Bulletin de veille
Champs électromagnétiques
N°15 – Avril/Mai 2026

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

Exposition professionnelle

Electromagnetic exposure assessment of Italian Coast Guard workers exposed to RADAR sources
Burriesci, G., Comelli, M., Zoppetti, N., D'agostino, S., Valentini, M. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
The study evaluates exposure to electromagnetic fields generated by radar systems on Italian Coast Guard vessels. The Furuno DRS4D- NXT and Lorenz MDS-9 radars (X-band, 9.4 GHz) were analyzed in the ports of Rome and Vibo Valentia (Italy), following the European Directive 2013/35/EU. The measurements conducted with advanced instruments indicate that maximum exposure remains within safety limits, although the Lorenz radar recorded higher values due to its greater peak power. Although the results comply with the occupational limits, the increasing use of radar on small vessels also raises concerns about the exposure of the general population, highlighting the need for further studies and more accessible measurement tools.
https://ieeexplore.ieee.org/document/11185451

Risk assessment of EMF exposure in the operating room: a new paradigm
Cimino, A., Cavallari, M., Di Liberto, R., Comelli, M., Zoppetti, N., Burriesci, G., D'agostino, S. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.

Physicians who perform electrosurgical unit (ESU) procedures are exposed to an electromagnetic field (EMF), the waveform of which is generally complex. This requires performing the exposure assessment under unperturbed field conditions and using the weighted peak (WP) method, according to international ICNIRP guidelines and the European Union Directive.It is not uncommon to measure electric field (EF) values on the order of hundreds of V/m at a few tens of centimeters away from the handpiece. Therefore, it is reasonable to assume, upon contact with the handpiece, the Action Levels (ALs) defined by current legislation for worker health protection will be exceeded. However, only the assessment of ALs for sensory effects can be considered, since the electrosurgical unit never emits EMF for six minutes and therefore the assessment of ALs for thermal effects is not applicable. Due to the close distance between the source and the exposed subject, dosimetric evaluation becomes the only reasonably usable method of analysis (as suggested by ICNIRP guidelines). This is further confirmed by the fact that the EF measurement in contact with the ESU handpiece is perturbed, making EF measurements metrologically incorrect, and thus confirming the importance of the dosimetric evaluation methods. Assuming that the ALs for sensory effects may be exceeded, the question has been raised as to why symptoms in surgeons are not reported in the literature. The evaluation of induced currents in the limbs of surgeons could help to assess the potential effects that the physicians might undergo.This work presents the results of a measurement campaign regarding the evaluations of induced currents in the limbs of operators using such electromedical equipment.The values obtained were compared with the reference levels (RLs) reported in the last ICNIRP guidelines and with the exposure reference levels (ERLs) reported in the last IEEE standard, and considerations were made regarding the lack of evidence in the literature concerning stimulation effects in the limbs of surgeons.
https://ieeexplore.ieee.org/document/11185553

The WebNIR platform: a web tool for the risk assessment of workers with active implantable medical devices exposed to electromagnetic fields
Comelli, M., Vivarelli, C., Mattei, E., Calcagnini, G., Falsaperla, R. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
Since 2017, the Italian National Institute of Health (ISS) and the Institute of Applied Physics "Nello Carrara" of the National Research Council (CNR-IFAC) have been among the entities involved in a series of Collaborative Research Calls (BRiC) issued by the National Institute for Insurance against Accidents at Work (INAIL) in the context of the protection of workers with active implantable medical devices (AIMDs) exposed to electromagnetic fields. As part of this collaboration, a web portal has been developed and can be accessed at https://webnir.eu. Among the tools made available on the portal, this work will focus in particular on an interactive procedure to help the personnel responsible for assessing the exposure of workers with AIMDs to electromagnetic fields to implement the procedure and follow the steps for risk evaluation reported in the technical standard EN 50527-1:2017 to identify actions to be taken, if any.
https://ieeexplore.ieee.org/document/11185516

Numerical simulation studies regarding the workers' radiofrequency exposure monitoring using wearable multi-location measurement system
Gryz, K., Zradziriski, P., Karpowicz, J. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
The simulation study was to examine the effectiveness of reducing a discrepancy between parameters of unperturbed radiofrequency electromagnetic field (EMF) exposure in the work environment and results of workers exposure measurements using body-worn measurement systems, through performing simultaneous multi sensor (multi-location) measurements by sensors worn at various body locations and subsequent averaging of the results of such measurements. The obtained results revealed that the discrepancy in the outcome of EMF exposure assessments (the

value of E-field strength normalized to the parameters of unperturbed E-field) coming from body-worn measurement system (delivering the parameters of EMF disturbed by the body of user wearing this system) may be significantly reduced by using a distributed (multi-location) measurement system. When using the three-point system with one of sensors on the helmet, the lowest discrepancy in the results of exposure evaluation using body- worn system is in case of location of other sensors on the chest and waist. https://ieeexplore.ieee.org/document/11185390

Impact of extremely low frequency electromagnetic fields exposure on sleep quality and mental health in a Tunisian power plant: a cross-sectional study,
Kacem, I., Jammeli, I., Sridi, C., Gaddour, A., Makhloufi, M., Aloui, A., Chouchane, A., El Maalel, O., Kahloul, M. and Mrizak, N., *Frontiers in Psychiatry*, Apr 24 2026, Vol. 17.
Introduction Extremely low-frequency electromagnetic fields (ELF-EMFs) are ubiquitous in our daily life. They may have an impact not only on physical health but also on mental health. Objectives To assess the impact of occupational exposure to the ELF-EMFs on sleep quality, depression, anxiety and stress among workers at the Tunisian Electricity and Gas Company (TEGC).Methods This was a cross-sectional study. The study population included two groups: an exposed group (EG), consisting of power plant employees, and a non-exposed group (NEG), consisting of administrative workers. Exposure to ELF-EMFs was assessed via spot measurements using a magnetometer. Sleep quality, depression, anxiety and stress were assessed by the French versions of the Pittsburgh Sleep Quality Index (PSQI) and the Depression, Anxiety and Stress Scale (DASS-21). Results Seventy-seven participants in the EG and 88 participants in the NEG were included in the study. The median value of the ELF-EMFs was 5.86 mu T at the power plant [min 0.1, max 40.34 mu T]. According to the PSQI global score, 64.9% of the EG had poor sleep quality versus 29.5% of the NEG. Depression was registered in 24.7% of EG and in 3.4% of NEG. Anxiety was noted in 23.4% of the EG and in none of the NEG. Stress was found in 46.8% of the EG and none of the NEG. After multivariate analysis, ELF-EMF exposure was significantly associated with poor sleep quality and depression. Conclusion The present study revealed that ELF-EMFs can affect sleep and mental health. Further studies are needed to explain the mechanism involved. https://doi.org/10.3389/fpsyt.2026.1755918

Exogenous radiofrequency electromagnetic exposure of outdoor workers who are managing touristic boat journeys
Karpowicz, J., Anderson, V., Ramos, V. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
The frequency pattern of radiofrequency electromagnetic field exposure of outdoor workers, who are managing touristic boat journeys, has been investigated using frequency-selective portable, autonomous, data-loggers which allow recognizing the time pattern of exposure level and the composition of its sources. Significantly different patterns of relative contributions to recorded workers' exposure from various sources were found during activities at pier (dominating base stations downlink components of exposure) and during the touristic journey by boats (dominating mobile terminals uplink components, with exposure contribution also from radio and television terrestrial emitters). The differences found in the workers' exposure pattern recorded in particular microenvironments need attention when considering the protection measures aimed at improving the electromagnetic environment there. https://ieeexplore.ieee.org/document/11185521

Occupational exposure to electromagnetic fields: workers at particular risk and indications for health surveillance
Modenese, A. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
Occupational exposure to electromagnetic fields (EMF) is almost ubiquitous nowadays in industrialized countries. Specific work-related risks may involve the exposed workers and

accordingly an adequate health surveillance (HS) program is required, especially for the so called "workers at particular risk". In EU, the HS of workers exposed to EMF is mandatory based on the Directive 2013/35/EU.The EU Directive specifically addresses the prevention of direct biophysical effects and indirect effects of EMF exposure. These latter effects include interference and the risk can be relevant in case of presence of workers with Active Implanted Medical Devices (AIMD) and/or with Active Wearable Medical Devices (AWMD), even in conditions of exposure levels below the recognized limits to protect the general public. Accordingly, the medical examinations within the HS program should carefully look for the presence of AIMD and AWMD, as well as for possible signs of over-exposures. https://ieeexplore.ieee.org/document/11185544

Occupational exposure to electromagnetic fields in electrical utilities: field measurement, risk evaluation and safety control strategies,
Smadi, H. J., Albatran, S. and Alsyouf, M. A., *International Journal of Occupational Safety and Ergonomics*, 2026.
This article aimed to assess occupational exposure to power-frequency electromagnetic fields (EMFs) at various sites of electrical infrastructure in Jordan, including high-voltage (HV) substations, a thermal power plant and a photovoltaic station. Field measurements were taken under steady-state operating conditions and compared with occupational exposure guidelines recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE) Standard. The magnetic flux densities at the three sites were all below these guidelines. The electric field strengths at some HV substations occasionally exceeded the ICNIRP occupational reference levels but remained below the IEEE guideline levels. The results provide insight into EMF hotspots, the most hazardous sites and effective ways to avoid EMF exposure in power system environments. These measures include implementing engineering controls, administrative controls and personal protective equipment to reduce workers' exposure to EMFs, thereby improving workplace safety and EMF risk management policies.
https://doi.org/10.1080/10803548.2026.2665025

Near-field and far-field exposures to radiofrequency electromagnetic fields and cancer risks in humans: a protocol for an umbrella review of epidemiological studies,
Ziegler, J. L., Lagorio, S., Mattsson, M. O., Zeni, O., Bolte, J., Ledent, M., Velghe, M., Stam, R., Rijs, K., Deltour, I., Dolatkhah, R., Wollschläger, D., Petroulakis, N., Ortolano, L. C. and Baaken, D., *Systematic Reviews*, Mar 12 2026, Vol. 15, no. 1.
BackgroundExposure to radiofrequency electromagnetic fields (RF-EMF; frequencies 100 kHz to 300 GHz) is ubiquitous. As the use of RF-EMF has grown steadily since the 1950s due to advances in telecommunications and other technologies, concerns about potential health effects have persisted. The World Health Organization (WHO) identified key areas of concern, with cancer being most frequently rated as critical. To synthesize evidence on the association between RF-EMF exposure and neoplastic diseases, we will carry out two separate umbrella reviews to account for different RF-EMF exposure conditions: one will focus on near-field exposure and the other on far-field exposure. Both umbrella reviews will include RF-EMF exposure in living and occupational settings. Methods Systematic reviews and meta-analyses of human observational studies on RF-EMF and cancer were searched in MEDLINE, Web of Science Core Collection, EMF-Portal, and Epistemonikos databases. Eligibility criteria will follow the PECOS (Population, Exposure, Comparator, Outcome, Study type) scheme. Eligibility and quality of the identified articles will be evaluated by two reviewers independently. The tools AMSTAR 2 (A MeaSurement Tool to Assess systematic Reviews) and ROBIS (Risk of Bias in Systematic Reviews) will be used to systematically assess methodological quality and risk of bias. Data will be extracted and summarized in a qualitative synthesis using standardized forms and presented in text and tables. Discussion These umbrella reviews aim to offer a comprehensive overview of the topic by including systematic reviews and meta-analyses that

studied cancer-related health effects of near-field and far-field RF-EMF exposure. In addition, a risk of bias rating will be performed to assess the quality of existing systematic reviews and meta-analyses in the field. https://doi.org/10.1186/s13643-026-03142-9

Etudes épidémiologiques

Determining the Impact of Nonionizing Electromagnetic Waves on Human Pregnancy and Teratogenicity: Protocol for Systematic Review and Meta-Analysis,
Armalina, D., Susilaningsih, N., Sutanto, H. and Sunarno, S., *Jmir Research Protocols*, 2026 2026, Vol. 15.
Background: The widespread use of mobile devices has markedly increased global exposure to nonionizing electromagnetic waves (EMWs). Emerging evidence indicates potential biological effects of EMW exposure in susceptible populations, particularly pregnant women; however, findings remain inconsistent. Objective: This protocol delineates a systematic review aimed at synthesizing and critically evaluating the teratogenic and pregnancy-related effects of nonionizing EMW exposure in pregnant women. Methods: This protocol adheres to the PRISMA-P (Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols) 2020 guidelines and has been registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023475665). A comprehensive literature search will be conducted in PubMed/MEDLINE, Scopus, Web of Science, Embase, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar, with supplementary searches of the World Health Organization International Clinical Trials Registry Platform and ClinicalTrials.gov. Eligible studies will include pregnant women exposed to nonionizing EMWs from mobile phones and related wireless devices. The primary outcomes will be pregnancy complications and fetal anomalies, with secondary outcomes assessed as previously reported. Study selection, data extraction, and risk of bias assessment will be performed independently by 2 reviewers. Where appropriate, a random-effects meta-analysis will be conducted. Results: Funding for this study was secured in March 2026. The literature search and study screening are planned for April to July 2026, with data extraction, risk of bias assessment, and synthesis expected to be completed by September 2026. The final results are anticipated to be submitted for publication in late 2026. Conclusions: This systematic review is expected to provide consolidated evidence on the potential teratogenic and pregnancy-related effects of nonionizing EMW exposure, thereby supporting future research and evidence-based recommendations for public health. https://doi.org/10.2196/86479

Analysis of the effect of high-frequency electromagnetic radiation on electroencephalography wave frequencies,
Bisevac, B., Lukic, S. and Stojkovic, M., *Vojnosanitetski Pregled*, 2026 2026, Vol. 83, no. 3, p. 181-186.
Background/Aim. Interest in the effects of electromagnetic fields on the human organism has grown significantly with the advent of digital mobile communication systems, which employ pulsed high-frequency electromagnetic fields. In standby mode, a mobile phone does not emit significant signal power, while during active communication, the intensity of the electromagnetic field may reach values of up to 250 mW. The aim of this study was to examine whether exposure to high-frequency electromagnetic fields affects the frequency of electroencephalography (EEG) waves. Methods. The study included 60 participants (30 males and 30 females). Each participant underwent two consecutive EEG recordings, each lasting approximately 20 min. The first EEG recording was performed at rest, without exposure to an electromagnetic field generator. This was followed by a second EEG recording while using a mobile phone for 10 minutes on one ear, then a break of about 2 minutes was made and the recording was repeated on the opposite ear, also for 10 minutes. A standard mobile phone was used as the source of the high-frequency electromagnetic field. Results.

The analysis of EEG wave frequencies revealed no statistically significant differences in either sex before and after mobile phone exposure in the alpha, beta, or delta frequency bands. A change in the theta frequency band in female participants following mobile phone exposure was localized to the right hemisphere. Conclusion. Methodological limitations are the most likely reason for the absence of recorded changes in the majority of participants. The observed effects may be sufficiently subtle or infrequent to evade detection by standard EEG recordings. Therefore, the lack of observed changes cannot be interpreted as evidence that high-frequency electromagnetic fields have no effect on EEG activity. https://doi.org/10.2298/vsp260117015b

Personal radio frequency electromagnetic field exposure among Swiss adolescents in the 5G era, Jalilian, H., Waibl, V. J., Wipf, I., Mootz, I., Abend, S., Diez, N. S., Veludo, A. F., Loizeau, N., Dongus, S., Guxens, M. and Röösli, M., no. 1096-0953 (Electronic).
INTRODUCTION: The rapid expansion of wireless technologies, including 5G, has introduced complex radiofrequency electromagnetic field (RF-EMF) exposure patterns, yet real-world data on personal exposure in adolescents remain limited. This study, conducted within the HERMES3 (Health Effects Related to Mobile Phone Use in Adolescents) cohort, aims to characterize personal RF-EMF exposure among Swiss adolescents. METHODS: A subsample of 143 adolescents participated in a personal measurement study between June 2023 and January 2025. Participants carried a personal exposimeter (ExpoM-RF4) for ca. 72-hours, to collect Geographic Positioning System coordinates and exposure data from 35 frequency bands. During this period, participants were asked to fill-out an electronic activity diary. Following data quality control, frequency bands were categorized by source and analyzed descriptively. RESULTS: Mean and median daily total RF-EMF levels of 0.09 mW/m(2) and 0.06 mW/m(2), respectively, were measured. WiFi/Bluetooth contributed most to total exposure (35 %), followed by broadcast (31 %), uplink (19 %), downlink (10 %), time division duplex (4 %), and Digital Enhanced Cordless Telecommunications (0.7 %). Across environments, average RF-EMF exposure was highest in transport systems (0.47 mW/m(2)) and lowest at school (0.08 mW/m(2)) and home (0.07 mW/m(2)). CONCLUSION: Despite widespread 5G deployment, overall personal exposure among adolescents remains similar to pre-5G levels, with variations mainly reflecting user behavior and network density. However, this should not be interpreted as a direct causal estimate of the independent effect of 5G deployment. Personal measurements underestimate exposure contributions from sources emitting close to body.
https://doi.org/10.1016/j.envres.2026.124775

Prospective cohort study on non-specific symptoms, cognitive, behavioral, sleep and mental health in relation to electronic media use and transportation noise among adolescents (HERMES): study protocol,
Jalilian, H. a.-O., Sandoval-Diez, N. a.-O., Waibl, V. J., Schmutz, M., Trefalt, S., Arslan, N., Fernandes Veludo, A. a.-O., Tincknell, L. a.-O., Wipf, I., Steck, L. a.-O., Dongus, S. a.-O., Jankowska, A., G, P. P., Polanska, K., Popovic, M. a.-O., Maule, M., De Llobet, P. a.-O., Guxens, M. a.-O. and Röösli, M. a.-O., no. 2732-5121 (Electronic).
Electronic media (eMedia) devices along with exposure to transportation noise are integral to the daily routines of adolescents. The concerns associated with excessive eMedia usage extend beyond sleep deprivation to include the heightened exposure to radiofrequency electromagnetic fields (RF-EMF) emitted by these wireless devices. The aim of HERMES (Health Effects Related to Mobile PhonE Use in AdolescentS) study is to better understand biophysical and psychological pathways in relation to eMedia use, RF-EMF exposure and transportation noise that may affect cognitive, behavioral, sleep and mental health, as well as non-specific symptoms. Following two previous HERMES cohorts conducted between 2012 and 2015 we have initiated the third wave of HERMES study as a prospective cohort with intermediate (every four months) and one year follows-up. Eligible participants are adolescents attending 7 (th) or 8 (th) school grades in Northwest and Central

Switzerland. Baseline examinations are a questionnaire on eMedia usage and selected health outcomes, as well as computerized cognitive tests. In addition, parents/guardians are asked to fill in a questionnaire about their child's health and potential eMedia use determinants. Far-field RF-EMF exposure and transportation noise at the place of residence and school are predicted based on a propagation model. Cumulative RF-EMF brain dose is calculated based on self-reported eMedia use, mobile phone operator data, and RF-EMF modelling. A follow-up visit is conducted one year later, and two interim questionnaires are sent to adolescents to be completed at home. Between baseline and 1-year follow-up, a subsample of 150 study participants is invited to collect personal RF-EMF measurements as well as sleep and physical activity data using accelerometers. This new recruitment wave of HERMES study provides a greater understanding of causal pathways between eMedia, RF-EMF, and transportation noise exposure and their effects on health outcomes, with relevant implications for both governmental health policy and lay people alike. https://open-research-europe.ec.europa.eu/articles/4-120

Is occupational exposure to radiofrequency electromagnetic fields associated with glioma risk? An Australian population-based family case-control study,
Mate, R., Benke, G., Loughran, S. P., Abramson, M. J., Vjadic, C., Turner, M., Turuban, M., Cardis, E. and Karipidis, K., *Bmj Open*, Mar 12 2026, Vol. 16, no. 3.
Objectives This study investigated occupational exposure to radiofrequency electromagnetic fields (RF EMF) using two job-exposure matrices (JEMs) and risk of glioma. Design Population-based family case-control study. Setting Cases were recruited from participating hospitals in the Australian states of New South Wales, Queensland, Tasmania, Western Australia and Victoria between January 2013 and November 2017.Participants The study population consisted of 467 cases of glioma and 367 family controls recruited for the Australian Genomics and Clinical Outcomes of Glioma case-control study between 2013 and 2017. Participants completed questionnaires on demographic and other information, including a detailed occupational history. Exposures Exposure to RF EMF was estimated using both the multicountry case-control study INTEROCC JEM and the Canadian JEM (CANJEM). Primary outcome measures ORs and 95% CIs were calculated from logistic regression models adjusted for relatedness between cases and controls, sex, age, ethnicity, education level, smoking status and alcohol consumption. Results There was no statistically significant positive association overall for risk of glioma when applying either JEM. For the highest compared with the lowest quartile of lifetime exposure, results using the INTEROCC JEM showed an OR of 0.74 (95% CI 0.47 to 1.15) for electric fields and 0.92 (95% CI 0.58 to 1.45) for magnetic fields, while the CANJEM showed an OR of 0.85 (95% CI 0.54 to 1.32). We also did not observe associations when applying different assumptions regarding latency or time windows or with glioma grade. Conclusion Overall, this study found no evidence of an association between occupational RF EMF exposure and glioma. Future research should focus on refining occupational RF EMF exposure assessment.
https://doi.org/10.1136/bmjopen-2025-107281

Health Effects of Extremely Low-Frequency Electromagnetic Field Exposure From High-Voltage Power Lines and Substations: A Scoping Review of Primary Empirical Research,
Todorovic, P., Vukojevic, K., Matijaca, D., Poljak, D., Cvetkovic, M., Doric, V., Garma, T., Soldo, A., Sesnic, Z. N. and Caric, A., *Ieee Access*, 2026 2026, Vol. 14, p. 38447-38459.
This scoping review descriptively maps primary empirical research on associations between extremely low frequency electromagnetic field (ELF-EMF) exposure from high-voltage transmission lines (>= 110 kV) and substations and health outcomes, without establishing causality. We searched Web of Science, Scopus, and EMF Portal for epidemiological and experimental studies. Studies with mixed EMF sources or aggregated Job Exposure Matrix approaches were excluded. A total of 51 primary studies from 1979-2025 were included, spanning 46 years across >20 countries on five

continents. Study designs included case-control (n= 28, 55%), cohort (n= 10, 20%), cross-sectional (n= 10, 20%), experimental (n= 1, 2%), case report (n= 1, 2%), and pooled analysis (n= 1, 2%). The most frequently investigated outcomes were childhood leukemia (41%), neuropsychological symptoms (18%), adult cancers (16%), reproductive outcomes (8%), and neurodegenerative diseases (6%). Regarding association direction, 24 studies (47%) reported positive associations, 18 studies (35%) reported null findings, and 9 studies (18%) reported weak or mixed results. The most consistently reported positive associations emerged for childhood leukemia, with relative risks of 3.8-5.1 at magnetic field exposures >= 0.3 - 0.5 mu T, consistent with the IARC classification of ELF magnetic fields as "possibly carcinogenic to humans" (Group 2B). Suggestive associations have been reported for neuropsychological outcomes. Associations for adult cancers and reproductive outcomes remain limited or inconsistent. Associations for neurodegenerative diseases are limited, with suggestive findings for Alzheimer's disease but insufficient data for other conditions. Critical research gaps include absence of studies from southeastern Europe, Eastern Europe, Africa, South Asia, and China, highlighting a foundation for prioritizing future research and informing public health policy. https://doi.org/10.1109/access.2026.3671962

Evaluation de l'exposition

Assessment of electromagnetic radiation in the urban environment
Bouzekova-Penkova, A. D., Teodosiev, D. K. and Spasova, T. G. (2025). 11th International Conference on Remote Sensing and Geoinformation of the Environment-RSCy, Paphos, CYPRUS.
With the development and improvement of mobile communications, a very topical issue in urban areas is electromagnetic pollution (EMP) from telecommunication technologies. These are the so-called artificial sources of electromagnetic fields that affect the environment and living organisms. The paper presents an analysis and evaluation of results from measurements of electromagnetic radiation from base stations of mobile operators in a sparsely urbanized environment. The presented results were obtained using mobile measurement equipment Narda AMB-8057-03 in the frequency range 100 kHz to 7 GHz. This frequency range covers the frequencies of all mobile operators operating on the territory of Bulgaria and allows tracking the dynamics of electromagnetic emissions from the antennas, on weekdays and weekends. The observed dynamic changes were analyzed as a function of local time, distance from base stations, data traffic load, and the characteristics of the surrounding environment. The data obtained prove that the measured levels of electromagnetic fields are safe, according to current national legislation and European standards. The development of mobile communications requires continuous monitoring and control of electromagnetic pollution, through the construction of systems for monitoring electromagnetic emission. https://doi.org/10.1117/12.3069141

Electromagnetic radiation in urban environments, heat islands in the center of Sofia
Bouzekova-Penkova, A. D., Teodosiev, D. K. and Spasova, T. G. (2025). 11th International Conference on Remote Sensing and Geoinformation of the Environment-RSCy, Paphos, CYPRUS.
The problem of electromagnetic fields of artificial origin in populated areas, characterized by a high concentration of various terrestrial sources (television, radio transmitters, mobile operator base stations, etc.), is becoming increasingly relevant. The level of electromagnetic fields of artificial origin in a number of cases significantly exceeds the level of electromagnetic fields from natural sources. Therefore, it is necessary to monitor and assess the parameters of electromagnetic fields in urban environments, as these territories also fall into the so-called urban heat islands. The work presents results of measurements of electromagnetic radiation from base stations of mobile operators, at a site in a highly urbanized environment, the center of Sofia, Bulgaria. An analysis and evaluation of the results obtained was carried out and it was established that the reported values of

radiated electromagnetic energy in the range 100 kHz - 7 GHz are below the permissible levels, according to current national legislation and European standards.
https://doi.org/10.1117/12.3071084

Study of RF Electromagnetic Exposure in the subway trains
Hong, S. E., Moon, J. I. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
Exposure to radiofrequency (RF) electromagnetic fields (EMFs) in public environments is continuously evolving due to advancements in various communication systems. In 2025, we measured RF-EMF exposure in the subway environment using a personal measurement device, following the same methodology as in 2023. A comparative analysis revealed that total exposure levels in 2025 were generally higher than in 2023. https://ieeexplore.ieee.org/document/11185479

Absorbed Power in Human Head Skin Due to Near-Field Exposure up to 100 GHz,
Kaburcuk, F. and Elsherbeni, A. Z., *Applied Computational Electromagnetics Society Journal*, Jan 2026, Vol. 41, no. 1, p. 64-73.
prevent excessive skin temperature rise from overexposure due to near-field sources for frequencies from 6 to 300 GHz, international safety guidelines and standards for limiting exposure to electromagnetic (EM) waves introduce an incident power density (IPD) as an exposure reference limit and an absorbed power density (APD) as a basic restriction. At frequencies above 6 GHz, the penetration depth of EM waves in the human body model is particularly less, since EM wave penetration is more superficial in tissues. Therefore, the thickness of outermost tissues such as skin, which has different thicknesses in different realistic regions of a three-dimensional (3D) realistic human body, is a critical factor for the accuracy of EM dosimetry analysis. In this paper, the effect of skin thickness in a 3D planar head model on the spatially averaged APD over 1 cm2 and 4 cm2 areas due to near-field sources are investigated for the frequency range from 10 to 100 GHz. These investigations are performed using the finite-difference time-domain (FDTD) method considering different separation distances from the near-field source to the model of the skin surface. Numerical results show that skin thickness is the primary parameter in evaluating EM field exposure and the accuracy of EM dosimetry analysis. https://doi.org/10.13052/2026.Aces.J.410107

Geospatial mapping and 7-year temporal trends of electromagnetic field bands in Cyprus,
Kiouvrekis, Y., Psomadakis, I., Christakis, C. and Kalatzis, D., *Environmental Monitoring and Assessment*, May 7 2026, Vol. 198, no. 5.
This study presents the first integrated geospatial and temporal assessment of radiofrequency electromagnetic field (RF-EMF) exposure in Cyprus, using 7 years (2017-2023) of periodic in-situ measurements conducted at fixed locations around all operational mobile telephony base stations as part of the national RF-EMF monitoring program. Electric field strengths were evaluated across eleven frequency bands spanning 30 MHz-3.6 GHz, including broadcast services and cellular communication bands relevant to 4 G and 5 G networks. Spatial exposure distributions were characterized through geostatistical interpolation, while long-term variability was quantified using non-parametric Kruskal-Wallis and Mann-Kendall tests. Results show that exposure levels in all bands remain well below international reference limits. Broadcast bands exhibit consistently low and stable values (< 1 in & micro;V/m), whereas significant increasing monotonic trends were detected in several mobile communication bands, particularly 800 MHz, 1800 MHz, 2100 MHz, and 2600 MHz, reflecting network densification and growing data demand. The newly introduced 700 MHz and 3600 MHz 5 G bands did not yet display statistically significant trends due to the shorter observation period. The combined spatiotemporal evidence highlights localized hotspots in high-traffic areas and underscores the need for sustained, transparent monitoring to ensure safe and

adaptive EMF exposure governance in the evolving wireless landscape.
https://doi.org/10.1007/s10661-026-15361-7

Recording the extremely low frequency pulsations of wireless communication electromagnetic fields,
Panagopoulos, D. J., Litovsky, R. and Chamberlin, K., *Electromagnetic Biology and Medicine*, 2026.
All digital Wireless Communication (WC) electromagnetic field (EMF)/radiation (EMR) signals (from mobile/"smart" phones and corresponding base antennas, cordless domestic phones, Wireless Fidelity (Wi-Fi) routers, "Bluetooth" wireless connection among electronic devices, etc.) are emitted discontinuously, in the form of on/off pulses repeated at various Extremely Low Frequency (ELF) rates. Yet, many scientists ignore/underestimate these ELF pulsations, and characterize all WC emissions simply as Radio Frequency (RF)/Microwave (MW) signals. Here, we provide recordings of ELF pulsations with respect to time, emitted by the most common WC devices, specifically Wi-Fi router, 4th and 5th Generation (4G, 5G) mobile phones. We used a broadband antenna, connected to an RF spectrum analyzer (SA), calibrated the SA at the signal's carrier MW frequency and recorded the power of the final emitted RF/MW signal with respect to time. We recorded emissions at 10 ms, 100 ms, 1 s, and 2 s sweep times, capturing the pulses repeated at various ELF rates, clearly showing the ELF pulsing emissions from the WC devices. As in all real WC EMF signals emitted by commercially available devices and corresponding antennas, there is intense variability in the amplitude, shape, duration, and repetition frequency of the pulses. The present study, in combination with the Ion Forced Oscillation and Voltage-Gated Ion Channel (IFO-VGIC) mechanism of non-thermal EMF-bioeffects, imply that the non-thermal biological and health effects of WC EMFs are induced by the ELF pulsation, modulation and variability, and not by the standalone (non-modulated) RF carrier wave EMFs which can produce only heating.
https://doi.org/10.1080/15368378.2026.2654072

Electric field strengths and current densities induced inside the body due to exposure to electronic article surveillance (EAS) system antennas compared to ICNIRP's exposure limits,
Schneeweiss, P., Hirtl, R., Jhala, T., Ueberbacher, R., Cecil, S., Becker, C., Boemmels, I., Altekoester, C. and Schmid, G., *Journal of Radiological Protection*, Jun 1 2026, Vol. 46, no. 2.
Personal exposure to magnetic fields emitted by electronic article surveillance (EAS) systems was systematically assessed based on measurements of a representative sample of 21 different EAS devices. This sample included the two major EAS technologies currently on the market: acoustomagnetic (AM) and radio frequency (RF) systems. In addition to these measurements, numerical computations of the current densities and electric field strengths induced in body tissues were carried out for one representative AM-EAS device and several body models (adult male, adult female, child female, and a hand model) and reasonably foreseeable worst-case exposure scenarios using a real-valued magneto quasi-static solver, based on the scalar potential finite element method. The obtained measurement and computational results were compared to the different sets of exposure limits defined by the International Commission for Non-Ionizing Radiation Protection (ICNIRP) in 1998 and 2010. Our results demonstrated that current RF-EAS technology, which typically operates in the 8.2 MHz frequency range, does not conflict with the exposure limits, even under adverse exposure conditions. However, AM-EAS systems, which typically operate at 58 kHz, may lead to induced current densities in the central nervous system and induced electric field strengths in the peripheral nervous systems of adults and children that exceed the basic restrictions for the general public (up to a factor of 22.5 for the adult female bending in front of the antenna) and even for occupational exposure (up to a factor of 4.5 for the same scenario) according to the ICNIRP 1998 and 2010 guidelines under reasonably foreseeable exposure conditions, which are not covered by the assessment procedures defined in the present version of the applicable standard IEC EN 62369-1. Therefore, radiation protection and market regulatory authorities should have a close

look and check presently installed and future AM-EAS technology with respect to their compliance to exposure limits. https://doi.org/10.1088/1361-6498/ae553b

Characterization of Static Magnetic Fields Produced by Smartphones,
Zastko, L., Kubicková, L., Mísek, J., Kuchta, I., Makinistian, L. and Belyaev, I., *Ieee Journal of Electromagnetics Rf and Microwaves in Medicine and Biology*, Jun 2026, Vol. 10, no. 2, p. 316-323.
Smartphones integrate permanent magnets for speakers, cameras, vibration motors, or accessory magnetic snap systems, which generate static magnetic fields (SMF). While time-varying electromagnetic fields have been extensively studied, quantitative characterization of SMF remains limited. Modern smartphones generate measurable localized SMF hotspots that contribute to background electromagnetic exposure. In this study, we mapped the spatial distributions of SMF near smartphone surfaces and evaluated their potential biomedical relevance using computational exposure models. Three smartphone models released between 2021 - 2022 were measured with a triaxial magnetometer at multiple distances (5 - 50 mm) in triplicate, background-corrected, and analyzed for field intensity. Anatomical voxel models were used to simulate exposure conditions and field penetration into tissues. All smartphones exhibited heterogeneous SMF distributions with local hotspots, often exceeding 800 mu T at close distances (<15 mm), associated mostly with speakers, microphones, magnetic rings, and camera modules. Although overall SMF levels were below the ICNIRP public whole-body exposure limit (400 mT), localized peaks approached thresholds relevant to interference with implantable cardiac devices (0.5 - 1 mT). Simulations confirmed localized field penetration into adjacent tissues under realistic smartphone use conditions. Modern smartphones generate spatially complex SMF exposures that, although compliant with public exposure limits, may approach levels reported to activate magnet mode in implantable cardiac devices and represent a minor yet pervasive component of electromagnetic exposure. These findings provide quantitative data for exposure characterization and electromagnetic compatibility assessment.
https://doi.org/10.1109/jerm.2026.3683318

Toxicité

Radiofrequency exposure to LTE signal does not alter cancer-related endpoints in human neuroblastoma cell model either alone, or co-exposed to menadione or Wi-Fi signal,
Allocca, M., Scarfì, M. R., Romeo, S., Sannino, A., Peluso, V. and Zeni, O., *Environmental Research*, Jun 1 2026, Vol. 298.
Despite the long-term evolution (LTE) signal, also known as fourth generation (4G) technology, is the most employed and widely deployed system for telecommunications, only a few in vitro studies are devoted to assessing the biological effects related to exposure to LTE alone and in combination with other agents. To the best of our knowledge, the effect of simultaneous exposure to 4G LTE with other frequencies/signals has not been evaluated in any of these studies. In the present study we investigated the non-thermal carcinogenic effect of LTE signal under a co-exposure realistic scenario. Human neuroblastoma cells (SH-SY5Y) were exposed for 3 h to 1950 MHz LTE signal, either alone or in combination with the chemical agent menadione. Moreover, the effect of simultaneous exposure to 1950 MHz, 4G LTE signal and 2450 MHz Wireless-Fidelity (Wi-Fi) signal was also evaluated to account for possible effects due to the co-existence of these frequencies/signals. A waveguide-based exposure system, well characterized from dosimetric and experimental point of view, was used, and two specific absorption rate values, 0.3 and 1.25 W/kg, were tested in all cases. Cancer-related endpoints such as reactive oxygen species formation, apoptosis, and cell cycle progression were assessed in flow cytometry assays. In our experimental conditions, neither LTE exposure alone nor LTE and menadione co-exposure or multiple LTE and Wi-Fi exposure influenced the investigated cellular parameters in SH-SY5Y cells. https://doi.org/10.1016/j.envres.2026.124292

Impact of mobile phone use during pregnancy on fetal development and birth defects: a review, Chatha, W. A., Hegazy, A. M. S., Bayomy, N., Khan, D. S., El Shafey, S., Badawy, M., Niazi, A., Mosaed, M. M., Mohamed, H., Mustafa, M., Elgendy, H. and Alyan, A. R., *Annals of Clinical and Analytical Medicine*, Mar 2026, Vol. 17, p. 206-210.
Mobile phones are integral to modern life, but their potential health impacts, particularly on vulnerable groups such as pregnant women, have raised scientific concerns. The electromagnetic radiation (EMR) emitted by mobile phones is linked to biological effects, including oxidative stress, DNA damage, and cellular disruption, prompting intriguing questions about its influence on fetal development. Research highlights both direct and indirect effects of mobile phone use during pregnancy. Direct effects involve EMR's potential to interfere with cellular processes that may impact fetal growth. Indirect effects, meanwhile, stem from behavioral changes associated with phone usage, such as increased sedentary habits and disrupted sleep patterns, which can also affect maternal and fetal health. The advent of advanced technologies like 5G adds complexity to these concerns. While 5G networks provide faster connectivity, they operate at higher frequencies, raising new questions about potential health risks. However, disentangling direct effects of EMR from confounding factors like lifestyle and environmental variables remains challenging, requiring further investigation. This review consolidates current evidence on mobile phone usage during pregnancy, focusing on its direct biological effects, behavioral consequences, and emerging risks linked to new technologies. Although conclusive findings are still limited, existing research emphasizes the need for caution. Pregnant women and healthcare providers should stay informed about ongoing studies to make prudent decisions about mobile phone use. Continued long-term research is essential to clarify the interaction between EMR exposure and maternal-fetal health, ensuring a better understanding of its potential risks. https://doi.org/10.4328/acam.22598

Context-dependent effects of high-frequency pulsed electromagnetic fields on cytokine responses in human THP-1 monocytes in vitro,
Dekali, S., Jolly, N., De Araujo, S., Ballestra, F., Jaoui, R., Hermann, E. H., Valente, M. and Del Vecchio, F., *Toxicology in Vitro*, Aug 2026, Vol. 115.
High-frequency pulsed electromagnetic fields (HF-EMF) are increasingly encountered in modern environments, yet their potential immunomodulatory effects remain unclear. Here, we investigated whether L-band pulsed HF-EMF modulate cytokine responses in human THP-1 monocytes under basal conditions or during lipopolysaccharide (LPS)-induced inflammation. Cells were exposed to pulsed electric fields at 4.6 or 7.3 kV/m, with two exposure regimens applied at each intensity (intermittent 30 s bursts or continuous 1 h exposure). Cell viability, morphology and lipid peroxidation (MDA) were assessed, and cytokine secretion was profiled by cytokine array and multiplex immunoassay, complemented by PCA and correlation network analyses. HF-EMF exposure did not induce cytotoxicity or marked oxidative damage. Under LPS stimulation, HF-EMF produced subtle yet consistent shifts in cytokine patterns, with trends toward attenuation of LPS-elevated mediators including VEGF, IL-6 and CCL17/TARC at higher field intensity. In unstimulated cells, cytokine levels remained largely unchanged, except for a reproducible decrease in basal VEGF under the highest exposure condition. Overall, these data support a context-dependent immunomodulatory effect of pulsed HF-EMF in human monocytes, warranting follow-up studies in more physiological models and with refined exposure characterization.
https://doi.org/10.1016/j.tiv.2026.106246

Radiofrequency radiation-induced changes in Leydig cell function,
Jangid, P., Rai, U., Sevak, J. K., Ranjan, R., Singh, S. and Singh, R., *Scientific Reports*, Mar 25 2026, Vol. 16, no. 1.
Radiofrequency radiation, emitted from commonly used wireless communication devices, has been implicated in disrupting cellular homeostasis; however, its effects on testicular somatic cells such as

Leydig cells remain poorly understood. To address this, the present study investigated the frequency- and time-specific effects of RFR on cellular morphology, proliferation, and cell cycle dynamics in TM3 Leydig cells. Cells were exposed to mobile phone radiation and radiofrequency signals at 1800 MHz and 2450 MHz for 15-120 min under non-thermal conditions. Following exposure, morphological alterations were examined using Giemsa staining, while proliferation and cell cycle progression were evaluated by BrdU-ELISA and PI-based flow cytometry. BrdU assays showed a progressive reduction in DNA synthesis across conditions, indicating suppressed proliferative activity. Consistently, cell cycle analysis revealed accumulation of cells in G1 phase with a corresponding decline in S-phase population at longer durations, suggesting checkpoint activation. These changes were supported by morphological alterations such as cell rounding, loss of adherence, and membrane blebbing, features associated with stress-induced antiproliferative responses. Overall, these findings indicate that RFR disrupts cellular morphology, DNA synthesis, and cell cycle progression in a frequency- and time-dependent manner, highlighting Leydig cell vulnerability to prolonged exposure and potential implications for male reproductive health.
https://doi.org/10.1038/s41598-026-39244-6

Cellular redox disruption and apoptosis: Differential effects of RFR frequencies on Leydig cells, Jangid, P., Rai, U., Sevak, J. K., Singh, S. and Singh, R., *Toxicology and Applied Pharmacology*, Jun 2026, Vol. 511.
Radiofrequency radiation (RFR), widely emitted from modern wireless devices, has raised questions regarding its possible impact on male reproductive health. In this comparative study, we examined the redox and apoptotic responses of TM3 Leydig cells following exposure to mobile phone radiation, as well as 2450 MHz, and 1800 MHz frequencies for 15, 30, 45, 60, 90 & 120 min, and redox imbalance was assessed by quantifying nitric oxide (NO) and intracellular superoxide (SO) levels. Apoptotic cell percentages were evaluated by dual labeling with Annexin V-FITC/PI using flow cytometry. Mobile phone and 2450 MHz exposures induced biphasic alterations in NO levels, while 1800 MHz exposure resulted in a sustained reduction in NO. SO levels increased progressively in a time-and frequency-specific manner. Apoptotic analysis revealed early apoptotic activation in mobile and 2450 MHz groups, whereas 1800 MHz exposure led to delayed but sustained late-stage apoptosis. These findings demonstrate that RFR triggers redox imbalance and apoptosis in TM3 cells, with effects varying by frequency and exposure duration. This comparative analysis underscores the biological risks of chronic low intensity RFR exposure and highlights the growing concerns about RFR-associated testicular stress and its implications for male reproductive toxicity.
https://doi.org/10.1016/j.taap.2026.117807

The consequences of the extremely low frequency electromagnetic field (ELF-EMF) exposure on physiological processes in the uterus: novel insights and implications,
Khodadadi, M., Zmijewska, A. and Franczak, A., *Frontiers in Physiology*, Mar 11 2026, Vol. 17.
Extremely low frequency electromagnetic field (ELF-EMF), ranging from 1 Hz to 300 Hz, is prevalent in modern environments, yet its biological effects on the production remain insufficiently explored. This mini-review summarizes recent findings on ELF-EMF-induced alterations in the biological processes involved the uterus. It has been documented that the exposure to the ELF-EMF has been linked to significant changes in alterations of transcriptomic profile, histone modifications, DNA methylation, and microRNA pathways in the uterus, which may disrupt uterine contractility, secretory activity and hormonal signalling. Furthermore, the ELF-EMF influences myometrial and endometrial steroidogenesis, interferes with calcium ion channel regulation, elevates oxidative stress, apoptosis and cell proliferation, raising concerns about uterine tissues integrity. While direct evidence of ELF-EMF-induced tumorigenesis in the myometrium and the endometrium is lacking, its potential role in disrupting the mRNA transcript abundance involved in oxidative stress, apoptosis and cell proliferation underscores the need for further investigation. This review highlights the

potential reproductive risks associated with the ELF-EMF exposure and calls for additional in vivo studies to elucidate its long-term effects on female fertility and reproductive health.
https://doi.org/10.3389/fphys.2026.1753084

Correction: Loughran et al. Radiofrequency Electromagnetic Field Exposure and the Resting EEG: Exploring the Thermal Mechanism Hypothesis. Int. J. Environ. Res. Public Health 2026, 23(2), 157.
https://doi.org/10.3390/ijerph23020157
The authors have requested that the following changes be made to the original publication.
Radiofrequency Electromagnetic Field Exposure and the Resting EEG: Exploring the Thermal Mechanism Hypothesis. Int. J. Environ. Res. Public Health 2019, 16, 1505
Loughran, S. P., Verrender, A., Dalecki, A., Burdon, C. A., Tagami, K., Park, J., Taylor, N. a. S. and Croft, R. J.
There is now strong evidence that radiofrequency electromagnetic field (RF-EMF) exposure influences the human electroencephalogram (EEG). While effects on the alpha band of the resting EEG have been repeatedly shown, the mechanisms underlying that effect have not been established. The current study used well-controlled methods to assess the RF-EMF exposure effect on the EEG and determine whether that effect might be thermally mediated. Thirty-six healthy adults participated in a randomized, double-blind, counterbalanced provocation study. A water-perfusion suit (34 C) was worn throughout the study to negate environmental influences and stabilize skin temperature. Participants attended the laboratory on four occasions, the first being a calibration session and the three subsequent ones being exposure sessions. During each exposure session, EEG and skin temperature (8 sites) were recorded continuously during a baseline phase, and then during a 30 min exposure to a 920 MHz GSM-like signal (Sham, Low RF-EMF (1 W/kg) and High RF-EMF (2 W/kg)). Alpha EEG activity did not change during either of the exposure conditions compared to the Sham condition. As a measure of thermoregulatory activation, finger temperature was found to be higher during both exposure conditions compared to the Sham condition, indicating for the first time that RF-EMF exposure studies cause thermoregulatory changes. This supports the feasibility of the hypothesis that RF-EMF effects on alpha EEG activity are mediated via a thermal mechanism.
https://doi.org/*10.3390/ijerph16091505*

Nonthermal radiofrequency radiation promotes hematopoietic stem and progenitor cells function by regulating Ca2+ efflux,
Lv, Z. C., Zhao, K., Li, J. J., Li, S. Y., Zhao, X. W., Xu, A. Y., Wu, Y. Q., Gao, H. Y., Li, J. F., Sun, H. Y., Xue, Y., Li, S. L., Xiang, S. S., Yang, X. M. and Li, C. Y., *Stem Cell Research & Therapy*, Feb 14 2026, Vol. 17, no. 1.
BackgroundHematopoietic stem and progenitor cells (HSPCs) are crucial for blood production and regeneration. While their function is known to be regulated by diverse physical cues, the impact of pervasive radiofrequency electromagnetic fields (RF-EMF), particularly through non-thermal radiofrequency radiation (RFR) mechanisms, remains poorly understood.MethodsWe conducted colony-forming unit (CFU) assay in vitro and competitive transplantation assay in vivo to evaluate whether RFR influences hematopoiesis reconstitution capacity. Subsequently, the effects of RFR preconditioning on hematopoietic injury induced by ionizing radiation in mice were assessed by continuously monitoring the peripheral blood, HSPCs number, and colony-forming units. The influence of RFR on radioprotection unit frequency was evaluated using multiple gradients, non-competitive mouse transplantation models. Seahorse XF assays were employed to characterize cellular energy metabolic status, while specific fluorescent probes were utilized to detect calcium ion (Ca2+) levels in distinct cellular compartments using flow cytometry. Transcriptomic profiling was used to uncover the underlying mechanisms. HSPCs were pretreated with plasma membrane Ca2+-ATPase (PMCA) inhibitor prior to RFR exposure, and Seahorse assays along with CFU assay and competitive transplantation assay were performed to compare whether PMCA inhibition could

abrogate RFR-induced HSPCs function change. To investigate the mechanism by which RFR enhanced PMCA activity inducing Ca2+ efflux, we performed fluorescence recovery after photobleaching (FRAP) assays to detect membrane fluidity.ResultsNon-thermal 2856 MHz RFR enhanced HSPCs colony formation activity and reconstitution capacity, without compromising the multilineage differentiation homeostasis. RFR preconditioning accelerated hematopoietic recovery following ionizing radiation and increased radioprotection unit frequency. Mechanistically, RFR increased plasma membrane fluidity which potentiates PMCA activity, resulting in elevated Ca2+ efflux and reduced intracellular Ca2+ levels. These cellular alterations ultimately contributed to maintaining HSPCs in a low metabolic state, and consequently improving their functional capacity. Pharmacological inhibition of PMCA abolished both the functional enhancement and metabolic suppression.ConclusionOur results provided the first evidence that non-thermal RFR can improve HSPCs function. The central mechanism involved RFR-induced plasma membrane fluidity, activation of PMCA, thus accelerating Ca2+ efflux and maintaining HSPCs in a metabolically quiescent state. This work provided transformative insights into electromagnetic field biology and potential transplantation strategies for radiation-induced hematopoietic injury.
https://doi.org/10.1186/s13287-026-04937-2

RF Electromagnetic Fields on TRPM8 Receptors: A Molecular Dynamics Approach
Pisanoo, C., Caramazza, L., Ferri, L., Alvieri, N., Marracino, P., Del Signore, F., Liberti, M., Apollonio, F. and Ieee (2025). 2025 URSI Asia-Pacific Radio Science Meeting-AP-RASC, Sydney, AUSTRALIA.
In recent years, increasing attention has been given to the potential biological effects of radiofrequency electromagnetic fields (RF-EMF), particularly regarding their interaction with molecular and cellular components. Previous studies using RF-EMF signals suggest a possible modulation of thermo-sensitive receptors, highlighting TRPM8 as a key candidate for assessing RF-EMF-related effects; among transient receptor potential (TRP) ion channels, TRPM8 plays a key role in thermosensation and cellular signaling. However, direct structural observations require sophisticated and costly methodologies. Molecular dynamics (MD) simulations represent a cutting-edge computational approach, providing deep insights into molecular conformational changes under external stimuli, thus complementing experimental studies and reducing the need for costly laboratory techniques.This study employs MD simulations to investigate the interaction of a 26 GHz RF-EMF with the TRPM8 ion channel in a lipid bilayer. A rigorous multi-step approach ensured accurate molecular modeling and simulation. Comparative analyses under RF exposure and control conditions revealed that while TRPM8 remains structurally stable, RF-EMF induces specific modifications in the selectivity filter region, suggesting a potential modulatory effect on ion channel function. Although evidencing subtle effects, these preliminary results open the door for further investigation to understand the biological implications of RF exposure, especially in the context of 5G technology. https://ieeexplore.ieee.org/document/11185475

Biological effects of 5G-modulated 700 MHz RF-EMF exposure on neuronal and glial cell models under isothermal conditions,
Puginier, E., Leclercq, L., De Gannes, F. P., Hurtier, A., Orlacchio, R., Nabos, P., Tijou, H., Lévêque, P., Arnaud-Cormos, D., Percherancier, Y. and Lagroye, I., *Scientific Reports*, Mar 28 2026, Vol. 16, no. 1.
Whether radiofrequency electromagnetic fields (RF-EMF) at wireless telecommunication frequencies can alter brain physiology remains a matter of debate. The 700 MHz band, recently allocated for 4G and early 5G deployment, is increasingly prevalent in the environment, yet its biological effects are poorly documented. Here, we investigated the impact of 700 MHz 5G-modulated RF-EMF exposure on two complementary central nervous system cell models: primary rat cortical astrocytes and human SH-SY5Y neuroblastoma cells. Cells were exposed in transverse electromagnetic (TEM) cells at specific absorption rates (SAR) of 0.08 W/kg and 4 W/kg, for 1 h or 24 h, and analyzed immediately or after a 24 h recovery period. Multiparametric flow cytometry quantified

mitochondrial reactive oxygen species (ROS), cell viability, and apoptosis stratified as early and late, together with astrocytes' proliferation. Across all exposure conditions, no statistically significant differences were detected compared to sham controls, while positive controls with hydrogen peroxide elicited significant increases in ROS and apoptosis, validating assay sensitivity. These results demonstrate that, under strictly controlled iso-thermal conditions, 5G-modulated 700 MHz RF-EMF exposure does not induce measurable oxidative stress, apoptosis, or proliferative alterations in astrocytic and neuronal models. Our findings provide evidence supporting the absence of acute or subacute biological effects in vitro at isothermal exposure levels up to 4 W/kg, thereby reinforcing the scientific basis for current exposure guidelines. https://doi.org/10.1038/s41598-026-43960-4

Safety assessment of electromagnetic exposure to road users by Vehicle-to-Vehicle communication considering thermal characteristics,
Song, Y. X. and Lu, M., *Journal of the Chinese Institute of Engineers*, 2026.
The rapid development of Vehicle-to-Vehicle (V2V) communication raises concerns about potential health risks regarding radiofrequency electromagnetic fields (RF-EMF). This study evaluates thermal effects in a 5.9 GHz V2V exposure scenario using COMSOL Multiphysics (R) to construct a novel numerical model that encompasses a vehicle with a V2V antenna and road users at different positions. Through quantitative analysis of the specific absorption rate averaged over 10 g tissue (SAR10 g), under worst-case exposure scenarios for road users in closest proximity to the antenna, we observed temperature increases in both superficial sensitive organs and deep tissues. The results reveal that when the antenna operates at 1 W input power for 30 minutes, superficial tissues exhibit the highest thermal sensitivity, with skin tissue showing a maximum temperature rise of 0.047 degrees C, followed by ocular tissues (0.025 degrees C). Deeper tissues display progressively reduced thermal effects, including the central nervous system (gray matter: 0.02 degrees C, white matter: 0.018 degrees C) and visceral organs (gastrointestinal: 0.013 degrees C). All computed temperature rises are significantly below the safety limits set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), confirming no thermal health risk in this V2V scenario. This work also provides a methodological foundation for electromagnetic safety assessments in connected transportation environments. https://doi.org/10.1080/02533839.2026.2659726

A study on the health effects of pantograph-catenary arc from high-speed emus on cardiac pacemaker wearers,
Tian, R., Wang, S. J., Lu, M. and Li, J., *Journal of Radiological Protection*, Jun 1 2026, Vol. 46, no. 2.
Due to the characteristics of high-speed rail, such as speed, safety, intelligence, and economy, choosing to travel at high speed has become the norm. However, for passengers' with cardiac pacemakers, the electromagnetic radiation from the pantograph-catenary arc has emerged as a significant public concern. In this work, the Schwarz arc model was adopted for the modelling of the pantograph-catenary arc, and the frequency domain analysis of the arc pulse was conducted. Based on the frequency domain characteristics of the arc, the electromagnetic exposure of the pantograph-catenary arc to the wearer of the dual-chamber pacemaker was evaluated. This assessment included the distribution of induced electromagnetic fields within the passengers' pacemakers and cardiac tissue, and calculating of the induced voltage on the electrodes to determine potential health risks. In the simulation, two passengers were modelled, including one standing passenger and one seated passenger, and they were placed at two different positions within the train carriage for comparative analysis. The results indicated that the maximum induced electric field strength (Ein Max) within the passenger's cardiac tissue was 1.297 mV m-1, and a maximum specific absorption rate (SAR Max) of 0.7065 nW kg-1. These values were within the basic restrictions for public electromagnetic exposure established by the International Commission on Non-Ionising Radiation Protection (ICNIRP). For the two passengers', electromagnetic interference on the pacemakers was primarily concentrated on the metallic components, where the maximum

magnetic field intensity (Hin Max) reached 3.235 & times; 10-4 A m-1. The induced voltages (Uin) on the electrodes for the passengers' monopolar and bipolar sensing configurations were 0.068 mV and 0.00147 mV, respectively, both well below the sensitivity thresholds specified in ISO 14117:2019, which were 2 mV for monopolar and 0.3 mV for bipolar configurations. These findings suggested that the electromagnetic fields generated by the pantograph-catenary arc were well within the recognised acceptable limits for passengers with pacemakers. https://doi.org/10.1088/1361-6498/ae5665

SAR and Temperature Rise in Human Tissues Under 5G Electromagnetic Wave Exposure: A Numerical Study,
Verma, A., Kumar, V. and Singh, A. R., *Indian Journal of Pure & Applied Physics*, Mar 2026, Vol. 64, no. 3, p. 245-250.
The rollout of fifth-generation (5G) wireless networks is driving the pervasive exposure to high-frequency electromagnetic fields, in the range (28-60 GHz), to a new scale. These are faster in carrying out data, but possible thermogenic effects on human tissue have raised concerns. This study aims to investigate the numerical modelling of channel-specific absorption rate and associated temperature increase in the human organs for 5G exposure based on Maxwell's equations. Simulations were performed at different frequencies (28, 38, and 60 GHz) and exposure durations (6 and 20 min) in the visual part (skin and subcutaneous fat) and in/on the structures of the human head (eyes, brain, skull, ear canal, thyroid, wrist, chest). Results suggest that the SAR increases with frequency and has a maximum value in superficial tissues, whereas the temperature rise is strongly associated with both SAR and exposure time. The most sensitive tissues are the cornea, ear canal, which show temperature increases larger than 3 degrees C at 60 GHz for long exposure, even if SAR values stay under internationally accepted safety levels. The results indicate that 5G EMW Waves at frequencies are of negligible risk to deep tissues despite a small elevation in temperature due to resonant absorption within the skin, with localized heating of the skin surface becoming of concern given ultra-close proximity exposure of long duration to devices operating at or near 5 G frequencies. The research highlights the need to incorporate thermal safety evaluations into existing exposure standards and proposes more looking into the long-term biological impacts of prolonged exposure to 5G. https://doi.org/10.56042/ijpap.v64i3.22289

Méthodes

Optimizing a 6 GHz RF Exposure System for In Vivo Experiments: A Comparative Study of Open-Ended Waveguide and Horn Antennas
Alzahed, A., Gordon-Mcintosh, S. E., Egube, T., Ozgun, A., West, E., Mcgarr, G. W. and Ieee (2025). 2025 International Symposium on Antennas and Propagation and North American Radio Science Meeting-AP-S/CNC-USNC-URSI, Ottawa, CANADA.
This paper comprehensively investigates the optimization of localized radiofrequency electromagnetic field exposure configurations for human experiments with open-ended waveguide and horn antennas operating at 6 GHz. By using a simulation-based approach to vary the antenna-to-tissue distance and analyzing key performance metrics including the peak specific absorption rate (SAR) and beam spot, we aimed to optimize the experimental setup for safe exposures on the forearm while maintaining optimal performance levels. When comparing the two antennas across a range of antenna-to-tissue distances, the horn exhibited a higher SAR and a more focused beam spot compared to the open-ended waveguide. Specifically, at a distance of 50 mm, the spatially averaged peak SAR in 10 g (pSAR) on the skin surface was 5.5 W/kg and 3.4 W/kg for the horn and open-ended waveguide, respectively. These findings underscore the importance of antenna selection and placement when optimizing RF exposure configurations for human experiments.
https://doi.org/10.1109/ap-s/cnc-usnc-ursi55537.2025.11266436

RF exposure assessments near reflecting surfaces
Anderson, V. and Ludick, D. (2025). 2025 URSI Asia-Pacific Radio Science Meeting (AP-RASC).
This study quantifies the impact of plane wave reflections from various surfaces on RF exposure assessments, considering both measurements and calculations. TE and TM modes are analyzed across different incident angles and frequencies. Reflecting surfaces, including PEC and medium dry ground, are examined for their influence on exposure levels. Results show that common RF dosimetric practices used in Australia including direct ray-based calculations of RF exposure near the ground and reflecting walls, as well as single point measurements of E-field above ground can substantially underestimate actual exposure by failing to account for reflected field effects.
https://doi.org/10.46620/URSIAPRASC25/WDKL4234

Effect of staircasing artifacts on induced electric field assessment for low-frequency magnetic exposure,
Diao, Y., Zhou, A. and Hirata, A., *Physics in Medicine and Biology*, Apr 28 2026, Vol. 71, no. 8.
Objective. Voxel-based anatomical models play a central role in low-frequency (LF) numerical dosimetry and derivation of exposure limits. This study aims to quantify the effect of voxelization artifacts on the assessment of the induced in situ electric field in human body models exposed to LF magnetic fields. Approach. A high-resolution voxel-based whole-body model at two spatial resolutions was used to compute the induced electric field. A previously proposed effective conductance model was applied to reduce staircasing artifacts at the skin-air and skin-fat interfaces. Both whole-body uniform and localized non-uniform exposure scenarios were incorporated, with the magnetic fields aligned in different directions. The effect of staircasing artifact was evaluated by comparing the percentile values of spatially averaged electric field obtained with and without a mitigation method. Main results. The percentile values of the averaged electric field, both with and without the staircasing artifact mitigation method, show high consistency. Good agreement was observed for the 99th-99.999th percentile values of the averaged electric field strengths in both uniform and non-uniform exposure scenarios for different averaging methods. Significance. This study provides the first systematic quantification of voxelization (staircasing) effects on percentile-based dosimetric metrics in the skin, which is a critical tissue for peripheral nerve stimulation. The findings demonstrate that staircasing-induced variability in the 99th-99.999th percentile in situ electric fields is negligible, thereby supporting the robustness of the current exposure limit derivation in international guidelines and standards. The conclusions regarding the robustness of the percentile metrics refer to numerical stability against voxelization artifacts and do not imply the general suitability of these percentiles for highly localized exposure scenarios.
https://doi.org/10.1088/1361-6560/ae5eba

Full-Body vs. Head-Only Modeling: Full Wave Computational SAR and Adaptation of Corresponding ANN Models
Esmaeili, H., Yang, C., Schuster, C. and Ieee (2025). 2025 Europe International Symposium on Electromagnetic Compatibility-EMC EUROPE-Annual, Paris, FRANCE.
Electromagnetic compatibility (EMC) analysis is often computationally expensive, with partial modeling and domain-specific approximations commonly employed to improve efficiency, although these simplifications can introduce accuracy trade-offs. To address these challenges, this work focuses on bioelectromagnetic compatibility (Bio-EMC) problems, particularly the Specific Absorption Rate (SAR) calculations, by evaluating SAR in human head tissues using Full-Body and Head-Only models with finite element method (FEM) solvers under plane wave (PW) and near field (NF) exposures at 13.56 MHz. More than 2,000 full wave simulations are conducted, incorporating uncertainties in material properties and exposure angles, with machine learning techniques applied for enhanced analysis. Results show that while model truncation can impact SAR, certain scenarios

allow Head-Only data to effectively replace Full-Body data. In these cases, parameter prioritization in artificial neural networks (ANNs) achieves over 90% accuracy while reducing input parameters by up to 70%. For cases where truncation effects are more significant, the ANN trained on Head-Only data is refined using Full-Body data, improving predictive accuracy up to 85% while maintaining computational efficiency. The proposed ANN-based approach enhances both computational efficiency and prediction reliability in Bio-EMC analysis, making it applicable to other emission susceptibility scenarios by reducing system complexity and improving the physical interpretation of results. https://doi.org/10.1109/EMCEurope61644.2025.11176303

Full-Wave Characterization of Reverberation Chambers for Rodent Bioassays: Methodology and Realistic-Loading Impact Analysis,
Faraone, A., Bit-Babik, G., Sanderson, K., Russo, P., De Leo, A., Primiani, V. M. and De Santis, V., *Ieee Access*, 2026 2026, Vol. 14, p. 74261-74273.
This study presents a comprehensive full-wave numerical dosimetry approach for large-scale rodent bioassays in Reverberation Chambers (RCs), improving upon prior methods that rely on idealized Plane Wave (PW) superposition. A "digital twin" of the Universit & agrave; Politecnica delle Marche RC was implemented using Transmission-Line Matrix and Finite Element Method solvers to characterize exposure homogeneity across rodent cages at 900 MHz. Unlike PW-superposition models, loaded-RC simulations account for realistic experimental constraints, such as intruding water-supply metal piping, specific antenna designs and placements, and actual mode stirrers. The loaded-RC electromagnetic characteristics were investigated by analyzing the field impedance ratios, yielding discrimination criteria for the probe location and type. Cage-wise instantaneous and ensemble-averaged whole-body specific absorption rate (wbSAR) distributions were evaluated using postured homogeneous rat models. Furthermore, investigations into exposure imbalance mitigation strategies demonstrated significant benefits when spinning cage assemblies. An analysis of mass-dependent exposures revealed a notably weaker correlation between body mass and wbSAR, as well as a much larger wbSAR cage dependence, compared to earlier PW-based predictions, further highlighting the necessity of realistic RC modeling for reliable rodent bioassay exposure design.
https://doi.org/10.1109/access.2026.3692396

EIRP-Based Ray Tracing Simulation and Experimental EMF Exposure Assessment of Operational 5G-NR MaMIMO Base Stations,
Heidari, J., Joseph, W., Martens, L. and Vermeeren, G., *Ieee Access*, 2026 2026, Vol. 14, p. 61430-61440.
Accurate electromagnetic field (EMF) exposure assessment in operational fifth generation new radio (5G-NR) networks is challenging because most approaches rely on static or worst-case transmission assumptions, creating a gap between simulations and real-world measurements that this study bridges. We validate ray-tracing (RT) simulations for exposure estimation from 5G-NR massive multiple-input multiple output (MaMIMO) antennas operating in the 3.7-3.8 GHz frequency range 1 (FR1) band by integrating equivalent isotropically radiated power (EIRP) values recorded by base station antenna (BSA) counters. Using operational EIRP data enables realistic modelling of dynamic network behaviour and reduces uncertainty in line-of-sight (LOS) scenarios. In-situ EMF measurements performed according to IEC 62232 serve as a benchmark for evaluating simulation accuracy while considering the 4 dB target expanded uncertainty. Results show a median deviation of 1.6-3.8 dB between EIRP-based simulations and measurements, demonstrating good agreement, while the measured and estimated exposure levels remain well below International Commission on Non-Ionizing Radiation Protection (ICNIRP) limits, with a maximum of 0.6 %.
https://doi.org/10.1109/access.2026.3682896

Whole-Body SAR Evaluation under Far-Field Exposure with Daily Posture Variability: Toward an Epidemiologically Relevant Assessment
Kusakabe, K., Hikage, T., Nishimura, T., Kashiwa, T., Tamura, N., Bamai, Y. A., Ikeda, A. and Kishi, R. (2025). 2025 International Symposium on Antennas and Propagation (ISAP).
With the increasing use of wireless communication devices in daily life, the importance of accurately assessing human exposure to electromagnetic fields (EMFs) has grown significantly. While the whole-body averaged specific absorption rate (WB-SAR) is widely employed as a key safety metric for far-field exposure, most numerical studies rely on upright-standing human models. In everyday situations, however, individuals often adopt postures such as sitting or leaning forward, particularly when using devices like smartphones or computers. In this study, aiming to establish a posture-aware WB-SAR evaluation framework suitable for use in epidemiological research, we perform a numerical analysis using a high-resolution Japanese voxel human model and the finite- difference time-domain (FDTD) method. A plane wave representing far-field exposure is used to evaluate posture-dependent WB-SAR under various incident directions and polarizations. The results illustrate how postural variations influence SAR distribution. These findings are expected to enhance the accuracy and realism of SAR-based dosimetry assessments under typical usage conditions
https://doi.org/10.23919/ISAP63122.2025.11361986

Whole-Body SAR Evaluation under Far-Field Exposure with Daily Posture Variability: Toward an Epidemiologically Relevant Assessment
Kusakabe, K., Hikage, T., Nishimura, T., Kashiwa, T., Tamura, N., Bamai, Y. A., Ikeda, A., Kishi, R. and Ieee (2025). 7th International Symposium on Antennas and Propagation-ISAP, Fukuoka, JAPAN.
With the increasing use of wireless communication devices in daily life, the importance of accurately assessing human exposure to electromagnetic fields (EMFs) has grown significantly. While the whole-body averaged specific absorption rate (WB-SAR) is widely employed as a key safety metric for far-field exposure, most numerical studies rely on upright-standing human models. In everyday situations, however, individuals often adopt postures such as sitting or leaning forward, particularly when using devices like smartphones or computers. In this study, aiming to establish a posture-aware WB-SAR evaluation framework suitable for use in epidemiological research, we perform a numerical analysis using a high-resolution Japanese voxel human model and the finite-difference time-domain (FDTD) method. A plane wave representing far-field exposure is used to evaluate posture-dependent WB-SAR under various incident directions and polarizations. The results illustrate how postural variations influence SAR distribution. These findings are expected to enhance the accuracy and realism of SAR-based dosimetry assessments under typical usage conditions.
https://ieeexplore.ieee.org/document/11361986

Propagation- and gradient-guided GAN for E-field super-resolution in millimeter-wave exposure assessment,
Li, C. S., Yi, S. W., Liu, Z. C. and Wu, T. N., *Annals of Telecommunications*, 2026.
The rapid deployment of the new generation of mobile networks and terminals has significantly intensified public concern over potential health risks associated with electromagnetic field (EMF) exposure, particularly in the context of millimeter-wave frequency bands. The current measurement system based on point-wise sampling of electric field (E-field) strength in the given volume is inefficient at the frequency band. Therefore, super-resolution construction of the E-field from the low-resolution values is in great need. This study introduces a generative adversarial network (GAN) integrated with a field gradient branch and loss function to achieve super-resolution reconstruction of electric fields (E-fields), for the purpose of evaluating millimeter-wave (mmW) exposure. Utilizing a dataset created based on plane wave integral representation (PWIR) and randomized parameter incidence, the model effectively captures the wave propagation characteristics of diverse antennas. The incorporation of gradient information sharpens the E-field distribution details. When combined

with cubic interpolation, this approach is validated for frequencies of 30 GHz and 60 GHz. Results by numerical validation show that this method achieves a maximum mean relative error (MRE) below 8% at up to 60 GHz, surpassing both interpolation techniques and conventional GAN-based approaches. In conclusion, this method demonstrates a physics-guided, standard-aligned framework for E-field super-resolution, enabling high-fidelity exposure assessment from sparsely sampled data and offering a potential pathway to support high-frequency electromagnetic exposure evaluation in the compliance testing of fifth-generation (5 G) millimeter-wave (mmW) communication devices.
https://doi.org/10.1007/s12243-026-01175-8

Computational Human Skin Model for 5G Electromagnetic Field Exposure Studies
Otin, R., Soudah, E., Chirico, G., Schettino, F., Betzalel, N. and Ieee (2025). 2025 International Workshop on Electromagnetics-IWEM-Annual, Hong Kong, PEOPLES R CHINA.
This study examines human exposure to electromagnetic (EM) fields in the 5G Frequency Range 1 (FR1: 410 MHz - 7125 MHz) and Frequency Range 2 (FR2: 24.25 GHz - 52.6 GHz). Due to the strong attenuation of EM fields within the body at FR2, our focus is on the skin, where most energy is absorbed. For comparison, we also analyze FR1. A multi-layer skin model is exposed to EM fields at 700 MHz, 3.5 GHz, and 26 GHz to evaluate the electric field distribution and Specific Absorption Rate (SAR) across the different skin layers. Simulations were performed using the finite element method in the frequency domain implemented in the open-source software ERMES 20.0 and cross-verified with a commercial software tool. The results of the analysis will be used in experiments inside the project EU project NextGEM to contribute to a more comprehensive understanding of 5G-related EM exposure and its potential implications for human health.
https://doi.org/10.1109/iwem65640.2025.11168062

Silicone-Carbon-Based Phantom for Nearfield Characterization of Wearable Antennas at 60 GHz
Rizzo, R., Ruello, G., Zhadobov, M. and Sacco, G. (2025). 2025 URSI Asia-Pacific Radio Science Meeting (AP-RASC).
This paper evaluates a solid silicone-carbon-based phantom for nearfield antenna characterization at millimeter-wave (mmW) frequencies. Unlike conventional phantoms designed to mimic permittivity, this phantom is optimized to replicate the skins reflectivity. Numerical simulations compare the phantoms response to a homogeneous skin model, focusing on S11, radiation efficiency, total efficiency, and radiation patterns for a patch antenna operating at 60 GHz.The results indicate a strong agreement between the phantom and skin models, with mean absolute errors below 1 dB. These findings validate the phantoms applicability for wearable antenna testing, offering a reliable experimental model for near-body electromagnetic (EM) interaction studies.
https://doi.org/10.46620/URSIAPRASC25/EFDX2349

Toxicité sur les animaux

Involvement of the Primary Auditory Cortex-Basolateral Amygdala Circuit in Altered Conditioned Fear Memory Retrieval Following Electromagnetic Field Exposure in Mice,
Cui, Z. L., Shi, L., Yang, M. Y., Chang, C. X., Jin, S. K., Hao, Y. H., Zhao, X. L., Lu, Y. J., Li, Y. and Zuo, H. Y., *Journal of Integrative Neuroscience*, Apr 17 2026, Vol. 25, no. 4.
Background: Electromagnetic field (EMF) exposure is increasingly common and has been implicated in a range of effects on human health. Conditioned fear memory plays a critical role in enabling organisms to respond appropriately to previously encountered threats. Despite growing interest in the neurobiological consequences of EMF exposure, its impact on the neural circuits underlying conditioned fear responses has not been clearly defined.Methods: Using a mouse model exposed to combined microwave and static magnetic fields, we examined the involvement of the primary auditory cortex-basolateral amygdala (Au1-BLA) circuit in EMF-associated alterations in conditioned fear retrieval. A multifaceted experimental approach was employed, including behavioral assays,

viral tracing, genetically encoded calcium imaging, chemogenetic modulation, histopathological analysis, and immunofluorescence.Results: Exposure was associated with reduced conditioned fear memory retrieval, pathological changes in Au1 and BLA tissue ultra-structures, and decreased Nissl bodies in Au1 neurons and Au1-BLA neuronal fiber projections. The attenuation of conditioned fear memory retrieval coincided with decreased calcium activity in Au1 and BLA neurons. Consistently, chemogenetic activation of Au1 calcium-dependent protein kinase II (CaMKII)-expressing neurons enhanced calcium activity in BLA neurons during fear retrieval and was accompanied by changes in cholinergic signaling in the BLA. These findings suggest that cholinergic neuronal populations downstream of the Au1-BLA circuit are sensitive to EMF exposure and may participate in EMF-related modulation of fear retrieval.Conclusions: Our findings support an association between EMF exposure and altered conditioned fear expression involving functional changes within the Au1-BLA circuit, especially for the changes in calcium activity and chemogenetic modulation of Au1 CaMKII-expressing neurons. This study provides direct experimental evidence linking EMF exposure to circuit-level functional interactions underlying fear memory retrieval.
https://doi.org/10.31083/jin48640

Thermal responses of rats exposed to continuous or intermittent 915 MHz mobile phone RF signals,
Kim, H. S., Kim, Y., Jeon, S. B., Moon, J. I., Choi, H. D., Lee, A. K. and Ahn, Y. H., *Journal of Thermal Biology*, Jul 2026, Vol. 139.
The thermal effects of a mobile phone emitting radiofrequency electromagnetic fields (RF-EMFs) are well known, but the in vivo impact of different exposure patterns has not been directly demonstrated. This study aimed to compare the in vivo effects of continuous and intermittent exposure to 915 MHz LTE-modulated mobile phone signals under conditions that simulate typical mobile phone use. Male Sprague-Dawley rats were exposed either continuously at whole-body averaged specific absorption rates (SAR) of 0, 4, 6, or 8 W/kg, or intermittently at 0 or 8 W/kg using 10-min on/off cycles. Rectal and interscapular temperatures were recorded during 9 h of continuous exposure or 10 h of intermittent exposure. Comparisons were made under two matched conditions: continuous exposure at 8 W/kg for 5 h versus intermittent exposure at 8 W/kg for 10 h (equal RF-on time), and continuous 4 W/kg versus intermittent 8 W/kg (50% duty cycle; equal time-averaged SAR). Under equal cumulative RF-on time, intermittent 8 W/kg exposure caused only a brief temperature increase, whereas continuous 8 W/kg exposure resulted in a gradual and sustained rise. Under equal time-averaged SAR, continuous 4 W/kg showed no temperature change, whereas intermittent 8 W/kg caused a transient rise. No significant effects were observed at 6 W/kg continuous exposure, and sham groups remained stable. These findings provide direct, comparative in vivo evidence that both SAR level and exposure pattern significantly influence thermal outcomes during exposure to mobile phone RF signals. https://doi.org/10.1016/j.jtherbio.2026.104464

Effects of prolonged exposure to 2.45 GHz electromagnetic fields on mouse health over a 5-month period,
Lv, Z. C., Wu, Y. Q., Zhao, K., Li, J. J., Gao, H. Y., Zhao, X. W., Li, S. Y., Xu, A. Y., Li, J. F., Cai, Y. Y., Xiang, S. S., Chen, H., Yin, R. H., Yu, M., Yang, X. M. and Li, C. Y., *Ecotoxicology and Environmental Safety*, Apr 15 2026, Vol. 315.
With the ubiquitous and prolonged nature of human exposure to S-band electromagnetic fields (EMF, 2.45 GHz), concerns regarding its potential health impacts are growing. However, existing preclinical evidence is inconsistent, and a comprehensive assessment of its effects across multiple physiological systems is lacking. This study aimed to perform an integrated evaluation of the biological consequences of prolonged 2.45 GHz EMF exposure in mice, focusing on the reproductive, immune, metabolic, and hematopoietic systems. We established a murine model of prolonged EMF

exposure, wherein mice were subjected to 2.45 GHz radiation (whole-body average specific absorption rate, SAR 15 W/kg) for 5 months. A combination of physiological monitoring, functional sperm analysis, comprehensive flow cytometry, hematopoietic stem cell functional assays, and metabolic challenge tests insulin tolerance test (ITT) and pyruvate tolerance test (PTT) was employed to assess systemic impacts. Our findings revealed a system-specific pattern of responses. Notably, prolonged EMF exposure did not induce measurable adverse effects on core physiological parameters, sperm functional integrity (kinematics and morphology), immune cell populations and distribution, or hematopoietic competence. In stark contrast, it significantly disrupted systemic glucose homeostasis, leading to elevated fasting blood glucose and impaired insulin sensitivity. This study demonstrates that biological effects of prolonged 2.45 GHz EMF exposure are not monolithic but exhibit distinct organ susceptibility. We identified a selective vulnerability in metabolic regulation, while reproductive, immune, and hematopoietic systems remained resilient under our specific exposure conditions. These findings challenge the universality of generalized toxicity claims, underscore the critical role of exposure parameters, and highlight metabolic dysfunction as a potential risk for prolonged EMF exposure, providing crucial insights for future risk assessment.
https://doi.org/10.1016/j.ecoenv.2026.120106

Electric field-induced inflammatory and angiogenic responses in rat female reproductive tissues: evidence for early extracellular matrix remodeling,
Ozmen, O., Asci, H., Kolay, O., Selcuk, E. N., Yuksel, D., Comlekci, S. and Karabacak, P.,
Histochemistry and Cell Biology, Mar 27 2026, Vol. 164, no. 1.
High-intensity electric fields (EFs) are increasingly encountered in occupational and environmental settings, raising concerns regarding their potential biological effects on hormonally responsive organs. However, the cellular and molecular responses of female reproductive tissues to short-term exposure to high-voltage EFs remain insufficiently characterized. This study aims to investigate EF-associated histopathological and immunohistochemical alterations in major female reproductive organs. Forty adult female Wistar albino rats were randomly assigned to five experimental groups (n = 8 per group): a control group (0 min) and four EF-exposed groups subjected to a nominal electric field intensity of 10 kV/m EF for 1, 5, 15, or 30 min using a custom-designed parallel-plate exposure system. The field intensity was verified at predefined measurement points within the exposure setup. Ovaries, uterus, and uterine tubes were examined using hematoxylin-eosin staining and semi-quantitative histopathological scoring. Immunohistochemical analyses were performed to evaluate the expression of tumor necrosis factor-alpha (TNF-alpha), vascular endothelial growth factor (VEGF), and osteonectin as markers of inflammation, angiogenesis, and extracellular matrix remodeling. Exposure to the electric field was associated with time-dependent histopathological alterations, including tissue edema, hemorrhage, epithelial degeneration, and leukocyte infiltration. The most pronounced ovarian and uterine changes were observed in the 30-min exposure group, whereas the uterine tubes exhibited comparatively milder structural alterations. Immunohistochemical analysis demonstrated increased TNF-alpha and VEGF expression in higher-exposure groups, suggesting activation of inflammatory and angiogenic pathways. Osteonectin expression was elevated in all examined reproductive tissues and was also detected in regions without overt morphological damage, indicating its potential sensitivity to early tissue stress responses associated with EF exposure. Significant correlations were observed between histopathological injury scores and immunohistochemical marker expression levels. Overall, short-term exposure to high-intensity electric field was associated with inflammatory signaling, angiogenic responses, and extracellular matrix remodeling in female reproductive tissues in this experimental model. These findings provide histological and immunohistochemical evidence of tissue responses to EF exposure and underscore the need for further studies incorporating comprehensive exposure characterization and additional molecular endpoints to better define

potential reproductive health implications to high-voltage electric fields. https://doi.org/10.1007/s00418-026-02470-0

Testicular Heat-Shock Protein Expression in Rats Following 3.5 GHz and 24 GHz RF-EMF Exposure, Taha, S., Jaffar, F. H. F., Hairulazam, A., Vijay, S., Jamaludin, N., Zulkefli, A. F., Ros, M. F. M., Osman, K., Zakaria, Z., Bahar, M. and Ibrahim, S. F., *International Journal of Molecular Sciences*, Apr 12 2026, Vol. 27, no. 8.
The expansion of fifth-generation (5G) wireless networks has increased environmental exposure to mid-band and millimeter-wave radiofrequency electromagnetic fields (RF-EMF), but their molecular effects on male reproductive tissues remain insufficiently understood. This study evaluated whether repeated exposure to 3.5 GHz and 24 GHz RF-EMF alters testicular stress-associated molecular responses by integrating electromagnetic dosimetry with an in vivo rat model. Whole-body specific absorption rate (SAR) and 10 g peak SAR were estimated using a rat voxel model and scaled to the 20 cm antenna-to-cage geometry used during exposure. Thirty-six adult male Sprague Dawley rats were allocated to sham, 3.5 GHz, or 24 GHz groups and exposed for 1 h/day or 7 h/day over 60 days. Testes were examined histologically and assessed for HSP27, HSP70, and HSP90 protein expression. SAR values were low overall, although absorption was higher at 3.5 GHz than at 24 GHz. Histological evaluation showed preserved seminiferous tubule architecture without consistent structural injury. In contrast, molecular analysis demonstrated frequency- and duration-dependent modulation of heat shock proteins, including early HSP70 downregulation at both frequencies, followed by HSP90 upregulation at 3.5 GHz and HSP27 upregulation at 24 GHz. These findings indicate that low-level 5G-relevant RF-EMF exposure can modify molecular stress responses in testicular tissue even in the absence of overt histological damage.
https://doi.org/10.3390/ijms27083452

Morphometry of red blood cells in sow blood: effects of short-term in Vitro exposure to 5G network frequencies,
Zura, N., Vince, S., Vugrovecki, A. S., Vilic, M., Peric, P., Malaric, K., Tur, S. M., Milas, N. P., Samardzija, M., Ostovic, M., Miljkovic, J., Mencik, S., Hlede, J. P., Pecin, M., Kowalczyk, A. and Zaja, I. Z., *Journal of Applied Animal Research*, Dec 31 2026, Vol. 54, no. 1.
The effects of 5G radiofrequency electromagnetic radiation (RF-EMR) on complete blood count (CBC) and RBC morphometric parameters in pigs are unknown. Aim of this study was to determine effect of 5G RF-EMR at different frequencies on CBC and RBC morphometry after short-term in vitro exposure of sow blood. Blood samples were taken from 16 sows aged 1 to 2 years. Three ethylenediaminetetraacetic acid (EDTA) tubes per sow were labelled as experimental tubes and three as control tubes. Experimental samples were placed in a Half-cone gigahertz transversal electromagnetic cell and exposed to 5G RF-EMR at 700 MHz, 2500 MHz and 3500 MHz with electric field strength of 10 V/m for 2 hours. CBC was determined using a haematology analyser. RBC morphometric parameters were determined using the computer-assisted program SFORM. The most detrimental effect on sow RBC morphometry was observed after exposure at 700 MHz, resulting in significantly more elongated and irregularly bordered RBCs. These results suggest that in vitro exposure to 5G RF-EMR may impact RBC shape and mechanical properties or integrity, which could affect cell function. This study provides first evidence of frequency-dependent effects of 5G RF-EMR on RBC morphometry and CBC parameters in pigs, offering novel insights for veterinary and translational research. https://doi.org/10.1080/09712119.2026.2648186

Actualité, société et mesures de prévention

Wearable fabrics against ultra-broadband electromagnetic interference,
Deng, L. C., Zhang, Y. H., Xu, H. L., Zhang, W. J., Hui, S. C., Yan, W. X., Luo, F., Wu, H. J., Colombo, P. and Chen, Q., *Matter*, May 6 2026, Vol. 9, no. 5.
Broadband electromagnetic interference (EMI) poses multifaceted health risks to clinicians, necessitating wearable shielding materials. A critical challenge persists: the ultra-long wavelengths of low-frequency EMI demand shielding thicknesses that far exceed practical limits for wearable materials. Herein, we engineer dual-shelled EMI shielding composites via homogenization/recrystallization annealing, which not only hierarchically modulates built-in electric fields, minimizing electron migration resistance while preserving interfacial polarization, but also achieves a cascaded magnetization optimization through unpaired atoms, magnetic domain refinement, exchange coupling, and long-range magnetic coupling. The optimized architecture yields an ultra-broadband shielding (100 kHz-3 GHz) with record effectiveness (99.9 dB at 100 kHz). Roll coated onto textiles, the composite attenuates EMI-induced neural damage, validated through almost unchanged cell viability compared to a control in in vitro assays based on HT-22 cells. By integrating material design, mechanistic insights, prototype development, and biological efficacy, this work establishes a blueprint for the next-generation development of electromagnetic protective materials. https://doi.org/10.1016/j.matt.2026.102697

Web Application for Managing and Monitoring Exposure to Electromagnetic Fields
Dragomir, C. M., Maricaru, M., Bogdan, E. A., Stanculescu, M. and Ieee (2025). 14th International Symposium on Advanced Topics in Electrical Engineering-ATEE, Bucharest, ROMANIA.
This paper presents the design and implementation of a web application for the centralized management of electromagnetic compatibility (EMC) tests and the assessment of human exposure to electromagnetic fields (EMF). The platform integrates a relational database, role-based access control, and an automated compliance engine that evaluates measurements against ICNIRP 2020 and FCC 47 CFR 1.1310 limits, producing PASS/FAIL results and interactive visualizations. By automating the workflow-from planning to data entry, analysis, and reporting-the system reduces manual effort, improves traceability and reproducibility, and supports consistent application of evolving exposure standards. Evidence for non-thermal health effects remains uncertain, therefore, the tool focuses on transparent implementation of current regulatory and guideline limits while facilitating comparative analysis across frequency bands and exposure scenarios
https://doi.org/10.1109/atee66006.2025.11299946

Sequential Self-Assembly of Reduced Graphene Oxide and Polypyrrole on Cotton Fabrics for Efficient Electromagnetic Interference Shielding,
Fu, C. C., Ye, J., Fan, B. J. and Cao, J. L., *Fibers and Polymers*, 2026.
With the ubiquitous integration of electronic devices into daily life, managing electromagnetic radiation pollution has become a critical environmental and health concern. Developing textile materials that simultaneously offer high-efficiency electromagnetic interference (EMI) shielding and wear comfort is of significant research value. This study investigates a novel composite coating strategy on cotton fabrics, utilizing a sequential self-assembly process involving graphene oxide (GO) adsorption-reduction and in situ pyrrole polymerization. The research systematically explores the effects of precursor concentrations and, crucially, the assembly sequence on the fabric's electrical and shielding properties. Results demonstrate that constructing a reduced graphene oxide (RGO) conductive skeleton followed by the polymerization of a polypyrrole (PPy) layer (Cotton/RGO/PPy) yields superior performance compared to the reverse sequence. This optimized architecture facilitates the formation of a continuous, smooth conductive network where PPy bridges the gaps between RGO sheets, enhanced by strong pi-pi stacking interactions. The resulting composite fabric, fabricated with 1 g/L GO and 0.35 mol/L pyrrole, achieves an EMI shielding

effectiveness of approximately 80% (corresponding to similar to 15-20 dB) with excellent wash durability. This work provides a robust strategy for fabricating lightweight, flexible, and durable protective textiles. https://doi.org/10.1007/s12221-026-01422-8

Multi-scale structural design of electromagnetic wave absorbers: pathways to improved performance,
Guan, Y., Wu, Y. P., Zhou, J. Y., Yao, K., Liu, R. L., Yang, Y. and Lu, W., *Materials Horizons*, 2026.
With the rapid advancement of wireless communication technologies and the proliferation of Internet of Things (IoT) devices over the past decade, electromagnetic interference (EMI) has emerged as a significant challenge. EMI can degrade the performance, stability, and lifespan of advanced electronics and even poses potential health risks. One of the most effective strategies to mitigate this issue is the development of highly efficient electromagnetic wave absorbers (EMAs), a field that has garnered considerable attention. However, achieving the necessary efficiency for widespread adoption remains a challenge. The internal structure of EMAs plays a pivotal role in determining their absorption performance. This review explores the fundamental principles of electromagnetic wave absorption and highlights recent advancements in optimizing internal structures across various length scales, from the atomic to the macroscopic level. We examine design strategies, structure-performance relationships, and fabrication methods for tuning absorption efficiency, either independently or in combination. Finally, we address key challenges and future directions for the next generation of EMAs, offering insights into their potential for practical applications. https://doi.org/10.1039/d5mh02482j

Cs2SnI6: A Perovskite-Based Electromagnetic Wave Absorbing Material,
Han, F., Ye, W. P., Wang, L. L., Liu, F., Pang, Q., Yan, X., Zhang, Y., Zhang, Z. D., Xue, W. D., Wang, W. J., Zhao, R. and Yang, X. Y., *Rare Metals*, Mar 26 2026, Vol. 45, no. 4.
Lead halide perovskites and carbon-based materials are interesting, high-performing electromagnetic wave absorbing materials. However, only a few studies have been carried out to examine in detail the electromagnetic wave absorption properties of these materials. Moreover, because most perovskites contain lead and have low structural stabilities, concerns exist about the potential environmental and biological toxicity impacts associated with their use. In this effort, we demonstrate for the first time that the novel, non-toxic, and lead-free inorganic halide perovskite Cs2SnI6 absorbs electromagnetic waves. Specifically, we show that the SnI4-derived Cs2SnI6 perovskite can be synthesized by using a one-step solution-based method and that it has an effective absorption bandwidth of 6.4 GHz at a thickness of 1.9 mm. The outstanding performance profile of this material is attributed to dipole-like oscillation of cations and anions within Cs2SnI6 under alternating electromagnetic wave fields caused by mismatched motion of phases having different charges and masses that leads to dipole polarization. Furthermore, an investigation of sources for this effect provides valuable insights into the interrelationship that exists between impedance matching characteristics and electromagnetic wave absorption performance, which should highly benefit future designs of novel halide perovskite-based absorbing materials.
https://doi.org/10.1002/rar2.70227

A Ten-Country Study on Public Perceptions of 5G EMF Emissions: Who Feels Exposed, and Why?,
Link, S. C., Grellier, J., Martin, L., Eggeling-Böcker, M., Abacioglu, F., Schulz, C., Vaupotič, N., White, M. P. and Boehmert, C., *Bioelectromagnetics*, Vol. 47, no. 5.
Formal risk assessment considers characteristics such as proximity, dose, and vulnerability. However, public risk perception may also be influenced by other?possibly less relevant?factors such as visibility and novelty. The introduction of 5G and its associated infrastructure and radiofrequency electromagnetic fields (RF-EMF) may therefore change perceptions of RF-EMF from mobile communications in general. To explore this, we conducted an online survey in 10 European countries

(n?=?10,358) using a picture-based approach. Respondents perceived daily RF-EMF exposures as moderate but expected them to increase with 5G. A mobile phone at the ear was generally associated with higher perceived exposure than multiple base stations. Overall, distance to the RF-EMF source most strongly influenced perceived exposure, followed by the number of sources. 5G reception was linked to higher exposure perception than 4G or Wi-Fi reception. These patterns were consistent across most countries. We conclude that when assessing RF-EMF exposure, people rely on heuristics (e.g., more sources imply more exposure) that often guide them correctly. Understanding when and why people feel particularly exposed can help develop more effective communication about true levels of exposure and risk. https://doi.org/https://doi.org/10.1002/bem.70058

The further away the better? Factors influencing the public's location preferences for mobile phone base stations. A 10-country study,
Link, S. C., Martin, L., Grellier, J., Eggeling-Böcker, M., Abacioglu, F., Schulz, C., Vaupotic, N., White, M. P. and Boehmert, C., *Journal of Environmental Psychology*, Jun 2026, Vol. 112.
New mobile phone base stations are frequently opposed by the public, even though mobile phones are used by most of the population. While such reaction has often been described as NIMBYism ('not in my back yard'), this label offers little insight into the psychological mechanisms underlying such opposition. The present mixedmethods research moves beyond a simple NIMBY interpretation through an in-depth investigation of public location preferences for 4G-plus 5G-capable base stations. Study 1 included six focus groups conducted in December 2022, and Study 2 was a ten-country survey (n = 10,358) conducted between September-December 2023. In both studies, participants were asked to select their preferred base station site from six hypothetical locations and indicate the reasons underlying their choice. Overall, many participants followed one of two siting approaches: approach A preferring locations 'as far away as possible', and approach B preferring the 'least visually appealing' location. While in Study 1 participants tended to follow approach B (16 out of 35), in Study 2 approach A was followed most frequently (53.6%). Among the reasons surveyed, distance had the greatest influence on location preferences, followed by reception, exposure to EMFs, and visual appearance. Distance and EMF were strongly correlated (r = .531), which is why we assume that distance was a proxy for reduced exposure. However, greater distance can in fact increase overall exposure due to the increased power required for higher handset transmission. Age, gender, risk perception, exposure perception, use of 5G, acceptance and the expected impact of 5G were also associated with the choice of location. We found that widespread public communication efforts are needed to explain how 5G technology works, and that other issues such as visual amenity also need to be sensitively managed. Our results inform the broader discourse on base station siting: communication between stakeholders needs to be improved, fostering mutual understanding of preferences, and guiding decision-making for both telecommunication companies and the public. https://doi.org/10.1016/j.jenvp.2026.103070

Predictors of Risk Perception Among General Practitioners and Paediatricians Concerning Potential Health Effects of Exposure to Electromagnetic Fields,
Lüthy, K., Forster, F., Riesmeyer, C., Ermel, L., Radon, K. and Weinmann, T., *Bioelectromagnetics*, Mar 2026, Vol. 47, no. 3.
Scientific evidence for health issues due to exposure to electromagnetic fields (EMF) is limited but there is considerable concern in the population about such effects. Physicians are seen as an important multiplier to the general population. The presented work intends to identify predictors of risk perception concerning EMF among general practitioners (GPs) and paediatricians. A cross-sectional study was carried out in 2023 among 292 (response rate: 6%) GPs and paediatricians across Germany. Logistic regression modelling was applied to examine the relationship between different variables (technology acceptance, media health literacy, conspiracy belief, trust in organisations/institutions and environmental worry) and the physicians' health-related risk

perception regarding EMF. Ninety-one participants (31%) indicated to believe in health issues as a consequence of EMF exposure. Higher EMF risk perception was indicated by physicians with high conspiracy belief compared to their peers with less conspiracy belief (odds ratio [OR]: 2.92; 95% confidence interval [CI]: 1.81-4.13). High trust in bodies like WHO (OR: 0.57; 95% CI: 0.35-0.82) or the Federal Office for Radiation Protection (OR: 0.50; 95% CI: 0.28-0.76) was associated with lower EMF risk perception. Overall, we observed considerable evidence that conspiracy belief and trust in organisations may predict EMF risk perception. Bioelectromagnetics. 00:00-00, 2026.
https://doi.org/10.1002/bem.70047

Exposure limits to radiofrequency EMF do not account for cancer risk or reproductive toxicity assessed from data in experimental animals,
Melnick, R. L., Moskowitz, J. M. and Int Commiss Biol Effects Electromagnet Fields, I.-E., *Environmental Health*, Mar 14 2026, Vol. 25, no. 1.
Background Recent WHO-commissioned systematic reviews have concluded with "high certainty" that exposure to radiofrequency electromagnetic fields (RF-EMF) increases cancer risk and reduces male fertility in experimental animals. Methods We performed benchmark dose (BMD) analyses on experimental cancer data to estimate exposure levels associated with cancer risk of 1 & times; 10(-5) (1 in 100,000). Due to the lack of an established non-linear mode of action for RF-EMF-induced tumor responses, we utilized linear low-dose extrapolation from 1% BMD values. In addition, we applied traditional uncertainty factors to the reported linear potency value of 0.03 per W/kg for male reproductive toxicity to derive health-protective exposure limits. Results The derived dose per hour (expressed as the specific absorption rate, SAR) at 1 & times; 10(-5) cancer risk ranges from about 0.8 to 5 mW/kg. It should be noted that cancer risk increases with increasing time of exposure to RF-EMF. For protection of male fertility due to exposure to RF-EMF, the estimated SAR exposure limit was 3.3 to 10 mW/kg. These health protective whole-body exposure values are significantly lower than the current whole-body exposure limit value of 0.08 W/kg (80 mW/kg) established by ICNIRP and the FCC for the general public. Conclusions For the general public, current regulatory limits to RF-EMF are 15- to 900-fold higher than our estimates of exposure levels associated with cancer risk of 1 & times; 10(-5) (depending on the duration of daily exposure), and 8- to 24-fold higher than levels that are protective of male reproductive health. Thus, we strongly recommend an independent re-evaluation of RF-EMF exposure limits, integrating scientific data accumulated over the past 30 years and applying rigorous health-protective methodologies.
https://doi.org/10.1186/s12940-026-01288-6

Reporting of subjective symptoms after a specific training intervention on radiofrequency electromagnetic fields exposure in a sample of Italian students using smartphone devices
Modenese, A. (2025). 2025 URSI Asia-Pacific Radio Science Meeting (AP-RASC).
Several studies investigate effects of problematic smartphone use on non-specific symptoms. These symptoms are not associated to RF-EMF exposure, but can be related to the fatigue caused by the very intense use of the devices. In this study we surveyed a group of university students, grouped according to the reported hours of smartphone use and with respect to a specific training intervention on the recognized biophysical effects of RF-EMF. We tested the reported percentages of ten different symptoms, and their frequency of occurrence in the previous year. Six symptoms were related to different types of sleep problems, then also concentration problems, headache, palpitation and daily tiredness have been investigated. As these symptoms are subjective and related to the different individual perceptions, it was hypothesized that their reporting could be changed when receiving specific information on the effects of RF-EMF exposure from smartphones' use. The results showed that eight out of ten symptoms resulted more frequent in the subgroup of very intense smartphone users in the no-intervention arm compared to very intense users in the

post-intervention group, suggesting a possible modification of the subjective reporting after the specific training received by the students. https://doi.org/10.46620/URSIAPRASC25/JZSN3145

A Decision Support System for Managing Health Symptoms of Living Near Mobile Phone Base Stations,
Parsaei, H., Faraz, M. and Mortazavi, S. M. J., no. 2251-7200 (Print).
BACKGROUND: The rapid increase in the number of Mobile Phone Base Stations (MPBS) has raised global concerns about the potential adverse health effects of exposure to Radiofrequency Electromagnetic Fields (RF-EMF). The application of machine learning techniques can enable healthcare professionals and policymakers to proactively address concerns surrounding RF-EMF exposure near MPBS. OBJECTIVE: The current study aimed to investigate the potential of machine learning models for the prediction of health symptoms associated with RF-EMF exposure in individuals residing near MPBS. MATERIAL AND METHODS: This analytical study utilized Support Vector Machine (SVM) and Random Forest (RF) algorithms, incorporating 11 predictors related to participants' living conditions. A total of 699 adults participated in the study, and model performance was assessed using sensitivity, specificity, accuracy, and the Area Under Curve (AUC). RESULTS: The SVM-based model demonstrated strong performance, with accuracies of 85.3%, 82%, 84%, 82.4%, and 65.1% for headache, sleep disturbance, dizziness, vertigo, and fatigue, respectively. The corresponding AUC values were 0.99, 0.98, 0.920, 0.89, and 0.81. Compared to the RF model and a previously developed model, the SVM-based model exhibited higher sensitivity, particularly for fatigue, with sensitivities of 70.0%, 83.4%, 85.3%, 73.0%, and 69.0% for these five health symptoms. Particularly for predicting fatigue, sensitivity and AUC were significantly improved (70% vs. 8% and 11.1% for SVM, Multilayer Perceptron Neural Network (MLPNN), and RF, respectively, and 0.81 vs. 0.62 and 0.64, for SVM, MLPNN, and RF, respectively). CONCLUSION: Machine learning methods, specifically SVM, hold promise in effectively managing health symptoms in individuals residing near or planning to settle in the vicinity of MPBS.
https://doi.org/10.31661/jbpe.v0i0.2310-1667

One or many environmental intolerance(s)? A cluster analysis over two representative samples,
Petzke, T. M., Rippe, R. C. A., Witthöft, M., Szemerszky, R., Köteles, F., Lemogne, C., Nordin, S. and Pitron, V., no. 1618-131X (Electronic).
OBJECTIVE: People with symptoms associated with environmental factors (SAEFs) attribute somatic symptoms to chemicals, electromagnetic fields, noise, or other environmental sources. Debates are ongoing whether these different types constitute different disorders ("splitting") or rather different presentations of the same underlying disorder ("lumping"), and which characteristics contribute to this disorder/these disorders. METHODS: To shed further light on this question, we performed a k-prototypes cluster analysis of two representative population-based datasets. We selected 23 clinically relevant variables from the Västerbotten Environmental Health Study (N = 1576), a representative dataset from Sweden. Common measures of cluster partitioning were used, and cluster profiles inspected. We then replicated the analysis in the Österbotten Environmental Health Study dataset (N = 1233), a representative dataset from Finland. RESULTS: The cluster analysis distinguished between people with versus without SAEF, but did not provide evidence for empirically different SAEF clusters. Inspecting the profiles of the two clusters revealed that the main differences were in chemical sensitivity (r(Sweden)=0.53,r(Finland)=0.71), noise sensitivity (r(Sweden)=0.56,r(Finland)=0.61), electromagnetic field sensitivity (r(Sweden)=0.36,r(Finland)=0.58), and sleep (r(Sweden)=0.66,r(Finland)=0.30).People in the SAEF cluster scored higher on markers of psychopathology (e.g., anxiety: r(Sweden)=0.42,r(Finland)=0.22, depression: r(Sweden)=0.49,r(Finland)=0.22), and more women were in the SAEF cluster (Cramer's V(Sweden)=0.19,V(Finland)=0.29,allp<.001). CONCLUSIONS: The data supports the idea that different SAEF subtypes share similar clinical features. In terms of underlying mechanisms, this

suggests that similar biopsychosocial determinants might be involved in shaping symptom experience over distinct SAEF subtypes. People with different SAEFs might thus profit from similar interventions. https://doi.org/10.1016/j.ijheh.2026.114764