All links herein incorporated by reference.

https://pubmed.ncbi.nlm.nih.gov/26151230/

Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation

Abstract

This review aims to cover experimental data on oxidative effects of low-intensity radiofrequency radiation (RFR) in living cells. Analysis of the currently available peer-reviewed scientific literature reveals molecular effects induced by low-intensity RFR in living cells; this includes significant activation of key pathways generating reactive oxygen species (ROS), activation of peroxidation, oxidative damage of DNA and changes in the activity of antioxidant enzymes. It indicates that among 100 currently available peer-reviewed studies dealing with oxidative effects of low-intensity RFR, in general, 93 confirmed that RFR induces oxidative effects in biological systems. A wide pathogenic potential of the induced ROS and their involvement in cell signaling pathways explains a range of biological/health effects of low-intensity RFR, which include both cancer and non-cancer pathologies. In conclusion, our analysis demonstrates that low-intensity RFR is an expressive oxidative agent for living cells with a high pathogenic potential and that the oxidative stress induced by RFR exposure should be recognized as one of the primary mechanisms of the biological activity of this kind of radiation.

https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2026.1915745/full

A review of potential health risks of radiofrequency electromagnetic field exposure from mobile phones and base stations in children and pregnant women

Abstract

Over the last decade, the rapid expansion of mobile communication technologies has substantially increased population exposure to radiofrequency electromagnetic fields (RF-EMF). This has raised concerns about possible health implications, particularly for vulnerable groups like children and pregnant women. Although international agencies have reported no consistent evidence of harmful effects at established exposure limits, uncertainties remain regarding long-term and developmental effects. This review synthesizes and evaluates epidemiological and experimental evidence published between 2015 and 2025; a period characterized by rapid technological transitions (4G to 5G), advances in exposure assessment techniques, and increasing reliance on wireless devices. Confining the timeframe ensures a more relevant and up-to-date assessment of current exposure patterns and emerging biological insights. The review explores the association between RF-EMF exposure and major health outcomes, including reproductive and developmental effects, cancer risk, and neurological changes. It also integrates mechanistic pathways involving oxidative stress, DNA damage, and ROS signalling. Although no definitive causal relationship has been established, the evidence remains inconsistent due to variability in study design, exposure metrics, and outcome definitions. Notably, experimental and high-exposure studies provide biologically plausible mechanisms, particularly through oxidative stress pathways; however, these findings have not been consistently observed in the human population. Children and foetuses may exhibit greater susceptibility because of developmental and physiological factors, yet high-quality longitudinal evidence remains limited. Overall, further standardized, mechanistic, and long-term studies are needed to strengthen the scientific evidence base and inform public health policy.

Balmori, A. (2022). Evidence for a health risk by RF on humans living around mobile phone base stations: From radiofrequency sickness to cancer. *Environmental Research, 214*, 113851. https://doi.org/10.1016/j.envres.2022.113851

Chokeli, R., Yuswir, N. S., Ho, Y. B., Chiang, H. L., & How, V. (2026).

Environmental radiofrequency exposure and genotoxic biomarkers in schoolchildren: A cross-sectional analysis. *Scientific Reports*. https://doi.org/10.1038/s41598-026-60822-1

Al Musawi, M. A., & Mahmud, H. S. (2026). Investigating the relationship between the proximity of cell phone towers to residential areas and health symptoms in adolescents: A study from Maysan Governorate. *Malaysian Journal of Nursing, 17*(5). https://doi.org/10.31674/mjn.2026.v17i05.015

Laldinpuii, Sailo, L., Weller, S., Varte, C. L., Tochhawng, L., Bandara, P., McCredden, J. E., & Zothansiama. (2026). Effects of exposure to nearby mobile phone base stations and mobile phone usage on human blood parameters. *Electromagnetic Biology and Medicine*, 1–20. https://doi.org/10.1080/15368378.2026.2623473

Gulati, S., Mosgoeller, W., Moldan, D., Kosik, P., Durdik, M., Jakl, L., Skorvaga, M., Markova, E., Kochanova, D., Vigasova, K., & Belyaev, I. (2024). Evaluation of oxidative stress and genetic instability among residents near mobile phone base stations in Germany. *Ecotoxicology and Environmental Safety, 279*, 116486. https://doi.org/10.1016/j.ecoenv.2024.116486

Rangkooy, H., Rahmati, A., & Dehaghi, B. F. (2023). Base transceiver station antenna exposure and workers' health. *International Journal of Occupational Safety and Ergonomics, 29*(2), 863–868. https://doi.org/10.1080/10803548.2022.2085892

Jayaraju, N., Pramod Kumar, M., Sreenivasulu, G., Lakshmi Prasad, T., Lakshmanna, B., Nagalaksmi, K., & Madakka, M. (2023). Mobile phone and base stations radiation and its effects on human health and environment: A review. *Sustainable Technology and Entrepreneurship*. https://doi.org/10.1016/j.stae.2022.100031

Hardell, L., & Koppel, T. (2022). Electromagnetic hypersensitivity close to mobile phone base stations – A case study in Stockholm, Sweden. *Reviews on Environmental Health*. https://doi.org/10.1515/

reveh-2021-0169

Koppel, T., Ahonen, M., Carlberg, M., & Hardell, L. (2022). Very high radiofrequency radiation at Skeppsbron in Stockholm, Sweden from mobile phone base station antennas positioned close to pedestrians' heads. *Environmental Research, 208*, 112627. https://doi.org/10.1016/j.envres.2021.112627

Rodrigues, N. C. P., Dode, A. C., Andrade, M. K. N., O'Dwyer, G., Monteiro, D. L. M., Reis, I. N. C., Rodrigues, R. P., Frossard, V. C., & Lino, V. T. S. (2021). The effect of continuous low-intensity exposure to electromagnetic fields from radio base stations to cancer mortality in Brazil. *International Journal of Environmental Research and Public Health, 18*(3), 1229. https://doi.org/10.3390/ijerph18031229

López, I., Félix, N., Rivera, M., Alonso, A., & Maestú, C. (2021). What is the radiation before 5G? A correlation study between measurements in situ and in real time and epidemiological indicators in Vallecas, Madrid. *Environmental Research, 194*, 110734. https://doi.org/10.1016/j.envres.2021.110734

Thamilselvan, S., Behera, A., Nair, S. K., Chandru, C. S., Krishnakumar, M., & Ramani, P. (2021). Micronuclei analysis in people residing within 25 m of radiation-exposed areas around mobile towers in Chennai, India: An observational study. *Journal of International Oral Health, 13*, 350–355. https://www.jioh.org/article.asp?issn=0976-7428;year=2021;volume=13;issue=4;spage=350;epage=355;aulast=Thamilselvan

Zosangzuali, M., Lalremruati, M., Lalmuansangi, C., Nghakliana, F., Pachuau, L., Bandara, P., & Zothan, S. (2021). Effects of radiofrequency electromagnetic radiation emitted from a mobile phone base station on the redox homeostasis in different organs of Swiss albino mice. *Electromagnetic Biology and Medicine, 40*, 393–407. https://doi.org/10.1080/15368378.2021.1895207

Pearce, J. M. (2020). Limiting liability with positioning to minimize

negative health effects of cellular phone towers. *Environmental Research, 181*, 108845. https://doi.org/10.1016/j.envres.2019.108845

Meo, S. A., Almahmoud, M., Alsultan, Q., Alotaibi, N., Alnajashi, I., & Hajjar, W. M. (2019). Mobile phone base station tower settings adjacent to school buildings: Impact on students' cognitive health. *American Journal of Men's Health, 13*(1), 1557988318816914. https://doi.org/10.1177/1557988318816914

Brizzi, M., & Marinelli, F. (2018). Increased risk of cancer and heart diseases due to the exposure to the radar EMF among the population of Potenza Picena, Italy (1986–91). *European Journal of Oncology, 23*(4), 204–210. https://mattioli1885journals.com/index.php/EJOEH/article/view/6342

Abdel-Rassoul, A., El-Fateh, O., Salem, M., Michael, A., Farahat, F., El-Batanouny, M., & Salem, E. (2018). The importance of quantification of data in studies on the health effects of exposure to electromagnetic fields generated by mobile base stations. In M. Markov (Ed.), *Mobile Communications and Public Health* (pp. 297–305). Springer. https://link.springer.com/chapter/10.1007/978-3-319-62521-8_26

Zothansiama, Zosangzuali, M., Lalramdinpuii, M., & Jagetia, G. C. (2017). Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. *Electromagnetic Biology and Medicine, 36*(3), 295–305. https://doi.org/10.1080/15368378.2017.1350584

Pachuau, L. R., & Pachuau, Z. (2016). Health effects of mobile tower radiation on human — Case study. *International Journal of Applied Physics and Mathematics, 6*(2), 72–79.

Meo, S. A., Alsubaie, Y., Almubarak, Z., Almutawa, H., AlQasem, Y., & Hasanato, R. M. (2015). Association of exposure to radio-frequency electromagnetic field radiation (RF-EMFR) generated by mobile phone base stations with glycated hemoglobin (HbA1c) and risk of type 2

diabetes mellitus. *International Journal of Environmental Research and Public Health, 12*(11), 14519–14528. https://doi.org/10.3390/ijerph121114519

Roda, C., & Perry, S. (2014). Mobile phone infrastructure regulation in Europe: Scientific challenges and human rights protection. *Environmental Science & Policy, 37*, 204–214. https://doi.org/10.1016/j.envsci.2013.09.009

Dode, A. C., Leão, M. M. D., Tejo, F. A. F., Gomes, A. C. R., Dode, D. C., Dode, M. C., Moreira, C. W., Condessa, V. A., Albinatti, C., & Caiaffa, W. T. (2011). Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. *Science of the Total Environment, 409*(19), 3649–3665. https://doi.org/10.1016/j.scitotenv.2011.05.051

Levitt, B. B., & Lai, H. (2011). Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. *Environmental Reviews, 19*, 495–514. https://doi.org/10.1139/A10-018

Yakymenko, I., Sidorik, E., Kyrylenko, S., & Chekhun, V. (2011). Long-term exposure to microwave radiation provokes cancer growth: Evidences from radars and mobile communication systems. *Experimental Oncology, 33*(2), 62–70. https://pubmed.ncbi.nlm.nih.gov/21716201/

Khurana, V. G., Hardell, L., Everaert, J., Bortkiewicz, A., Carlberg, M., & Ahonen, M. (2010). Epidemiological evidence for a health risk from mobile phone base stations. *International Journal of Occupational and Environmental Health, 16*(3), 263–267. https://doi.org/10.1179/107735210799160192

Panagopoulos, D. J., Chavdoula, E. D., & Margaritis, L. H. (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology,*

86(5), 345–357. https://doi.org/10.3109/09553000903567961

Abdel-Rassoul, G., El-Fateh, O. A., Salem, M. A., Michael, A., Farahat, F., El-Batanouny, M., & Salem, E. (2007). Neurobehavioral effects among inhabitants around mobile phone base stations. *NeuroToxicology, 28*(2), 434–440. https://doi.org/10.1016/j.neuro.2006.07.012

Bortkiewicz, A., Zmyślony, M., Szyjkowska, A., & Gadzicka, E. (2004). Subjective symptoms reported by people living in the vicinity of cellular phone base stations: Review. *Medycyna Pracy, 55*(4), 345–351. https://pubmed.ncbi.nlm.nih.gov/15620045/

Eger, H., Hagen, K., Lucas, B., Vogel, P., & Voit, H. (2004). The influence of being physically near to a cell phone transmission mast on the incidence of cancer. *Umwelt Medizin Gesellschaft, 17*, 326–332. http://www.tetrawatch.net/papers/naila.pdf

Wolf, R., & Wolf, D. (2004). Increased incidence of cancer near a cell-phone transmitter station. *International Journal of Cancer Prevention*, 123–128. https://www.researchgate.net/publication/228490892_Increased_incidence_of_cancer_near_a_cell-phone_transmitter_station

Navarro, E. A., Segura, J., Portolés, M., et al. (2003). The microwave syndrome: A preliminary study in Spain. *Electromagnetic Biology and Medicine, 22*, 161–169. https://doi.org/10.1081/JBC-120024625

Santini, R., Santini, P., Le Ruz, P., Danze, J. M., & Seigne, M. (2003). Survey study of people living in the vicinity of cellular phone base stations. *Electromagnetic Biology and Medicine, 22*(1), 41–49. https://doi.org/10.1081/JBC-120020353

Sharma, A. B., Lamba, O. S., Sharma, L., & Sharma, A. (2018). Effect of mobile tower radiation on microbial diversity in soil and antibiotic resistance. In *International Conference on Power Energy, Environment and Intelligent Control (PEEIC)*. G. L. Bajaj Institute of Technology and Management, Greater Noida, India. https://ieeexplore.ieee.org/

document/8665432