

# Public Health implications of Cellphone Radiation and the rollout of 5G

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With great fanfare the minister of communications, Dr. Yoaz Hendel, announced the forthcoming rollout of 5G cellular technology in Israel last Tuesday. His speech, prepared for him, one imagines, by the senior staff of the ministry, was full of the promise of a Brave New World, where wireless serves man and machines talk to each other for our comfort. There was no mention in his speech of Public health or possible concerns towards it. This is because the premise underlying the regulation that governs the level of exposure of the public to electromagnetic radiation emanating from wireless, cellphones and their infrastructure, is based on a belief that there are only thermal effects to consider. I choose the word 'belief' with care. A belief can ignore the facts that might negate it. The regulations governing the level of exposure to low intensity RF radiation (300 Hz - 3 GHz and soon to be extended to 3 THz [1], [2]) are derived from the recommendations of the the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [3], first established in 1996 and virtually unchanged since. This opinion was adopted as regulation by the FCC in 1997 [4] However, a growing body of research negates this premise and demonstrates long term impacts on public health arise from exposure. However, industry and regulation, including the Israeli Ministry of Communications prefer the "belief".

According to the industry and private sector supported extensive database of relevant literature, provided by the EMF-Portal [5], there is currently an inventory of 31,195 publications and 6,724 summaries of individual scientific studies on the effects of electromagnetic fields. A recent research review on the health risks of Radio Frequency Radiation (RFR), involving independent verification based on 5,400 studies in the MedLine database, concludes that "the literature shows there is much valid reason for concern about potential adverse health effects from both 4G and 5G technology" and that extant research "should be viewed as extremely conservative, substantially underestimating the adverse impacts of this new technology"[6].

non-thermal biological effects of RF electromagnetic field (EMF) exposure in both experimental animals and humans, even at low levels of exposure (under  $10 \text{ W/m}^2$ ), are wide spread. Both adverse and beneficial biological effects of RF have been demonstrated throughout species. These impacts can take place at the level of cells and sub-cellular structures, including mitochondrial processes critical to cellular energy and metabolism. On the microscopic cellular level harmful effects on both the structures and functions of cells have been demonstrated to arise from mobile phone radiation; these include effects on protein expression, transcription and stability mediated by the MAPK (mitogen-activated protein kinase) cascades[7], enzyme activity [8], ovarian follicle development [9] and increased reactive oxygen species in stem cells [10]. These studies are representative of a large body of work - more than 3000 studies according to EMF Portal [24] and the [ORSAA database](#) of studies demonstrating non-thermal effects at the cellular level [11], [12]. Another noted pathway to cellular damage has been the effect of mobile EMF exposure on cell

metabolism and membranes termed Voltage-Gated Calcium Channels (VGCC) [13]. VGCCs are a class of membrane proteins responsible for the transport of calcium and other ions into and out of the cellular interior. One of the roles played by these ions is the control of reactive oxygen species (ROS) [14]. ROS can lead to the production of free radicals that have the capacity to damage DNA and to destroy essential cellular components. Further, ROS have been identified as important precursors or early biological markers for a number of chronic neurological and other diseases as well as indicators of harmful effects on reproduction [15]-[18].

On the tissue level of the organism (human being), EMF exposure has been linked to degradation of the antioxidant defence system [19]. A common argument against the relevance of this body of work is that it is mainly *in - vitro* and therefore not applicable to the “real world” situation of mobile phone use, although the “real world” use of cellphones shows that they consistently violate allowed exposure levels [20], [21]. However, recent studies of people living in proximity to mobile base stations have found evidence for ROS in their blood, which is recognized as a biochemical indicator of stress that has been associated with increased risks of cancer and other chronic diseases [22]. Another important 2015 review of existing studies on radio frequency radiation (RFR) effects was published by the National Academy of Sciences in the Ukraine, Indiana University, and the University of Campinas in Brazil [16]. Based on 93 out of 100 peer-reviewed studies, that paper concluded that low-intensity RFR is an oxidative agent for living cells with a high pathological potential. The oxidative stress induced by RFR exposure explains a range of RFR health impacts, both cancer and non-cancer illnesses. In addition to chronicling illnesses, this study outlines 6 different biological mechanisms that may explain these RFR effects in the body. To quote this source: “In conclusion, our analysis demonstrates that low-intensity radio frequency radiation (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.” [23]

Studies have also found that nonthermal cellphone radiation and laptop radiation can damage human sperm, reducing sperm quantity and quality, impair mitochondrial DNA of sperm, and appear to play a role in testicular dysgenesis and erectile dysfunction. We should note, as have other commentators, that male infertility clinics in Australia, the United States and India regularly advise men having difficulty impregnating their partners to remove all wireless devices from their bodies. This advice is consistent with studies showing that current levels of cell phone radiation can damage mitochondrial DNA of sperm,, increase reactive oxygen species (ROS), and reduce sperm quantity and quality [18], [24]

Contrary to the position of the Israel’s ministry of health [25], there exist ample proof of detrimental effects to human health in epidemiological studies. I list a few here:

- Miller et al. [26] states *“recent case-control studies from Sweden and France corroborate findings of earlier studies in providing support for making a causal connection between cell phone use and brain cancer, as well as acoustic neuroma, also called Vestibular Schwannoma. Hardell and Carlberg (2013) [27] concluded that the Bradford Hill criteria for causality have now been fulfilled. It is notable that three recent meta-analyses all confirm significant increased risk of glioma after 10 or more years of use of cell phones (Bortkiewicz et al., 2017 [28]; Prasad et al., 2017 [29]; Yang et al., 2017 [30]).”*

- Luo et al. also noted the carcinogenicity of cellphone radiation increased the incidence of thyroid cancers when genetic susceptibility was taken into account [31].
- The incidence of ROS in in-vivo studies was summarized by Dasdag and Akdag [32] and listed over 50 in-vivo studies demonstrating adverse ROS stress as a result of cellphone radiation.
- In a meta study by Belpomme et al. [33] it was shown that in case -controlled studies there is a consistent increased risk (40%) for glioma and acoustic neuroma associated with mobile phone use. These results are backed by results from animal studies that show co-carcinogenic and tumor promoting effects [34]. The conclusions are further confirmed by studies by Vornoli et al. [35] and Falcioni et al.[36].
- A significant increase in Electromagnetic Hypersensitivity has also been reported by Belpomme, based on epidemiological studies [33].
- A statistically significant increase in heart malignant schwannoma in rats subject to life time exposure to 1.8 GHz GSM transmission was reported by Soffritti and Giuliani [37] as well as by the National Toxicology Program of the NIH [38].
- Significant DNA damage, caused by exposure to real life exposure to mobile phones was found by Panagopoulos [39].

These studies represent a small portion of the epidemiological studies and in-vivo studies documenting substantiated increases in cancer rates that can be attributed to the use of and exposure to cellphone radiation.

Furthermore, 5G will eventually migrate to higher frequencies around 27 GHz. In this case the modality of coupling to tissue is enhanced by the 'standing wave effect' whereby the wavelength of the impinging signal approaches that of the layer dimensions of the tissue, leading to unacceptable increases in absorption and therefore tissue temperature. This effect is well documented, but totally ignored by industry and regulation. To mention a few articles by Christ et al. [40], [41], Klemm and Troester [42] and Betzalel et al. [43], [44], amongst others showing clear evidence that 5G frequencies can be absorbed deeply and have biological impacts. To quote from the thesis of Dr. G. Melia [45];

*"Over this range (sic 5-10 GHz range), we may expect EM absorption by the human body to be complicated, with possibly no strong relationship to any one biometric parameter (especially once non-normal and non-planar incidence are introduced), due to the effects of reflections within the body's outer layers. We should add that the eye remains exquisitely vulnerable to RF as the volume is quite small and it lacks any natural cooling mechanism."*

Given the extensive proof of detrimental effects arising from exposure to low intensity RF radiation emanating from wireless and cellphone, it is illogical not to instigate a thorough review of public health safety before blindly allowing the Ministry of Communications to push forward on the 5G rollout.

## References

- [1] "FCC Maintains Current RF Exposure Safety Standards," *Federal Communications Commission*, Dec. 04, 2019. <https://www.fcc.gov/document/fcc-maintains-current-rf-exposure-safety-standards> (accessed Apr. 11, 2020).
- [2] *Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies*. 2019.

- [3] "Wireless Devices and Health Concerns," *Federal Communications Commission*, May 26, 2011. <https://www.fcc.gov/consumers/guides/wireless-devices-and-health-concerns> (accessed May 04, 2020).
- [4] C. L. Russell, "5 G wireless telecommunications expansion: Public health and environmental implications," *Environ. Res.*, vol. 165, pp. 484-495, Aug. 2018, doi: 10.1016/j.envres.2018.01.016.
- [5] "EMF-Portal | Home." <https://www.emf-portal.org/en> (accessed May 18, 2020).
- [6] R. N. Kostoff, P. Heroux, M. Aschner, and A. Tsatsakis, "Adverse health effects of 5G mobile networking technology under real-life conditions," *Toxicol. Lett.*, vol. 323, pp. 35-40, May 2020, doi: 10.1016/j.toxlet.2020.01.020.
- [7] J. Friedman, S. Kraus, Y. Hauptman, Y. Schiff, and R. Seger, "Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies," *Biochem. J.*, vol. 405, no. 3, pp. 559-568, Aug. 2007, doi: 10.1042/BJ20061653.
- [8] A. A. Warille *et al.*, "Skeptical approaches concerning the effect of exposure to electromagnetic fields on brain hormones and enzyme activities," *J. Microsc. Ultrastruct.*, vol. 5, no. 4, pp. 177-184, Dec. 2017, doi: 10.1016/j.jmau.2017.09.002.
- [9] F. Azimipour, S. Zavareh, and T. Lashkarbolouki, "The Effect of Radiation Emitted by Cell Phone on The Gelatinolytic Activity of Matrix Metalloproteinase-2 and -9 of Mouse Pre-Antral Follicles during In Vitro Culture," *Cell J.*, vol. 22, no. 1, pp. 1-8, Apr. 2020, doi: 10.22074/cellj.2020.6548.
- [10] M. Durdik *et al.*, "Microwaves from mobile phone induce reactive oxygen species but not DNA damage, preleukemic fusion genes and apoptosis in hematopoietic stem/progenitor cells," *Sci. Rep.*, vol. 9, no. 1, p. 16182, Nov. 2019, doi: 10.1038/s41598-019-52389-x.
- [11] "ORSAA Database," *OCEANIA RADIOFREQUENCYSCIENTIFIC ADVISORY ASSOCIATION (ORSAA)*. <https://www.orsaa.org/orsaa-database.html> (accessed May 18, 2020).
- [12] V. Leach, S. Weller, and M. Redmayne, "A novel database of bio-effects from non-ionizing radiation," *Rev. Environ. Health*, vol. 33, no. 3, pp. 273-280, Sep. 2018, doi: 10.1515/reveh-2018-0017.
- [13] M. L. Pall, "Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects," *J. Cell. Mol. Med.*, vol. 17, no. 8, pp. 958-965, Aug. 2013, doi: 10.1111/jcmm.12088.
- [14] A. Görlach, K. Bertram, S. Hudecova, and O. Krizanova, "Calcium and ROS: A mutual interplay," *Redox Biol.*, vol. 6, pp. 260-271, Dec. 2015, doi: 10.1016/j.redox.2015.08.010.
- [15] A. A. Alfadda and R. M. Sallam, "Reactive Oxygen Species in Health and Disease," *Journal of Biomedicine and Biotechnology*, 2012. <https://www.hindawi.com/journals/bmri/2012/936486/> (accessed May 06, 2020).
- [16] I. Yakymenko, O. Tsybulin, E. Sidorik, D. Henshel, O. Kyrylenko, and S. Kyrylenko, "Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation," *Electromagn. Biol. Med.*, vol. 35, no. 2, pp. 186-202, 2016, doi: 10.3109/15368378.2015.1043557.
- [17] I. Yakymenko, E. Sidorik, D. Henshel, and S. Kyrylenko, "Low intensity radiofrequency radiation: a new oxidant for living cells," *Oxid. Antioxid. Med. Sci.*, vol. 3, no. 1, pp. 1-3, 2014.
- [18] M. Sepehrimanesh and D. L. Davis, "Proteomic impacts of electromagnetic fields on the male reproductive system," *Comp. Clin. Pathol.*, vol. 26, no. 2, pp. 309-313, Mar. 2017, doi: 10.1007/s00580-016-2342-x.
- [19] E. G. Kivrak, K. K. Yurt, A. A. Kaplan, I. Alkan, and G. Altun, "Effects of electromagnetic fields exposure on the antioxidant defense system," *J. Microsc. Ultrastruct.*, vol. 5, no. 4, pp. 167-176, Dec. 2017, doi: 10.1016/j.jmau.2017.07.003.

- [20] O. P. Gandhi, "Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body," *IEEE Access*, vol. 7, pp. 47050-47052, 2019, doi: 10.1109/ACCESS.2019.2906017.
- [21] "OPINION of the French Agency for Food, Environmental and Occupational Health & Safety on the possible health effects associated with high specific absorption rate values from mobile telephones carried close to the body," ANSES, Opinion 2017-SA-0229, Jul. 2019. [Online]. Available: <https://www.anses.fr/en/system/files/AP2017SA0229EN.pdf>.
- [22] Zothansiyama, M. Zosangzuali, M. Lalramdinpuii, and G. C. Jagetia, "Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations," *Electromagn. Biol. Med.*, vol. 36, no. 3, pp. 295-305, 2017, doi: 10.1080/15368378.2017.1350584.
- [23] L. Slesin, "Time to Clean House," *Microwave News*, Apr. 07, 2020. <https://microwavenews.com/news-center/time-clean-house> (accessed May 20, 2020).
- [24] N. R. Desai, K. K. Kesari, and A. Agarwal, "Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system," *Reprod. Biol. Endocrinol.*, vol. 7, no. 1, p. 114, 2009, doi: 10.1186/1477-7827-7-114.
- [25] "סלולרית קרינה", סלולרית קרינה. [https://www.health.gov.il/Subjects/radiation/cell\\_phone/Pages/default.aspx](https://www.health.gov.il/Subjects/radiation/cell_phone/Pages/default.aspx) (accessed Aug. 26, 2020).
- [26] A. B. Miller, L. L. Morgan, I. Udasin, and D. L. Davis, "Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102)," *Environ. Res.*, vol. 167, pp. 673-683, Nov. 2018, doi: 10.1016/j.envres.2018.06.043.
- [27] L. Hardell and M. Carlberg, "Using the Hill viewpoints from 1965 for evaluating strengths of evidence of the risk for brain tumors associated with use of mobile and cordless phones," *Rev. Environ. Health*, vol. 28, no. 2-3, pp. 97-106, 2013, doi: 10.1515/reveh-2013-0006.
- [28] A. Bortkiewicz, E. Gadzicka, and W. Szymczak, "Mobile phone use and risk for intracranial tumors and salivary gland tumors - A meta-analysis," *Int. J. Occup. Med. Environ. Health*, vol. 30, no. 1, pp. 27-43, Feb. 2017, doi: 10.13075/ijomeh.1896.00802.
- [29] M. Prasad, P. Kathuria, P. Nair, A. Kumar, and K. Prasad, "Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes," *Neurol. Sci.*, vol. 38, no. 5, pp. 797-810, May 2017, doi: 10.1007/s10072-017-2850-8.
- [30] M. Yang *et al.*, "Mobile phone use and glioma risk: A systematic review and meta-analysis," *PLOS ONE*, vol. 12, no. 5, p. e0175136, May 2017, doi: 10.1371/journal.pone.0175136.
- [31] J. Luo *et al.*, "Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut," *Environ. Res.*, vol. 182, p. 109013, Mar. 2020, doi: 10.1016/j.envres.2019.109013.
- [32] S. Dasdag and M. Z. Akdag, "The link between radiofrequencies emitted from wireless technologies and oxidative stress," *J. Chem. Neuroanat.*, vol. 75, no. Pt B, pp. 85-93, 2016, doi: 10.1016/j.jchemneu.2015.09.001.
- [33] D. Belpomme, L. Hardell, I. Belyaev, E. Burgio, and D. O. Carpenter, "Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective," *Environ. Pollut.*, vol. 242, pp. 643-658, Nov. 2018, doi: 10.1016/j.envpol.2018.07.019.
- [34] T. Tillmann *et al.*, "Indication of cocarcinogenic potential of chronic UMTS-modulated radiofrequency exposure in an ethylnitrosourea mouse model," *Int. J.*

*Radiat. Biol.*, vol. 86, no. 7, pp. 529–541, Jul. 2010, doi: 10.3109/09553001003734501.

- [35] A. Vornoli, L. Falcioni, D. Mandrioli, L. Bua, and F. Belpoggi, “The Contribution of In Vivo Mammalian Studies to the Knowledge of Adverse Effects of Radiofrequency Radiation on Human Health,” *Int. J. Environ. Res. Public Health*, vol. 16, no. 18, Art. no. 18, Jan. 2019, doi: 10.3390/ijerph16183379.
- [36] L. Falcioni *et al.*, “Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission,” *Environ. Res.*, vol. 165, pp. 496–503, Aug. 2018, doi: 10.1016/j.envres.2018.01.037.
- [37] M. Soffritti and L. Giuliani, “The carcinogenic potential of non-ionizing radiations: The cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation,” *Basic Clin. Pharmacol. Toxicol.*, vol. 125, no. S3, pp. 58–69, 2019, doi: 10.1111/bcpt.13215.
- [38] S. L. Smith-Roe *et al.*, “Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure,” *Environ. Mol. Mutagen.*, vol. 61, no. 2, pp. 276–290, 2020, doi: 10.1002/em.22343.
- [39] D. J. Panagopoulos, “Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields,” *Mutat. Res. Mutat. Res.*, vol. 781, pp. 53–62, Jul. 2019, doi: 10.1016/j.mrrev.2019.03.003.
- [40] A. Christ, T. Samaras, E. Neufeld, A. Klingenböck, and N. Kuster, “SAR distribution in human beings when using body-worn RF transmitters,” *Radiat. Prot. Dosimetry*, vol. 124, no. 1, pp. 6–14, 2007, doi: 10.1093/rpd/ncm377.
- [41] A. Christ, T. Samaras, A. Klingenböck, and N. Kuster, “Characterization of the electromagnetic near-field absorption in layered biological tissue in the frequency range from 30 MHz to 6,000 MHz,” *Phys. Med. Biol.*, vol. 51, no. 19, pp. 4951–4965, Oct. 2006, doi: 10.1088/0031-9155/51/19/014.
- [42] M. Klemm and G. Troester, “EM ENERGY ABSORPTION IN THE HUMAN BODY TISSUES DUE TO UWB ANTENNAS,” *Prog. Electromagn. Res.*, vol. 62, pp. 261–280, 2006, doi: 10.2528/PIER06040601.
- [43] N. Betzalel, P. Ben Ishai, and Y. Feldman, “The human skin as a sub-THz receiver – Does 5G pose a danger to it or not?,” *Environ. Res.*, vol. 163, pp. 208–216, May 2018, doi: 10.1016/j.envres.2018.01.032.
- [44] N. Betzalel, Y. Feldman, and P. Ben Ishai, “The Modeling of the Absorbance of Sub-THz Radiation by Human Skin,” *IEEE Trans. Terahertz Sci. Technol.*, vol. 7, no. 5, pp. 521–528, Sep. 2017, doi: 10.1109/TTHZ.2017.2736345.
- [45] G. Melia, “Electromagnetic Absorption by the Human Body from 1 - 15 GHz,” PhD., University of York, York, 2013.