of germination and flowering, Ellenberg's light indicator value, and the proportion of individuals in the classes of competitors and stress tolerators according to Grime's CSR strategy scheme. The group of "non-plant" indicators includes primarily the frequency of flower visits by beetles, wasps, hoverflies, and bees that have their nests over ground. To detect ecological responses that occur for the first year since a herbaceous community has been exposed to potentially bioactive RF-EMF, the first two indicators groups should be used.

<https://www.sciencedirect.com/science/article/pii/S1470160X19306764?via%3Dihub>

LONG-DISTANCE NAVIGATION AND MAGNETORECEPTION IN MIGRATORY ANIMALS

Mouritsen H. Long-distance navigation and magnetoreception in migratory animals. *Nature*. 2018 Jun;558(7708):50-59. doi: 10.1038/s41586-018-0176-1.

Abstract

For centuries, humans have been fascinated by how migratory animals find their way over thousands of kilometres. Here, I review the mechanisms used in animal orientation and navigation with a particular focus on long-distance migrants and magnetoreception. I contend that any long-distance navigational task consists of three phases and that no single cue or mechanism will enable animals to navigate with pinpoint accuracy over thousands of kilometres. Multiscale and multisensory cue integration in the brain is needed. I conclude by raising twenty important mechanistic questions related to long-distance animal navigation that should be solved over the next twenty years.

<https://www.ncbi.nlm.nih.gov/pubmed/29875486>

EXPOSURE EFFECTS OF TERAHERTZ WAVES ON PRIMARY NEURONS AND NEURON-LIKE CELLS UNDER NONTHERMAL CONDITIONS

Tan SZ, Tan PC, Luo LQ, et al. Exposure Effects of Terahertz Waves on Primary Neurons and Neuron-like Cells Under Nonthermal Conditions. *Biomed Environ Sci*. 2019 Oct;32(10):739-754. doi: 10.3967/bes2019.094.

Abstract

OBJECTIVE: This study aimed to explore the potential effects of terahertz (THz) waves on primary cultured neurons from 4 rat brain regions (hippocampus, cerebral cortex, cerebellum, and brainstem) and 3 kinds of neuron-like cells (MN9D, PC12, and HT22 cells) under nonthermal conditions.

METHODS: THz waves with an output power of 50 (0.16 THz) and 10 (0.17 THz) mW with exposure times of 6 and 60 min were used in this study. Analysis of temperature change, neurite growth, cell membrane roughness, micromorphology, neurotransmitters and synaptic-related proteins (SYN and PSD95) was used to evaluate the potential effects.

RESULTS: Temperature increase caused by the THz wave was negligible. THz waves induced significant neurotransmitter changes in primary hippocampal, cerebellar, and brainstem neurons and in MN9D and PC12 cells. THz wave downregulated SYN expression in primary hippocampal neurons and downregulated PSD95 expression in primary cortical neurons.

CONCLUSION: Different types of cells responded differently after THz wave exposure, and primary hippocampal and cortical neurons and MN9D cells were relatively sensitive to the THz waves. The biological effects were positively correlated with the exposure time of the THz waves.

Open access paper: <http://www.besjournal.com/en/article/doi/10.3967/bes2019.094>

BEHAVIORAL EVIDENCE FOR GEOMAGNETIC IMPRINTING AND TRANSGENERATIONAL INHERITANCE IN FRUIT FLIES

Oh IT, Kwon HJ, Kim SC, Kim HJ, Lohmann KJ, Chae K. Behavioral evidence for geomagnetic imprinting and transgenerational inheritance in fruit flies. *Proc Natl Acad Sci U S A*. 2019 Dec 30. pii: 201914106. doi: 10.1073/pnas.1914106117.

Abstract

Certain long-distance migratory animals, such as salmon and sea turtles, are thought to imprint on the magnetic field of their natal area and to use this information to help them return as adults. Despite a growing body of indirect support for such imprinting, direct experimental evidence thereof remains elusive. Here, using the fruit fly as a magnetoreceptive model organism, we demonstrate that exposure to a specific geographic magnetic field during a critical period of early development affected responses to a matching magnetic field gradient later in life. Specifically, hungry flies that had imprinted on a specific magnetic field from 1 of 3 widely separated geographic locations responded to the imprinted field, but not other magnetic fields, by moving downward, a geotactic behavior associated with foraging. This same behavior occurred spontaneously in the progeny of the next generation: female progeny moved downward in response to the field on which their parents had imprinted, whereas male progeny did so only in the presence of these females. These results represent experimental evidence that organisms can learn and remember a magnetic field to which they were exposed during a critical period of development. Although the function of the behavior is not known, one possibility is that imprinting on the magnetic field of a natal area assists flies and their offspring in recognizing locations likely to be favorable for foraging and reproduction.

<https://www.ncbi.nlm.nih.gov/pubmed/31889001>

THE SIGNIFICANCE OF PRIMARY TUMORS IN THE NTP STUDY OF CHRONIC RAT EXPOSURE TO CELL PHONE RADIATION]

Lin JC. The Significance of Primary Tumors in the NTP Study of Chronic Rat Exposure to Cell Phone Radiation [Health Matters]. *IEEE Microwave Magazine*. 20(11):18-21. Nov 2019. DOI:10.1109/MMM.2019.2935361

Abstract

Most media accounts of the U.S. National Toxicology Program's (NTP's) final report have understandably focused on the statistically significant finding of "clear evidence" that both

GSM and code-division multiple access (CDMA)-modulated 900-MHz wireless RF radiation led to the development of malignant schwannoma, a rare form of tumor, in the hearts of male rats. In addition to this, unusual patterns of cardiomyopathy, i.e., damage to heart tissue, were observed in both RF-exposed male and female Sprague-Dawley rats compared with concurrent control animals, although the findings for female rats were deemed as providing only uncertain or "equivocal" evidence for schwannomas and malignant gliomas, compared to concurrent controls.

<https://ieeexplore.ieee.org/document/8866792>

Excerpts

"A Closer Look at the NTP Findings

“In all fairness, the primary cancer or overall cancer rates detected in any organ or tissue inside the animal body do not appear to have been purposefully overlooked or unnoticed. Indeed, the results for total primary cancer or tumor occurrences in NTP animal studies can be found in the appendices of its final reports [1]. However, although the data may not have been purposefully disregarded or ignored, the NTP excluded them from its publicized report summaries. An independent analysis of the data showed that rats exposed to GSM and CDMA RF radiation had significantly higher overall or total primary tumor rates than did the concurrent control rats [4].

In particular, the highest overall cancer (or malignant tumors) rates were found in male rats exposed to whole-body SARs of 3 W/kg from 900-MHz cell phone RF radiation (42 and 46% for GSM and CDMA, respectively), and the lowest rate was found in the concurrent control group (27%). Thus, the RF-exposed groups had significantly higher overall or total primary cancer rates than did the concurrent control rats. Moreover, the highest overall tumor rates (either a benign or malignant tumor in any organ or tissue) were observed in male rats exposed to SARs of 3-W/kg (87 and 84% for GSM and CDMA, respectively) cell phone RF radiation. As stated previously, the lowest rate was seen in the concurrent control group (63%). The RF-exposed groups had significantly higher overall tumor rates than did the concurrent control rats. Male rats in the lowest RF-exposed groups (whole-body SARs of 1.5 W/kg) had significantly higher rates of benign primary tumors (76 and 73% for GSM and CDMA, respectively) than did concurrent or sham control groups (54%).”

"IARC Assessment

The International Agency for Research on Cancer (IARC) assessed the then available scientific literature and concluded that the epidemiological studies on humans that had reported increased risks for malignant gliomas and acoustic neuromas among heavy or long-term users of cell phones were sufficiently strong to support a classification of 2B, i.e., possibly carcinogenic to humans [9]. With its classification of RF radiation as a 2B carcinogen, the IARC suggested that it also believed the available scientific evidence was incomplete and limited, especially with regard to results from animal experiments.

“The time is right for the IARC to upgrade its previous epidemiology-based classification of RF exposure to higher levels in terms of the carcinogenicity of RF radiation for humans.

Recently, two relatively well- conducted RF and microwave exposure studies employing the Sprague–Dawley strain of rats—without, however, using any cancer-promoting agents (or cocarcinogens)—showed consistent results in significantly increased total primary cancer or overall tumor rates in animals exposed to RF radiation.”

It is important to note that the recent NTP and Ramazzini animal RF exposure studies presented similar findings in heart schwannomas and brain gliomas. The increased schwannomas and abnormal heart tissue development/damage to heart tissue are significant findings in RF-exposed animal research studies. In addition to this, the incidence of benign pheochromocytomas of the adrenal medulla was found to be higher in the exposed group than in the sham controls for the 2,450-MHz circular waveguide experiment [6]. Interestingly, in the recent NTP study, there was “some evidence” of carcinogenicity in the adrenal gland. The number of pheochromocytomas was significantly higher ($p < 0.05$) in male rats at 1.5 and 3 W/kg, compared with the concurrent controls. Moreover, the increase in malignant tumor-like hyperplasia in the adrenal gland of female rats was significantly higher at 6 W/kg, relative to the concurrent controls ($p < 0.05$)."

"Postscripts

... It is important to note that the recent NTP and Ramazzini animal RF exposure studies presented similar findings in heart schwannomas and brain gliomas. The increased schwannomas and abnormal heart tissue development/damage to heart tissue are significant findings in RF-exposed animal research studies....

A particular perspective to keep in mind is that, with the induction of cancer by a carcinogen, an agent is typically considered carcinogenic if it induces a significant response in a specific tissue.”

[4] J. Moskowitz, “National toxicology program publishes final cell phone radiation study reports,” Electromagn. Radiation Safety, Nov. 2018. [Online]. Available: <https://www.saferemr.com/2018/11/NTP-final-reports31.html>

EVALUATION OF GENOTOXICITY OF CELL PHONE RADIATION IN MALE AND FEMALE RATS AND MICE FOLLOWING SUBCHRONIC EXPOSURE (NTP STUDY)

Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Shockley KR, Tice RR, Bucher JR, Witt KL. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environ Mol Mutagen*. 2019 Oct 21. doi: 10.1002/em.22343.

Abstract

The National Toxicology Program tested two common radiofrequency radiation (RFR) modulations emitted by cellular telephones in a 2-year rodent cancer bioassay that included interim assessments of additional animals for genotoxicity endpoints.

Male and female Hsd:Sprague Dawley SD rats and B6C3F1/N mice were exposed from gestation day 5 or postnatal day 35, respectively, to code division multiple access (CDMA) or

global system for mobile (GSM) modulations over 18 h/day, at 10 min intervals, in reverberation chambers at specific absorption rates (SAR) of 1.5, 3, or 6 W/kg (rats, 900 MHz) or 2.5, 5, or 10 W/kg (mice, 1900 MHz). After 19 (rats) or 14 (mice) weeks of exposure, animals were examined for evidence of RFR-associated genotoxicity using two different measures. Using the alkaline (pH > 13) comet assay, DNA damage was assessed in cells from three brain regions, liver cells, and peripheral blood leukocytes; using the micronucleus assay, chromosomal damage was assessed in immature and mature peripheral blood erythrocytes.

Results of the comet assay showed significant increases in DNA damage in the frontal cortex of male mice (both modulations), leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). Increases in DNA damage judged to be equivocal were observed in several other tissues of rats and mice. No significant increases in micronucleated red blood cells were observed in rats or mice. In conclusion, these results suggest that exposure to RFR is associated with an increase in DNA damage.

<https://www.ncbi.nlm.nih.gov/pubmed/31633839>

Excerpts

The NTP bioassay was designed to evaluate non-thermal effects of cell phone RFR exposure, which meant that body temperature could not change more than 1 °C under our exposure condition. Therefore, we consider it unlikely that thermal effects were a confounding factor for our genetic toxicity tests, although more work in general is needed to clarify the thermal effects of RFR on different tissues, and the degree to which increases in body or tissue temperature affect genomic integrity.

... our results and the results of other experiments suggest that non-thermal exposure of cells or whole organisms to RFR may result in measurable genotoxic effects, despite varied and weak responses across studies overall (Brusick et al., 1998; Ruediger, 2009; Verschaeve et al., 2010). Induction of oxygen radicals or interference with DNA repair processes have been proposed as possible mechanisms by which RFR could cause DNA damage (Ruediger 2009; Yakymenko et al. 2015).

... NTP Technical Reports on the results of the 2-year cancer bioassay for exposure to RFR for rats (TR 595) and mice (TR 596) were finalized, peer reviewed, and made publicly available in 2018. The NTP concluded that results demonstrated clear evidence of carcinogenic activity of cell phone RFR (both modulations) based on incidences of malignant schwannomas of the heart in male rats. Malignant gliomas in the brain were also observed in male rats exposed to cell phone RFR and were considered to be related to exposure. Female rats exhibited malignant schwannomas of the heart and malignant gliomas, but incidences of these tumors were considered equivocal. The observation that cell phone RFR affects heart and brain tissue in Sprague Dawley rats after long-term exposure was replicated in a similar study (that used only the GSM modulation) by the Ramazzini Institute (Falcioni et al., 2018). The gliomas and schwannomas observed in rats are similar to the tumor types reported in some epidemiology studies to be associated with cell phone use. The NTP bioassay findings in mice, in which different organs were affected compared to rats, were considered equivocal....

The highest exposure of 6 W/kg in rats and 10 W/kg in mice, for a total of 9 h 10 min a day

(achieved by cycling for 10 min on, 10 min off over 18 h 20 min), produced higher exposures than experienced by humans under normal cellular phone use conditions. Thus, whether the findings in the NTP animal studies (e.g. malignant gliomas in the brain and malignant schwannomas in the hearts of male rats; increased levels of DNA damage in hippocampal cells of male rats and the frontal cortex of male mice) indicate a potential for adverse health outcomes in humans remains a question. Because one of the most important questions prompted by our results concerns the mechanism(s) by which RFR might induce biological effects, follow-up studies by the NTP to investigate mechanisms of genetic damage associated with RFR exposure are underway.

ADVERSE EFFECTS OF WIRELESS RADIATION

Kostoff RN. Adverse Effects of Wireless Radiation. 2019. PDF. <http://hdl.handle.net/1853/61946>.

Abstract

This monograph identifies adverse effects of wireless radiation as reported in the premier biomedical literature. It shows that most of the reported laboratory experiments are not designed to elicit the more severe adverse effects reflective of the real-life operating environment in which wireless radiation is embedded. Many do not include pulsing and modulation of the carrier signal, and most do not account for synergistic effects of other toxic stimuli acting in concert with the wireless radiation. It also presents evidence that the nascent 5G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have systemic adverse effects as well. The monograph includes a substantial bibliography of papers that present these adverse effects, and shows that what has been reported is the tip of the iceberg of the full spectrum of potential adverse effects from wireless radiation.

Open access paper:

<https://smartech.gatech.edu/bitstream/handle/1853/61946/ADVERSE%20EFFECTS%20OF%20WIRELESS%20RADIATION%20%283%29.pdf>

Note: This 649-page monograph is not a peer-reviewed publication.

MOBILE PHONE INDUCED COGNITIVE AND NEUROCHEMICAL CONSEQUENCES

Sharma A, Sharma S, Shrivastava S, Singhal PK, Shukla S. Mobile phone induced cognitive and neurochemical consequences. J Chem Neuroanat. 2019 Sep 22:101684. doi: 10.1016/j.jchemneu.2019.101684.

Highlights

- Use of mobile phone lowers acetyl cholinesterase activity of brain.
- MWR cause increase in lipid per oxidation thus alters membrane integrity.
- Microwave radiation alters the oxidative stress management.
- Effects on Hippocampus, Spatial Memory, Learning Behavior in Rats.

Abstract

With the rapid advances in technology, extensive use of mobile phones has increased the risk of health problems. This study was performed to find out the effect of mobile phone frequency on male Wistar rats. Animals were divided into two groups (n = 6 in each group). Group one was considered as control and group two (experimental group) was exposed to microwave radiation (2100 MHz) for 4 hours/day (5 days/week) for 3 months. Exposure of microwave radiation frequency showed significant alterations in cholinesterase activity, muscular strength, learning ability and anxiety. MWR exposure was also associated with significant alteration in the oxidative defense system and hippocampus degeneration. Histopathological observations clearly depicted the neural degeneration. Thus, it can be concluded that MWR significantly affects the central nervous system and may lead to many severe illnesses. This study may reveal a platform to understand its toxic effect and can further be used for amendment in current guidelines of mobile radiation.

<https://www.ncbi.nlm.nih.gov/pubmed/31553920>

CANCERS OF THE BRAIN AND CNS: GLOBAL PATTERNS AND TRENDS IN INCIDENCE

Mortazavi SMJ, Mortazavi SAR, Paknahad M. J Biomed Phys Eng. 2018 Mar 1;8(1):151-152.

Abstract

Miranda-Filho et al. in their recently published paper entitled "Cancers of the brain and CNS: global patterns and trends in incidence" provided a global status report of the geographic and temporal variations in the incidence of brain and CNS cancers in different countries across continents worldwide. While the authors confirm the role of genetic risk factors and ionizing radiation exposures, they claimed that no firm conclusion could be drawn about the role of exposure to non-ionizing radiation. The paper authored by Miranda-Filho et al. not only addresses a challenging issue, it can be considered as a good contribution in the field of brain and CNS cancers. However, our correspondence addresses a basic shortcoming of this paper about the role of electromagnetic fields and cancers and provides evidence showing that exposure to radiofrequency electromagnetic fields (RF- EMFs), at least at high levels and long durations, can increase the risk of cancer.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5928307/>

RADIOFREQUENCY FIELD EXPOSURE ASSESSMENT: A PILOT STUDY ON MOBILE PHONE SIGNAL STRENGTH AND TRANSMITTED POWER LEVELS

Brzozek C, Zeleke BM, Abramson MJ, Benke KK, Benke G. Radiofrequency electromagnetic field exposure assessment: a pilot study on mobile phone signal strength and transmitted power levels. *J Expo Sci Environ Epidemiol*. 2019 Oct 22. doi: 10.1038/s41370-019-0178-6.

Abstract

In many epidemiological studies mobile phone use has been used as an exposure proxy for radiofrequency electromagnetic field (RF-EMF) exposure. However, RF-EMF exposure assessment from mobile phone use is prone to measurement errors limiting epidemiological research. An often-overlooked aspect is received signal strength levels from base stations and its correlation with mobile phone transmit (Tx) power. The Qualipoc android phone is a tool that provides information on both signal strength and Tx power. The phone produces simultaneous measurements of Received Signal Strength Indicator (RSSI), Reference Signal Received Power (RSRP), Received Signal Code Power (RSCP), and Tx power on the 3G and 4G networks. Measurements taken in the greater Melbourne area found a wide range of signal strength levels. The correlations between multiple signal strength indicators and Tx power were assessed with strong negative correlations found for 3G and 4G data technologies (3G RSSI -0.93, RSCP -0.93; 4G RSSI -0.85, RSRP -0.87). Variations in Tx power over categorical levels of signal strength were quantified and showed large increases in Tx power as signal level decreased. Future epidemiological studies should control for signal strength or factors influencing signal strength to reduce RF-EMF exposure measurement error.

Conclusions

This study has demonstrated the use of the Qualipoc handheld android phone to assess the correlations between multiple signal strength indicators and Tx power on the 3G and 4G networks in the greater Melbourne area. The phones provided objective measurements of exposure rather than self-reported estimates from surveys. It found Tx power from a mobile phone device varied greatly depending on signal strength level, with exposure differing by orders of magnitude between poor and excellent signal strength levels. In order to reduce measurement error in RF-EMF exposure, data on distance the phone is held from the body and Tx power are required. As Tx power is difficult to measure and costly with the Qualipoc android device, it is recommended that future epidemiological studies control for signal strength as a proxy due to the strong correlations found between signal strength and Tx power. Factors influencing signal strength, such as distance from base station or base station concentration, line of site, vegetation, building materials, and service provider provide measures to control for signal strength.

Open access paper: <https://www.nature.com/articles/s41370-019-0178-6>

METHODOLOGICAL LIMITATIONS IN EXPERIMENTAL STUDIES ON SYMPTOMS IN INDIVIDUALS WITH IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS (IEI-EMF) - REVIEW

Schmiedchen K, Driessen S, Oftedal G. Methodological limitations in experimental studies on symptom development in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI- EMF) - a systematic review. *Environ Health*. 2019 Oct 22;18(1):88. doi: 10.1186/s12940-019-0519-x.

Abstract

BACKGROUND: Hypersensitivity to electromagnetic fields (EMF) is a controversial condition. While individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) claim to experience health complaints upon EMF exposure, many experimental studies have found no convincing evidence for a physical relation. The aim of this systematic review was to evaluate methodological limitations in experimental studies on symptom development in IEI-EMF individuals that might have fostered false positive or false negative results. Furthermore, we compared the profiles of these limitations between studies with positive and negative results.

METHODS: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guided the methodological conduct and reporting. Eligible were blinded experimental studies that exposed individuals with IEI-EMF to different EMF exposure levels and queried the development of symptoms during or after each exposure trial. Strengths and limitations in design, conduct and analysis of individual studies were assessed using a customized rating tool.

RESULTS: Twenty-eight studies met the eligibility criteria and were included in this review. In many studies, both with positive and negative results, we identified methodological limitations that might have either fostered false or masked real effects of exposure. The most common limitations were related to the selection of study participants, the counterbalancing of the exposure sequence and the effectiveness of blinding. Many studies further lacked statistical power estimates. Methodically sound studies indicated that an effect of exposure is unlikely.

CONCLUSION: Overall, the evidence points towards no effect of exposure. If physical effects exist, previous findings suggest that they must be very weak or affect only few individuals with IEI-EMF. Given the evidence that the nocebo effect or medical/mental disorders may explain the symptoms in many individuals with IEI-EMF, additional research is required to identify the various factors that may be important for developing IEI-EMF and for provoking the symptoms. We recommend the identification of subgroups and exploring IEI-EMF in the context of other idiopathic environmental intolerances. If further experimental studies are conducted, they should preferably be performed at the individual level. In particular, to increase the likelihood of detecting hypersensitive individuals, if they exist, we encourage researchers to achieve a high credibility of the results by minimizing sources of risk of bias and imprecision.

EXCERPT: At present, it is not clear whether further provocation or intervention studies would provide new insight, but if further experimental studies are conducted, they should preferably

be performed at the individual level. In order to increase the likelihood of detecting hypersensitive individuals, if they exist, we encourage researchers to achieve a high credibility of the results by minimizing of sources of risk of bias and imprecision. In any such study, efforts must be made to identify and include any individuals whose symptoms are caused by physical effects of the EMF exposure.

Open access paper: <https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0519-x>

MY NOTE: Some scientists have argued that the provocation studies which this review paper evaluated employ an inappropriate methodology to test individuals with electromagnetic hypersensitivity (EHS, or IEI-EMF). Provocation studies assume that symptoms appear immediately after an exposure to EMF ignoring the fact that in many instances there is a time lag between an EMF exposure and experience of symptoms. Thus, I concur with the authors' suggestion that further provocation studies are likely a waste of time. I would argue we need new paradigms to study EHS.

MEASUREMENT AND MAPPING OF THE ELECTROMAGNETIC RADIATION IN THE URBAN ENVIRONMENT

Liu J, Wei M, Li H, Wang X, Wang X, Shi S. Measurement and mapping of the electromagnetic radiation in the urban environment. *Electromagn Biol Med*. 2019 Oct 31:1-6. doi: 10.1080/15368378.2019.1685540.

Abstract

People are increasingly exposed to electromagnetic radiation with the rapid development of technologies such as broadcasting and mobile communication system. There is a concern that long-term exposure at low levels may be associated with various non-specific physical symptoms and ecological effects on animals and plants. It is extremely important to measure and analyze the electromagnetic radiation levels in order to protect people from the possible effects of electromagnetic radiation. A large-scale assessment of the effects of electromagnetic radiation on health or on ecology requires the ambient electromagnetic radiation levels over areas too vast to cover with conventional measurement methods. In this article, detailed information about the measurement tools and measurement method are given. The electromagnetic radiation exposure levels were measured on the main streets in the dense urban areas of Beijing, the capital of China. We apply ordinary kriging as an interpolation technique to assess the electromagnetic radiation exposure in large outdoor areas based on car-mounted measurements along the surrounding roads. The electromagnetic radiation exposure levels for larger areas can be investigated visually on the electromagnetic pollution map, which can assist decision makers by identifying the hotspots.

<https://www.ncbi.nlm.nih.gov/pubmed/31668093>

CHROMOSOME DAMAGE IN HUMAN CELLS INDUCED BY UMTS MOBILE TELEPHONY RADIATION

Panagopoulos DJ. Chromosome damage in human cells induced by UMTS mobile telephony radiation. *Gen Physiol Biophys*. 2019 Sep 13. doi: 10.4149/gpb_2019032.

Abstract

Environmental exposure to modern microwave telecommunication electromagnetic fields (EMFs) has increased to unprecedented levels with consequent health complaints and concerns. Many studies have already reported genotoxic effects on a variety of organisms and cell/tissue types. Human peripheral blood lymphocytes from six healthy donors were stimulated for mitosis and exposed to microwave EMF of Universal Mobile Telecommunications System (UMTS) or third generation (3G) mobile telephony (MT) EMF/radiation emitted by a commercially available mobile phone handset. Lymphocytes exposed during the G2 phase of the cell division cycle and observed at metaphase, exhibited chromatid-type aberrations (gaps and breaks) at highly significant percentages - up to 275% - compared to the control (sham-exposed) samples. Each subject exhibited a different sensitivity to the microwave exposure. Moreover, the percentages of aberrations in the control samples among subjects were different due to genetic and environmental factors. The MT EMF exposure induced mainly achromatic lesions (gaps), and secondarily terminal deletions (breaks) in a smaller degree. In conclusion, the present study shows that microwave 3G MT EMF/radiation - within the current exposure limits - has significant genotoxic action on human cells, and human exposure to this EMF/radiation should be kept at levels as low as possible.

<https://www.ncbi.nlm.nih.gov/pubmed/31516130>

Excerpts

Exposures were performed by a UMTS (3G) commercially available mobile phone handset in order to test the effects of real-life exposures experienced daily by billions of MT users around the world. UMTS employs the “Wideband Code Division Multiple Access” (W-CDMA) code to offer greater spectral efficiency and bandwidth to mobile network operators. All modern digital MT signals, combine both high (RF) and low (ELF) frequencies....

... Representative average power density (from five representative instant measurements excluding background) in the RF band $\pm$ SD was $92 \pm 27 \mu\text{W}/\text{cm}^2$. The carrier frequency was variable $\sim 1920\text{--}1960$ MHz during the exposures. Representative average ELF-E and ELF-B (from five representative instant measurements excluding background) $\pm$ SD at 100 Hz was 12 ± 4.2 V/m, and 0.9 ± 0.4 mG, respectively. Corresponding average ELF-E and ELF-B (from five instant measurements excluding background) $\pm$ SD at 1500 Hz was 8 ± 4.6 V/m, and 0.06 ± 0.02 mG, respectively. All measurements were carried out separately from the exposures in order to have the measuring devices at exactly the same position with the samples during the exposures. The above measured EMF/radiation intensity values are representative for UMTS mobile phone EMFs during “talk” mode, and are well within the current exposure limits (ICNIRP 1998, 2010)....

The disruption of cell electrochemical balance by manmade (polarized) EMFs through irregular gating of voltage- gated ion channels on cell membranes is described by the “ion

forced-oscillation mechanism” (Panagopoulos et al. 2000, 2002, 2015b). In turn, it is explained how the disruption of intracellular ionic concentrations may lead to DNA damage by intracellular release of free radicals or hydrolytic enzymes like DNases (Barzilai and Yamamoto 2004; Phillips et al. 2009; Panagopoulos 2011; Pall 2013). This is in line with the attribution of the DNA and chromosome damage to oxidative stress by El-Abd and Eltoweissy (2012). According to the ion forced- oscillation mechanism, the bioactivity of a polarized EMF is proportional to its intensity and inversely proportional to its frequency, meaning that the ELF pulsing and modulation of the MT EMFs seem to be responsible for their intense bioactivity and not the carrier (RF) frequency which is several orders of magnitude higher than ELF. This is supported by significant experimental evidence (Panagopoulos 2019). Thus, reports that MT EMF-bioactivity depends on carrier frequency (Markova et al. 2005) seem unlikely according to this mechanism and the corresponding experimental evidence.

The present study – in line with previous studies of my group – indicates that people should necessarily reduce exposures to MT EMFs as much as possible by making prudent use of this technology and reduce drastically the number and duration of calls, make use of wired headsets (especially air-tube headsets) or the loudspeaker during calls and keep the device at the greatest possible distance from the body, not carry the mobile phones on their bodies while they are turned on, keep them at the greatest possible distance during the day, and switch them off during sleep. An avoidance strategy is the key for protection against the tremendously increased levels of man-made EMF exposures rather than metal shielding which is accused for internal desynchronization. This is a severe medical syndrome in which the circadian rhythms of an individual (activity, temperature sleep/waking cycles, body secretions, etc.) start deviating from their normal 24 h-periodicity. Long-term persistence of this phenomenon is connected to a variety of health problems such as depression, sleep disorders, impulsivity, mania, metabolic syndrome, cardiovascular disease, and increased cancer risk (Panagopoulos and Chrousos 2019). Finally, the responsible public health authorities should take into account the results of the present study as well as the results of hundreds of other peer-reviewed published studies (Panagopoulos 2019) and establish much stringer exposure limits than the existing ones.

EFFECT OF ELECTROMAGNETIC FIELD EXPOSURE ON THE TRANSCRIPTION OF REPETITIVE DNA ELEMENTS IN HUMAN CELLS

Del Re B, Bersani F, Giorgi G. *Electromagn Biol Med*. 2019 Sep 21:1-9. doi: 10.1080/15368378.2019.1669634.

Abstract

Repetitive DNA (RE-DNA) was long thought to be silent and inert; only recent research has shown that it can be transcribed and that transcription alteration can be induced by environmental stress conditions, causing human pathological effects. The aim of this study was to determine whether exposure to radiofrequency electromagnetic fields (RF-EMF) could affect the transcription of RE-DNA. To this purpose, three different human cell lines (HeLa, BE(2)C and SH-SY5Y) were exposed to 900 MHz GSM-modulated RF-EMF at specific absorption rate of 1 W/kg or to sham. After exposure, mRNA levels of RE-DNA were evaluated through quantitative real- time PCR. The following RE-DNA types were investigated: Long Interspersed nucleotide Element 1, DNA alpha satellite and Human Endogenous Retroviruses-like sequences. When comparing cells exposed to RF-EMF versus control samples, different

results were found for the three cell lines evaluated, indicating that RF-EMF exposure can significantly affect RE-DNA transcription and that the effects strongly depend on the cellular context and the tissue type. Further studies are needed to elucidate which molecular mechanisms could be involved.

<https://www.ncbi.nlm.nih.gov/pubmed/31542968>

INVESTIGATION OF THE NEUROPROTECTIVE EFFECTS OF THYMOQUINONE ON RAT SPINAL CORD EXPOSED TO 900 MHZ ELECTROMAGNETIC FIELD

Yahyazadeh A, Altunkaynak BZ.J Chem Neuroanat. 2019 Oct;100:101657. doi: 10.1016/j.jchemneu.2019.101657.

Abstract

Exposure to electromagnetic field in long-term use of cell phones has increased concerns about serious health problems. Our aim was to survey the possible effects of electromagnetic field radiation (60 min/day for 28 days) on the spinal cords of 12 weeks old rats. Further, we investigated whether the administration of thymoquinone (10 mg/kg/day) would protect the spinal cord tissue against the adverse effects of electromagnetic field or not. Twenty-four adult male Wistar albino rats were assigned randomly into four groups: control, electromagnetic field, thymoquinone and electromagnetic field + thymoquinone. The cervical spinal cords of all rats was evaluated using the stereological, biochemical and histological methods. The number of motor neurons were reduced in the electromagnetic field group compared to the control group ($p < 0.05$). Superoxide dismutase level was higher in the electromagnetic field group compared to the control group ($p < 0.05$). In the electromagnetic field + thymoquinone group, we found an increase in the number of motor neurons and decrease in superoxide dismutase activity compared to the electromagnetic field group ($p < 0.05$). Our histological findings also exhibit the remarkable architectural alterations. We speculated that electromagnetic field radiation induced the morphological and biochemical damage to the spinal cord tissue of rats. Administration of antioxidant, thymoquinone, also ameliorated such complications caused by electromagnetic field.

<https://www.ncbi.nlm.nih.gov/pubmed/31228532>

EFFECT OF CELL PHONE RADIATION ON GELATINOLYTIC ACTIVITY OF MATRIX METALLOPROTEINASE-2 AND -9 OF MOUSE PRE- ANTRAL FOLLICLES DURING IN VITRO CULTURE

Azimipour F, Zavareh S, Lashkarbolouki T. The Effect of Radiation Emitted by Cell Phone on The Gelatinolytic Activity of Matrix Metalloproteinase-2 and -9 of Mouse Pre-Antral Follicles during In Vitro Culture. Cell J. 2020 Apr;22(1):1-8. doi: 10.22074/cellj.2020.6548..

Abstract

Objective: The unfavorable effects of electromagnetic radiation (EMR) emitted by the cell phone on reproduction health are controversial. Metalloproteinases play a vital role in ovarian follicle development. This study was designed to investigate the effects of exposure to the cell phone on the gelatinolytic activity of in vitro cultured mouse pre-antral follicle.

Materials and Methods: In this experimental study, pre-antral follicles were isolated from ovaries of immature mice (n=16) and cultured with or without exposure to the cell phone in

talking mode for 60 minutes. The gelatinolytic activity was evaluated through the zymography method, as well as the gene expression of matrix metalloproteinases (MMPs) namely MMP-2 and -9 and tissue inhibitors of metalloproteinases (TIMPs) namely, TIMP-1 and -2 by the real-time polymerase chain reaction (PCR) method. Also, in parallel, the development of pre-antral follicles was assessed.

Results: The maturation parameters of the cell phone-exposed pre-antral follicles were significantly lower compared with the control group ($P<0.05$). The gelatinolytic activity was significantly decreased in the cell phone-exposed preantral follicles compared with the control group ($P<0.05$). The relative mRNA expression of the MMP-2 gene was significantly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles whereas the expression rate of the MMP-9 gene was considerably ($P<0.05$) reduced when compared with the control group. Conversely, the relative expression of the TIMP-1 was markedly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles while the expression of the TIMP-2 was ($P<0.05$) significantly diminished in comparison with the control group.

Conclusion: Exposure to the cell phone alters the growth and maturation rate of murine ovarian follicle through the changing in the expression of the MMP-2 and -9 genes, as well as the gelatinolytic activity.

<https://www.ncbi.nlm.nih.gov/pubmed/31606960>

MELATONIN MODULATES NMDA-RECEPTOR 2B/CALPAIN-1/CASPASE-12 PATHWAYS IN RAT BRAIN AFTER LONG TIME EXPOSURE TO GSM RADIATION

Seymen CM, Ilgaz C, Erdogan D, Elmas C, Yar Saglam AS, Elmazoglu Z, Sirav Aral B, Take Kaplanoglu G. Melatonin Modulates NMDA-Receptor 2B/Calpain-1/Caspase-12 Pathways in Rat Brain After Long Time Exposure to GSM Radiation. Turk Neurosurg. 2019 Jul 11. doi: 10.5137/1019-5149.JTN.26492-19.2.

Abstract

AIM: In this study we aimed to investigate the potential protective effects of melatonin on the chronic radiation emitted by third generation mobile phones on the brain.

MATERIAL AND METHODS: 24 male Wistar albino rats were divided into four equal groups. Throughout a 90-day experiment, no application was performed on the control group. The second group was exposed to 2100 MHz radiation for 30 minutes. Subcutaneous melatonin was injected into the third group. Subcutaneous melatonin injection was applied 40 minutes before radiation and then the fourth group was exposed to radiation for 30 minutes. At the end of the experiment, brain (cerebrum and cerebellum) tissues were taken from the subjects. Histochemical, immunohistochemical, ultrastructural and Western blot analyses were applied. In addition to brain weight, Purkinje cells' number, immunohistochemical H Score analyses and the results of the Western blot were examined statistically.

RESULTS: As a result, with the application of radiation, neuronal edema, relatively-decreased numbers of neurons on hippocampal CA1 and CA3 regions, displacement of the Purkinje neurons and dark neurons findings were observed as a result of histochemical stainings. Radiation also activated the NMDA-receptor 2B/Calpain- 1/Caspase-12 pathway, NMDA-

receptor 2B and Calpain-1 with the findings being supported by Western blot analyses. Pre-increased protein synthesis before apoptosis was identified by electron microscopy.

CONCLUSION: Taken together, mobile phone radiation caused certain (ultra) structural changes on the brain and activated the NMDA-receptor 2B/Calpain-1/Caspase-12 pathway; in addition, melatonin was effective, but insufficient to demonstrate any protective effects.

<https://www.ncbi.nlm.nih.gov/pubmed/31608966>

UNCERTAINTY ANALYSIS OF MOBILE PHONE USE AND ITS EFFECT ON COGNITIVE FUNCTION: THE APPLICATION OF MONTE CARLO SIMULATION IN A COHORT OF AUSTRALIAN PRIMARY SCHOOL CHILDREN

Brzozek C, Benke KK, Zeleke BM, Croft RJ, Dalecki A, Dimitriadis C, Kaufman J, Sim MR, Abramson MJ, Benke G. Uncertainty Analysis of Mobile Phone Use and Its Effect on Cognitive Function: The Application of Monte Carlo Simulation in a Cohort of Australian Primary School Children. *Int J Environ Res Public Health*. 2019 Jul 8;16(13). pii: E2428. doi: 10.3390/ijerph16132428.

Abstract

Previous epidemiological studies on health effects of radiation exposure from mobile phones have produced inconsistent results. This may be due to experimental difficulties and various sources of uncertainty, such as statistical variability, measurement errors, and model uncertainty. An analytical technique known as the Monte Carlo simulation provides an additional approach to analysis by addressing uncertainty in model inputs using error probability distributions, rather than point-source data. The aim of this investigation was to demonstrate using Monte Carlo simulation of data from the ExPOSURE (Examination of Psychological Outcomes in Students using Radiofrequency dEVICES) study to quantify uncertainty in the output of the model. Data were collected twice, approximately one year apart (between 2011 and 2013) for 412 primary school participants in Australia. Monte Carlo simulation was used to estimate output uncertainty in the model due to uncertainties in the call exposure data. Multiple linear regression models evaluated associations between mobile phone calls with cognitive function and found weak evidence of an association. Similar to previous longitudinal analysis, associations were found for the Go/No Go and Groton maze learning tasks, and a Stroop time ratio. However, with the introduction of uncertainty analysis, the results were closer to the null hypothesis.

Open access paper: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6651811/>

RADIOFREQUENCY ELECTROMAGNETIC FIELDS, MOBILE PHONES, AND HEALTH EFFECTS: WHERE ARE WE NOW?

Miligi L. Radiofrequency electromagnetic fields, mobile phones, and health effects: where are we now? [Article in Italian]. *Epidemiol Prev.* 2019 Sep-Dec;43(5-6):374-379. doi: 10.19191/EP19.5-6.P374.107.

Abstract

This paper aims to present useful elements for framing the issue of exposure to radio frequencies (RFs), in particular those related to telecommunications, and the possible effects on health also in the light of the rapid evolution of technologies (the advent of 5G). New developments in the field oblige us to reflect on the possible implications in terms of public health. Here, we have preferred to take stock and not to demand a systematic review. The development of telecommunications is creating great interest in all sectors for the possibility of new applications, but is also increasing concern for the effects on health not yet fully known, to the point that there is a growing mobilization against the introduction of 5G both at national and at international level.

Epidemiological studies and metanalyses on the relationship between cancer and RFs, particularly those on mobile phones, still identify areas of uncertainty that need to be investigated, and studies on non-cancer effects are growing in number, suggesting the possibility of new risks. The relative scenarios that will open with the 5G trial are likely to change the overall exposure level of the population as a result of major changes in the network architecture. Therefore, it is important to adopt a strongly precautionary approach. Given the strong concerns of the population, the competent institutions should implement information and awareness programmes through adequate risk communication.

<https://www.ncbi.nlm.nih.gov/pubmed/31659885>

WHY WE DO NOT AGREE WITH THE REASSURING CONCLUSIONS OF THE REPORT ON RADIOFREQUENCIES AND CANCER OF THE ITALIAN NATIONAL INSTITUTE OF HEALTH

Di Ciaula A, Terracini B. Why we do not agree with the reassuring conclusions of the report on radiofrequencies and cancer of the Italian National Institute of Health. [Article in Italian], *Epidemiol Prev.* 2019 Sep-Dec;43(5- 6):314-316. doi: 10.19191/EP19.5-6.P314.097.

No abstract. <https://www.ncbi.nlm.nih.gov/pubmed/31659875>

COMPARATIVE INVESTIGATIONS ON THE INHIBITION OF MOBILE PHONE RADIATION BY MULTIPLE COMPARTMENT CAVITY RESONANCE DEVICES

Dartsch PC, König FM. Comparative Investigations on the Inhibition of Mobile Phone Radiation by Multiple Compartment Cavity Resonance Devices. *Japan Journal of Medicine.* 2019: 2:3.

Abstract

Mobile phone modulation technologies like LTE, UMTS and GSM are now fully established. Among these, mobile phones have been considered to emit only a radiation with low intensities when they are actively working and are placed near to the head. However, the safety aspects are not cleared evaluated. To address this topic, we have already investigated the cellular effects of DECT base radiation and its compensation by multiple compartment

cavity resonance devices (RD). Prompted by this background, this study compares the efficacy of a second-generation RD with an optimized design in comparison to the first-generation RD used in previous studies. Connective tissue fibroblasts (cell line L-929) were exposed to the radiation of an actively transmitting commercially available mobile phone with 1.25 W/m² at the level of the cells with and without the two different RD directed crosswise towards the cell layer during mobile phone irradiation. Unexposed cells in a similar incubator served as corresponding controls. The resulting cell vitality was checked by measurement of the enzymatic activity of mitochondrial dehydrogenases by the color change of the sodium salt 2,3-bis[2-methoxy-4-nitro-5-sulfo-phenyl]-2H-tetrazolium-5-carboxyanilide (XTT). The results clearly demonstrate that exposure to mobile phone radiation caused a significantly reduced cell vitality by more than 50 % for non-thermal radiation with an intensity of 1.25 W/m² at the level of the cells. The decreased cell vitality after mobile phone radiation exposure could be largely compensated by use of two crossed RD directed towards the cells. However, the newly designed RD construction was even more effective (reduction of cell vitality by 13.01 ± 1.86 %; mean value ± standard deviation) than the standard RD (reduction of cell vitality by 20.17 ± 2.16 %; mean value ± standard deviation) which has been already used successfully to compensate digitally enhanced cordless telecommunication (DECT) phone base station radiation.

Open access paper: <https://japanjournalofmedicine.com/comparative-investigations-on-the-inhibition-of-mobile-phone-radiation-by-multiple-compartment-cavity-resonance-devices/>

CONFRONTING RISK OF BIAS IN RF BIOEFFECTS RESEARCH. COMMENTS ON TWO PAPERS BY VIJAYALAXMI AND PRIHODA

Foster KR, Simkó M, Verschaeve L. Confronting Risk of Bias in RF Bioeffects Research. Comments on Two Papers by Vijayalaxmi and Prihoda. Radiat Res. 2019 Aug;192(4):363-366. doi: 10.1667/RR15478.1.

No abstract <https://www.ncbi.nlm.nih.gov/pubmed/31393822>

REVIEW: THE INFLUENCE OF BIOACTIVE MOBILE TELEPHONY RADIATION AT THE LEVEL OF A PLANT COMMUNITY – POSSIBLE MECHANISMS AND INDICATORS OF THE EFFECTS

Czerwiński M, Januszkiewicz L, Vian, Lázaro A. Ecological Indicators. Volume 108, January 2020, 105683. <https://doi.org/10.1016/j.ecolind.2019.105683>

Highlights

- There are various indicators of microwave radiation impact on herbaceous vegetation.
- The best indicators are some parameters of vegetation canopy or individual plants.
- Specific plant functional groups may be indicators of long-term community processes.
- Other organisms interacting with plants, e.g. pollinators, should also be considered.
- The selection of indicators depends on the propagation of radiation in the canopy.

Abstract

Environmental exposure to radiofrequency electromagnetic fields (RF-EMFs) from mobile telephony has rapidly increased in the last two decades and this trend is expected to continue. The effects of this exposure at plant community level are unknown and difficult to assess in a scientifically appropriate manner. Such an assessment can be scientifically adequate if studied

plant community is completely new and control-impact radiation treatment is used.

In this review we aimed to predict ecological effects and identify indicators of the impact of bioactive RF-EMFs at the mobile telephony frequency range on plant communities. We considered the scenario where a plant community was exposed to radiation generated by a base transmitting station antenna mounted on a nearby mast. This plant community can be represented by mesic meadow, ruderal or arable weed community, or other herbaceous, moderately productive vegetation type. We concentrated primarily on radiation effects that can be recorded for a year since the exposure started. To predict them we used physical theories of radiowave propagation in vegetation and the knowledge on plants physiological responses to RF-EMF. Our indicators can be used for the detection of the impact of RF-EMFs on vegetation in a control-impact experiment.

The identified indicators can be classified into the following groups:

- (1) canopy parameters;
- (2) plant characteristics to be measured in the field or laboratory in a number of individuals that represent the populations of selected species;
- (3) community weighted means/medians (CWMs) of plant traits and strategies;
- (4) the abundance of other organisms that interact with plants and can influence their fitness or population size.

The group of canopy parameters includes mean height, vertical vegetation structure and dry weight of above- ground standing phytomass. Plant characteristics requiring biometric sampling in the field are plant height, the number of fruits and seeds, as well as seed viability. The group of plant traits that are calculated as CWMs covers seed releasing height, seed dispersal mode, SLA, leaf orientation, month of germination and flowering, Ellenberg's light indicator value, and the proportion of individuals in the classes of competitors and stress tolerators according to Grime's CSR strategy scheme. The group of "non-plant" indicators includes primarily the frequency of flower visits by beetles, wasps, hoverflies, and bees that have their nests over ground. To detect ecological responses that occur for the first year since a herbaceous community has been exposed to potentially bioactive RF-EMF, the first two indicators groups should be used.

<https://www.sciencedirect.com/science/article/pii/S1470160X19306764>
