

Cancer Association of South Africa (CANSA)



Fact Sheet and Position Statement on Exposure to Radiofrequency Electromagnetic Fields

Introduction

On 31 May 2011, The International Agency for Research on Cancer (IARC) as part of The World Health Organization (WHO), resolved to classify radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use.



[Picture Credit: Electromagnetic Fields]

Over the last few years, there has been mounting concern about the possibility of adverse health effects resulting from exposure to radiofrequency electromagnetic fields, such as those emitted by wireless communication devices. The number of mobile phone subscriptions is estimated at 5 billion globally.

Cell Phones in Use in South Africa

Today about 20 to 22 million people in South Africa use a smartphone, which accounts for about one third of the country's population. The overall number of mobile connections is much higher though with more than 90 million, as feature phones are still popular and widely used in the country.

The number of cell phones in South Africa surpasses the number of people living here. On the average, every one of South Africans (babies included) has 1,5 (or so) cell phones. Those are the averages; in real life, some have several handsets, some none, though the latter group is diminishing daily.

South Africa has one of the largest telecommunications markets on the continent. The main cellular providers are Vodacom, MTN, Telkom Mobile, Cell C, and virtual network operator Virgin Mobile.

According to forecasts, there will be 26,3 million smart phones in use in South Africa by 2023.

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June 2020

Besides calling and talking to people, South Africans use their cell phones to send text messages, access social media sites, chat with a group of friends on one of instant messaging services, and browse the internet.

Due to high cost of personal computers and poor coverage with fixed communication lines, cell phones have been touted, in South Africa and elsewhere in the developing world, as a basic necessity. They are seen as the tool to bridge the digital divide between the rich and the poor and become an enabler of economic development.

Mobile phones are the dominant communication technology among low-income users and informal businesses. South Africans internet users spend a third more time online than Americans - and almost double than Germans.

Social media marketing platform Hootsuite's Global State of Digital in 2019 report found that the typical South African internet user spent 8 hours 23 minutes on the internet per day, compared to 7 hours 2 minutes in Singapore and 6 hours 38 minutes in the US. Most of internet use in South Africa occurs via mobile connection.

According to the World Health Organization:

A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.

- Tissue heating is the principal mechanism of interaction between radiofrequency energy and the human body. At the frequencies used by mobile phones, most of the energy is absorbed by the skin and other superficial tissues, resulting in negligible temperature rise in the brain or any other organs of the body.
- To date, research does not suggest any consistent evidence of adverse health effects from exposure to radiofrequency field at levels below those that cause tissue heating.
- Research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or "electromagnetic hypersensitivity".
- Results of animal studies consistently show no increased cancer risk for long-term exposure to radiofrequency fields.
- The International Agency for Cancer Research (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to human (Group 2B).
- The increasing use of mobile phones and the lack of data for mobile phone use over time periods longer than 15 years warrant further research of mobile phone use and brain cancer risk.

International Agency for Research on Cancer Classification of Carcinogens

The International Agency for Research on Cancer (IARC) classifies carcinogens as follows:

Group 1

The agent is carcinogenic to humans.

This category is used when there is sufficient evidence of carcinogenicity in humans. Exceptionally, an agent may be placed in this category when evidence of carcinogenicity in humans is less than sufficient but there is sufficient evidence of carcinogenicity in experimental animals and strong evidence in exposed humans that the agent acts through a relevant mechanism of carcinogenicity.

Group 2

This category includes agents for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost sufficient, as well as those for which, at the other extreme, there are no human data but for which there is evidence of carcinogenicity in experimental animals. Agents are assigned to either Group 2A (probably carcinogenic to humans) or Group 2B (possibly carcinogenic to humans) on the basis of epidemiological and experimental evidence of carcinogenicity and mechanistic and other relevant data. The terms probably carcinogenic and possibly carcinogenic have no quantitative significance and are used simply as descriptors of different levels of evidence of human carcinogenicity, with probably carcinogenic signifying a higher level of evidence than possibly carcinogenic.

Group 2A

The agent is probably carcinogenic to humans.

This category is used when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. In some cases, an agent may be classified in this category when there is inadequate evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals and strong evidence that the carcinogenesis is mediated by a mechanism that also operates in humans. Exceptionally, an agent may be classified in this category solely on the basis of limited evidence of carcinogenicity in humans. An agent may be assigned to this category if it clearly belongs, based on mechanistic considerations, to a class of agents for which one or more members have been classified in Group 1 or Group 2A.

Group 2B

The agent is possibly carcinogenic to humans.

This category is used for agents for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. It may also be used when there is inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals. In some instances, an agent for which there is inadequate evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals together with supporting evidence from mechanistic and other relevant data may be placed in this group. An agent may be classified in this category solely on the basis of strong evidence from mechanistic and other relevant data.

Group 3

The agent is not classifiable as to its carcinogenicity to humans.

This category is used most commonly for agents for which the evidence of carcinogenicity is inadequate in humans and inadequate or limited in experimental animals. Exceptionally, agents for which the evidence of carcinogenicity is inadequate in humans but sufficient in experimental animals may be placed in this category when there is strong evidence that the mechanism of carcinogenicity

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in experimental animals does not operate in humans. Agents that do not fall into any other group are also placed in this category. An evaluation in Group 3 is not a determination of non-carcinogenicity or overall safety. It often means that further research is needed, especially when exposures are widespread or the cancer data are consistent with differing interpretations.

Group 4

The agent is probably not carcinogenic to humans.

This category is used for agents for which there is evidence suggesting lack of carcinogenicity in humans and in experimental animals. In some instances, agents for which there is inadequate evidence of carcinogenicity in humans but evidence suggesting lack of carcinogenicity in experimental animals, consistently and strongly supported by a broad range of mechanistic and other relevant data, may be classified in this group.

Electromagnetic Fields (EMF) and Public Health

Mobile telephony is commonplace around the world. This wireless technology relies upon an extensive network of fixed antennas, or base stations, relaying information with radiofrequency (RF) signals. Over 1.4 million base stations exist worldwide and the number is increasing significantly with the introduction of fourth generation technology. As the number of base stations and local wireless networks increases, so does the RF exposure of the population.

- According to the World Health Organization (2006), there has been concern about possible health consequences from exposure to the RF fields produced by wireless technologies.
- The common concern about base station and local wireless network antennas relates to the possible long-term health effects that whole-body exposure to the RF signals may have. To date, the only health effect from RF fields identified in scientific reviews has been related an increase in body temperature ($> 1^{\circ}\text{C}$) from exposure at very high field intensity found only in certain industrial facilities.
- The levels of RF exposure from base stations and wireless networks are so low that the temperature increases are insignificant and do not affect human health.
- The strength of RF fields is greatest at its source, and diminishes quickly with distance. Recent surveys have indicated that RF exposure from base stations and wireless technologies in publicly accessible areas (including schools and hospitals) are normally thousands of times below international standards.
- Media or anecdotal reports of cancer clusters around mobile phone base stations have heightened public concern. It should be noted that geographically, cancers are unevenly distributed among any population. Given the widespread presence of base stations in the environment, it is expected that possible cancer clusters will occur near base stations merely by chance.
- From all evidence accumulated so far, no adverse short- or long-term health effects have been shown to occur from the RF signals produced by base stations. Since wireless networks produce generally lower RF signals than base stations, no adverse health effects are expected from exposure to them.
- Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.

Miligi, L. 2019.

“This paper aims to present useful elements for framing the issue of exposure to radio frequencies (RFs), in particular those related to telecommunications, and the possible effects on health also in the light of the rapid evolution of technologies (the advent of 5G). New developments in the field oblige us to reflect on the possible implications in terms of public health. Here, we have preferred to take stock and not to demand a systematic review. The development of telecommunications is creating great interest in all sectors for the possibility of new applications, but is also increasing concern for the effects on health not yet fully known, to the point that there is a growing mobilization against the introduction of 5G both at national and at international level. Epidemiological studies and meta-analyses on the relationship between cancer and RFs, particularly those on mobile phones, still identify areas of uncertainty that need to be investigated, and studies on non-cancer effects are growing in number, suggesting the possibility of new risks. The relative scenarios that will open with the 5G trial are likely to change the overall exposure level of the population as a result of major changes in the network architecture. Therefore, it is important to adopt a strongly precautionary approach. Given the strong concerns of the population, the competent institutions should implement information and awareness programmes through adequate risk communication.”

Narayanan, S.N., Jetti, R., Kesari, K.K., Kumar, R.S., Nayak, S.B. & Bhat, P.G. 2019. “The primary objective of mobile phone technology is to achieve communication with any person at any place and time. In the modern era, it is impossible to ignore the usefulness of mobile phone technology in cases of emergency as many lives have been saved. However, the biological effects they may have on humans and other animals have been largely ignored and not been evaluated comprehensively. One of the reasons for this is the speedy uncontrollable growth of this technology which has surpassed our researching ability. Initiated with the first generation, the mobile telephony currently reaches to its fifth generation without being screened extensively for any biological effects that they may have on humans or on other animals. Mounting evidences suggest possible non-thermal biological effects of radiofrequency electromagnetic radiation (RF-EMR) on brain and behavior. Behavioral studies have particularly concentrated on the effects of RF-EMR on learning, memory, anxiety, and locomotion. The literature analysis on behavioral effects of RF-EMR demonstrates complex picture with conflicting observations. Nonetheless, numerous reports suggest a possible behavioral effect of RF-EMR. The scientific findings about this issue are presented in the current review. The possible neural and molecular mechanisms for the behavioral effects have been proposed in the light of available evidences from the literature.”

Loughran, S.P., Verrender, A., Dalecki, A., Burdon, C.A., Tagami, K., Park, J., Taylor, N.A.S. & Croft, R.J. 2019.

“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)). Consistent with previous research, alpha EEG activity increased during the High exposure condition compared to the Sham condition. As a measure of thermoregulatory activation, finger temperature

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was found to be higher during both exposure conditions compared to the Sham condition, indicating for the first time that the effect on the EEG is accompanied by thermoregulatory changes and suggesting that the effect of RF-EMF on the EEG is consistent with a thermal mechanism.”

Zarei, S., Vahab, M., Oryadi-Zanjani, M.M., Alighanbari, N. & Mortazavi, S.M. 2019.

BACKGROUND: Rapid advances in technology, especially in the field of telecommunication, have led to extraordinary levels of mothers' exposures to radiofrequency electromagnetic fields (RF-EMFs) prior to or during pregnancy.

OBJECTIVE: The main goal of this study was to answer this question whether exposure of women to common sources of RF-EMFs either prior to or during pregnancy is related to speech problems in the offspring.

MATERIALS AND METHODS: In this study, mothers of 110 three-to-seven-year-old children with speech problems and 75 healthy children (control group) were interviewed. These mothers were asked whether they had exposure to different sources of EMFs such as mobile phones, mobile base stations, Wi-Fi, cordless phones, laptops and power lines. Chi square test was used to analyze the differences observed between the control and exposed groups.

RESULTS: Statistically significant associations were found between the use of cordless phone and offspring speech problems for both before pregnancy and during pregnancy maternal exposures ($P=0.005$ and $P=0.014$, respectively). However, due to high rate of mobile phone use in both groups, this study failed to show any link between mobile phone use and speech problems in offspring. Furthermore, significant associations were observed between living in the vicinity of power lines and speech problems again for both before pregnancy and during pregnancy maternal exposures ($P=0.003$ and $P=0.002$, respectively). However, exposure to other sources of non-ionizing radiation was not linked to speech problems. Moreover, exposure to ionizing radiation (e.g. radiography before and during pregnancy) was not associated with the occurrence of speech problems.

CONCLUSION: Although this study has some limitations, it leads us to this conclusion that higher-than-ever levels of maternal exposure to electromagnetic fields could be linked to offspring speech problems.

The Position of the Cancer Association of South Africa (CANSA) on Radiofrequency Electromagnetic Fields

CANSA subscribes to cell phone radiation being classified as a Group 2B carcinogen until such time when consensus at IARC (International Agency for Research on Cancer) is reached to change the classification.

- Furthermore, in uncertain situations, CANSA advocates the Precautionary Principle which simply means to rather err on the side of caution until scientific clarity is reached. The precautionary principle states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus, that the action or policy is not harmful, the burden of proof that it is *not* harmful falls on those taking an action.
- CANSA stands for minimal use of cell phones as described below.
- CANSA acknowledges the existence of several very recent scientific studies that indicate that frequent exposure to cell phone radiation over periods longer than 10 years possibly correlate with an increased

risk for certain brain cancers like gliomas and meningiomas as well as multifocal breast cancer in young women with prolonged contact between their breasts and their cell phones.

Consequently, CANSA proposes that, in terms of the precautionary principle, exposure to cell phone radiation be kept to a minimum by:

- Limiting the number and duration of calls
- Texting rather than making calls
- Switching the sides of the head when a call is long – one should, however, avoid long conversations
- Making use of hands-free kits or speaker phone mode to keep the phone a distance from the head
- Instructing children and teenagers to limit calls to emergencies only as they are more vulnerable to electro-magnetic radiation because of the thickness of their skulls and their brains are still developing
- Not sleeping with one's cell phone close to one's bed or under one's pillow
- Women not to keep their cell phones in their brassiere
- Men not to carry their cell phones in the pockets of their pants (close to their testicles)

CANSA Further believes that:

Additional updated data should be gathered on exposures to cordless phones, other wireless transmitting devices (WTDs), mobile phone base stations and Wi-Fi routers as well as the, to be introduced, 5G network to evaluate their possible impact on public health.

CANSA, therefore, advises that the “as low as reasonably achievable” (ALARA) principle be adopted for uses of this technology until sufficient evidence shows that exposure from these devices is safe.

Electromagnetic Hypersensitivity

For some time a number of individuals have reported a variety of health problems that they relate to exposure to Electromagnetic Field (EMF) exposure. While some individuals report mild symptoms and react by avoiding the fields as best they can, others are so severely affected that they cease work and change their entire lifestyle. This reputed sensitivity to EMF has been generally termed “electromagnetic hypersensitivity” or EHS.

EHS is characterised by a variety of non-specific symptoms, which afflicted individuals attribute to exposure to EMF. The symptoms most commonly experienced include dermatological symptoms (redness, tingling, and burning sensations) as well as neurasthenic and vegetative symptoms (fatigue, tiredness, concentration difficulties, dizziness, nausea, heart palpitation, and digestive disturbances). The collection of symptoms is not part of any recognised syndrome.

The symptoms of EHS are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.

For EHS individuals with long lasting symptoms and severe handicaps, therapy should be directed principally at reducing symptoms and functional handicaps. This should be done in close co-operation

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with a qualified medical specialist (to address the medical and psychological aspects of the symptoms) and a hygienist (to identify and, if necessary, control factors in the environment that are known to have adverse health effects of relevance to the patient).
World Health Organization, 2005).

For further reading, please access the following World Health Organization (WHO) publications:

- Backgrounder. 2006. Electromagnetic fields and public health: Base stations and wireless technologies. Backgrounder, May 2006.
- Backgrounder. 2007. Electromagnetic fields and public health: Exposure to extremely low frequency fields. Backgrounder, June 2007.
- Backgrounder. 2006. Electromagnetic fields and public health: Static electric and magnetic fields. Backgrounder, March 2006.
- Backgrounder. 2005. Electromagnetic fields and public health: Electromagnetic hypersensitivity. Backgrounder, December, 2005.

Panaglopoulos, D.J. & Chrousos, G.P. 2019.

“Human exposure to man-made Electromagnetic Fields (EMFs) has increased to unprecedented levels, accompanied by increase in various health problems. A connection has been indicated by an increasing number of studies. Symptoms characterized as Electro-hyper-sensitivity (EHS) are frequently reported especially in urban environments. Lately, people are advised by private companies and individuals to protect themselves from man-made EMFs by metal shielding through various products, for which there are reasonable concerns about their protective efficacy and safety. Indeed, any metal shielding practice, even when correctly applied, attenuates not only man-made totally polarized EMFs accused for the health problems, but also the natural non-polarized EMFs responsible for the biological rhythmicity and well-being of all animals. Strong evidence on this was provided by pioneering experiments in the 1960's and 1970's, with volunteers staying in a shielded underground apartment. We analyze the physical principles of EMF-shielding, the importance of natural atmospheric EMFs, and examine available shielding methods and suggested products, relying on science-based evidence. We suggest that an avoidance strategy is safer than shielding, and provide specific protection tips. We do not reject shielding in general, but describe ways to keep it at a minimum by intermittent use, as this is theoretically safer than extensive permanent shielding. We explain why metallic patches or "chips" or minerals claimed by sellers to be protective, do not seem to make sense and might even be risky. We finally suggest urgent research on the safety and efficacy of shielding methods combined with use of generators emitting weak pulses of similar frequency, intensity, and waveform with the natural atmospheric resonances.”

How the Source of Funding May Influence Research Results

There are some scientists who believe that the source of funding may have an effect on the conclusions reached by some researchers.

Carpenter, D.O. 2019.

“While there has been evidence indicating that excessive exposure to magnetic fields from 50 to 60 Hz electricity increases risk of cancer, many argue that the evidence is inconsistent and inconclusive. This is particularly the case regarding magnetic field exposure and childhood leukemia. A major goal of this study is to examine how source of funding influences the reported results and conclusions.

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Several meta-analyses dating from about 2000 all report significant associations between exposure and risk of leukemia. By examining subsequent reports on childhood leukemia it is clear that almost all government or independent studies find either a statistically significant association between magnetic field exposure and childhood leukemia, or an elevated risk of at least OR = 1.5, while almost all industry supported studies fail to find any significant or even suggestive association. A secondary goal of this report is to examine the level of evidence for exposure and elevated risk of various adult cancers. Based on pooled or meta-analyses as well as subsequent peer-reviewed studies there is strong evidence that excessive exposure to magnetic fields increases risk of adult leukemia, male and female breast cancer and brain cancer. There is less convincing but suggestive evidence for elevations in several other cancer types. There is less clear evidence for bias based on source of funding in the adult cancer studies. There is also some evidence that both paternal and maternal prenatal exposure to magnetic fields results in an increased risk of leukemia and brain cancer in offspring. When one allows for bias reflected in source of funding, the evidence that magnetic fields increase risk of cancer is neither inconsistent nor inconclusive. Furthermore adults are also at risk, not just children, and there is strong evidence for cancers in addition to leukemia, particularly brain and breast cancer."

Medical Disclaimer

This Fact Sheet is intended to provide general information only and, as such, should not be considered as a substitute for advice, medically or otherwise, covering any specific situation. Users should seek appropriate advice before taking or refraining from taking any action in reliance on any information contained in this Fact Sheet. So far as permissible by law, the Cancer Association of South Africa (CANSA) does not accept any liability to any person (or his/her dependants/estate/heirs) relating to the use of any information contained in this Fact Sheet.

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Sources and References Consulted or Utilised

African Mobile Observatory 2011

<http://www.gsma.com>

Carpenter, D.O. 2019. Extremely low frequency electromagnetic fields and cancer: how source of funding affects results. *Environ Res.* 2019 Nov;178:108688. doi: 10.1016/j.envres.2019.108688. Epub 2019 Aug 24.

Electromagnetic Fields

<http://www.cnet.com/news/who-cell-phones-may-cause-cancer/>

Eltiti, S., Wallace, D., Russo, R. & Fox, E. 2018. Symptom Presentation in Idiopathic Environmental Intolerance With Attribution to Electromagnetic Fields: Evidence for a Nocebo Effect Based on Data Re-Analyzed From Two Previous Provocation Studies. *Front Psychol.* 2018 Aug 28;9:1563. doi: 10.3389/fpsyg.2018.01563. eCollection 2018.

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IARC

http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

IARC Monographs

<http://monographs.iarc.fr/ENG/Preamble/CurrentPreamble.pdf>

<http://monographs.iarc.fr/ENG/Classification/>

Loughran, S.P., Verrender, A., Dalecki, A., Burdon, C.A., Tagami, K., Park, J., Taylor, N.A.S. & Croft, R.J. 2019. Radiofrequency electromagnetic field exposure and the resting EEG: exploring the Thermal Mechanism Hypothesis. *Int J Environ Res Public Health*. 2019 Apr 28;16(9). pii: E1505. doi: 10.3390/ijerph16091505.

Miligi, L. 2019. Radiofrequency electromagnetic fields, mobile phones, and health effects: where are we now? *Epidemiol Prev*. Sep-Dec 2019;43(5-6):374-379. doi: 10.19191/EP19.5-6.P374.107.

Narayanan, S.N., Jetty, R., Kesari, K.K., Kumar, R.S., Nayak, S.B. & Bhat, P.G. 2019. Radiofrequency electromagnetic radiation-induced behavioural changes and their possible basis. *Environ Sci Pollut Res Int*. 2019 Oct;26(30):30693-30710. doi: 10.1007/s11356-019-06278-5. Epub 2019.

Panaglopoulos, D.J. & Chrousos, G.P. 2019. Shielding methods and products against manmade electromagnetic fields: protection versus risk. *Sci Total Environ*. 2019 Jun 1;667:255-262. doi: 10.1016/j.scitotenv.2019.02.344. Epub 2019 Feb 23.

South Africa Web

<http://www.southafricaweb.co.za/article/south-africans-and-their-cell-phones>

Statista

<https://www.statista.com/statistics/488376/forecast-of-smartphone-users-in-south-africa/>

Terzi, M., Ozberk, B., Deniz, O.G. & Kaplan, S. 2016. The role of electromagnetic fields in neurological disorders. *J Chem Neuroanat*. 2016 Sep;75(Pt B):77-84. doi: 10.1016/j.jchemneu.2016.04.003. Epub 2016 Apr 12.

Wikipedia

https://en.wikipedia.org/wiki/Precautionary_principle

https://en.wikipedia.org/wiki/List_of_countries_by_number_of_mobile_phones_in_use

World Health Organization

Media Centre. 2014. Electromagnetic fields and public health: mobile phones. Fact Sheet No 193, reviewed October 2014. Background. 2006. Electromagnetic fields and public health: Base stations and wireless technologies. Background, May 2006.

Background. 2007. Electromagnetic fields and public health: Exposure to extremely low frequency fields. Background, June 2007.

Background. 2006. Electromagnetic fields and public health: Static electric and magnetic fields. Background, March 2006.

Background. 2005. Electromagnetic fields and public health: Electromagnetic hypersensitivity. Background, December, 2005.

Zarei, S., Vahab, M., Oryadi-Zanjani, M.M., Alighanbari, N. & Mortazavi, S.M. 2019. Mother's exposure to electromagnetic fields before and during pregnancy is associated with risk of speech problems in offspring. *J Biomed Phys Eng*. 2019 Feb 1;9(1):61-68. eCollection 2019 Feb.