



What forms the body of scientific research and what about links to diseases?

There are two main types of research that make up the body of scientific knowledge around exposure to electric and magnetic fields (EMF): epidemiological studies and laboratory studies. These studies provide pieces of the puzzle but no single study can paint the whole picture. Therefore, weight-of-evidence reviews are often used to ensure that studies of better quality are given more weight and to ensure a comprehensive assessment of both epidemiologic and laboratory studies.

It should be noted that there are a small number of primarily epidemiologic studies that have statistically linked extremely low frequency (ELF) magnetic field exposure to increased risk factors for childhood leukemia and, to a lesser extent, other chronic illnesses. On the basis of these limited studies, ELF magnetic fields were classified as “possibly carcinogenic to humans” by the World Health Organization’s (WHO’s) International Agency for Research on Cancer (IARC) in 2001.¹ This category includes coffee and pickled vegetables. It is the lowest classification category in the index other than ‘not carcinogenic’.

¹ IARC-WHO, “Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields” International Agency for Research on Cancer – World Health Organization <<http://monographs.iarc.fr/ENG/Monographs/vol80/mono80.pdf>> (2001/2002, Accessed: January 2016).





Moreover, in 2007 the WHO cautioned against placing too much emphasis on this classification, saying:

“This classification was based on pooled analyses of epidemiological studies (and) is weakened by methodological problems, such as potential selection bias. In addition, there are no accepted biophysical mechanisms that would suggest that low-level exposures are involved in cancer development. Thus, if there were any effects from exposures to these low-level fields, it would have to be through a biological mechanism that is as yet unknown. Additionally, animal studies have been largely negative. Thus, on balance, the evidence related to childhood leukemia is not strong enough to be considered causal.”²

The vast majority of weight-of-evidence reviews and scientific literature reviews since 2007 have confirmed that there is no sound basis to determine a causal relationship between ELF magnetic field exposure and childhood leukemia. In 2012 Health Canada confirmed this fact stating that “the vast majority of scientific research to date does not support a link between ELF magnetic field exposures and human cancers.”³ For more information please see the weight-of-evidence and scientific literature reviews section below.

Epidemiological studies

In epidemiological studies, researchers try to establish whether there is a statistical association (mathematical link) between selected groups of people with certain types of exposure and certain kinds of disease.

The stronger the statistical association, the greater the probability that the particular exposure may cause the disease. However, epidemiological studies alone cannot establish a cause and effect relationship, as it cannot rule out other possible causes. Some epidemiological studies have suggested a possible statistical association between exposure to higher levels of magnetic fields and some diseases, including childhood leukemia. However, laboratory studies have not identified causal links between these diseases and EMF exposure.

² WHO, “Electromagnetic fields and public health: Exposure to extremely low frequency fields” [World Health Organization](http://www.who.int/peh-emf/publications/facts/fs322/en/) <<http://www.who.int/peh-emf/publications/facts/fs322/en/>> (June 2007, Accessed January 2016).

³ Health Canada (2012), 2.





Laboratory studies

Laboratory studies involve exposing cells, tissues, humans and/or animals to **electric and magnetic fields (EMF)** under controlled conditions. These studies allow researchers to closely control EMF exposure levels and to provide detailed information about any small scale biological changes that exposure to EMF may cause.

Laboratory studies have not confirmed that EMF are causally related to any significant health effects. This is one of the primary reasons why scientific literature reviews and weight-of-evidence reviews have not found there to be any established causation between chronic illnesses and **extremely low frequency (ELF)** magnetic or radio frequency (RF) magnetic field exposures.

The following is a closer look at the various weight-of-evidence and scientific literature review findings that have been released by governments, international organizations and related bodies in recent years. The vast majority of these findings support the Canadian Electricity Association's (CEA) conclusion that: Scientific evidence to date has not established adverse health effects resulting from exposure to power-frequency EMF, or smart meter RF EMF, at levels normally encountered in homes, schools and offices.





Recent ELF and RF scientific literature reviews and weight-of-evidence studies

Study Name	Institution	Date	ELF/RF	Key Findings
Fact Sheet: Electricity and Health	Australian Radiation Protection and Nuclear Safety Agency	October 2015	ELF	"The scientific evidence does not establish that exposure to ELF EMF found around the home, the office or near powerlines and other electrical sources is a hazard to human health." (pg. 2)
European Code against Cancer 4th Edition: Ionising and non-ionising radiation and cancer	International Agency for Research on Cancer - World Health Organization	June 2015	ELF and RF	<ul style="list-style-type: none"> "non-ionising radiation (...) is not an established cause of cancer, and is therefore not addressed by a recommendation of the Code." (pg. S94)
Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz	Health Canada	June 2015	RF	<ul style="list-style-type: none"> "the only established adverse health effects associated with RF field exposures in the frequency range from 3 kHz to 300 GHz relate to the occurrence of tissue heating and nerve stimulation (NS) from short-term (acute) exposures. At present, there is no scientific basis for the occurrence of acute, chronic and/or cumulative adverse health risks from RF field exposure at levels below the limits outlined" (pg. 2)





<p>Interagency Committee on the Health Effects of Non-ionising Fields: Report to Ministers 2015</p>	<p>New Zealand Ministry of Health</p>	<p>April 2015</p>	<p>ELF and RF</p>	<ul style="list-style-type: none"> • Epidemiological studies indicating a link between ELF and childhood leukemia are not supported by laboratory research. (pg. 10) • "there are still no clear indications of health effects caused by exposures that comply with the limits in the New Zealand RF field exposure standard" (pg. 18)
<p>Recent Research on EMF and Health Risk - Tenth report from SSM's Scientific Council on Electromagnetic Fields, 2015</p>	<p>Swedish Radiation Safety Authority</p>	<p>March 2015</p>	<p>ELF and RF</p>	<ul style="list-style-type: none"> • "Regarding the exposure to ELF magnetic fields and the development of childhood leukaemia (...) the conclusion from previous Council reports still holds: associations have been observed, but a causal relationship has not been established." (pg. 9) • "In terms of exposure from mobile phone base stations or other RF-EMF transmitters, no new evidence has become available indicating a causal link between exposure and symptoms" (pg. 12)





<p>Opinion on Potential health effects of exposure to electromagnetic fields (EMF)</p>	<p>Scientific Committee on Emerging and Newly Identified Health Risks - European Commission</p>	<p>January 2015</p>	<p>ELF and RF</p>	<ul style="list-style-type: none"> •"existing studies do not provide convincing evidence for a causal relationship between ELF MF exposure and self-reported symptoms" (pg. 7) •With regards to epidemiological findings relating ELF and childhood leukemia "no mechanisms have been identified and no support is existing from experimental studies that could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation." (pg. 7) •"the epidemiological studies on mobile phone RF EMF exposure do not show an increased risk of brain tumours (...) they do not indicate an increased risk of other cancers of the head and neck region." (pg. 5) •"Epidemiological studies do not indicate increased risk for other malignant diseases including childhood cancer (RF)." (pg.5) <ul style="list-style-type: none"> •"Overall, there is a lack of evidence that mobile phone RF EMF affects cognitive functions" (pg. 6)
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<p>Mobile phones and cancer: Part 2. Animal studies on carcinogenesis</p>	<p>Health Council of the Netherlands</p>	<p>September 2014</p>	<p>RF</p>	<ul style="list-style-type: none"> •"on the basis of the results of the animal studies presented in this systematic review, it is unlikely that long-term continuous or repeated exposure to RF EMF may have initiating or promoting effects on the development of cancer. " (pg. 51)
<p>Are there harmful Biological Effects of Low-Level Electromagnetic Fields at frequencies up to 300 GHz?</p>	<p>Institution of Engineering and Technology</p>	<p>2014</p>	<p>ELF and RF</p>	<ul style="list-style-type: none"> •"At power frequencies (...) the balance of evidence from the large body of scientific papers built up over several decades suggests that the existence of harmful health effects from environmental levels of exposure remains unsubstantiated." (pg. 3) •"At higher frequencies (such as those used for mobile communications), the existing data do not provide persuasive evidence that harmful health effects exist." (pg. 3)
<p>A Review of Safety Code 6 (2013): Health Canada's Safety Limits for Exposure to Radiofrequency Fields</p>	<p>The Royal Society of Canada</p>	<p>March 2014</p>	<p>RF</p>	<ul style="list-style-type: none"> •"Although research on many of the potential health effects described above continues, the Panel was unable to identify any established adverse health effects occurring at levels below the basic restrictions in SC6 " (pg. 116) •"this Panel does not believe that additional precautionary measures should be introduced directly into the exposure limits of SC6." (pg. 118)





<p>Review of Radiofrequency Health Effects Research - Scientific Literature 2000 - 2012</p>	<p>Australian Radiation Protection and Nuclear Safety Agency</p>	<p>March 2014</p>	<p>RF</p>	<ul style="list-style-type: none"> • "Epidemiological studies investigating occupational and environmental exposure from RF transmitters since 2000 have not altered the conclusion that no detrimental health effects have been observed consistently in such studies." (pg. 39)
<p>Exposure from mobile phones, base stations and wireless networks</p>	<p>Nordic Radiation Safety Authorities</p>	<p>December 2013</p>	<p>RF</p>	<ul style="list-style-type: none"> • "The overall data on brain tumour and mobile phone use do not show an effect on tumour risk" (pg. 2)
<p>COMAR Technical Information Statement: Radiofrequency Safety and Utility Smart Meter</p>	<p>Institute of Electrical and Electronics Engineers</p>	<p>September 2013</p>	<p>RF</p>	<ul style="list-style-type: none"> • "most Smart Meter actually transmit RF fields for only a few minutes per day at most. The low peak power of Smart Meter and the very low duty cycles lead to the fact that accessible RF fields near Smart Meter are far below both U.S. and international RF safety limits whether judged on the basis of instantaneous peak power densities or time-averaged exposures. This conclusion holds for Smart Meter alone or installed in large banks of meters." (pg. 1)





It's Your Health	Health Canada	November 2012	ELF	<ul style="list-style-type: none">• "the vast majority of scientific research to date does not support a link between ELF magnetic field exposure and human cancers. At present, the evidence of a possible link between ELF magnetic field exposure and cancer risk is far from conclusive and more research is needed to clarify this 'possible' link." (pg. 2)
It's Your Health	Health Canada	December 2011	RF	<ul style="list-style-type: none">• "RF energy from Smart Meter during transmission bursts were found to be far below the human exposure limits specified in Health Canada's Safety Code 6." (pg. 1)• in some townhouses or high-rise buildings, the total exposure levels from multiple Smart Meter will still be far below Health Canada's RF energy exposure limits, due to the infrequent nature of transmissions." (pg. 2)





<p>Response Statement to Public Concerns Regarding Electric and Magnetic Fields (EMFs) from Electrical Power Transmission and Distribution Lines</p>	<p>Health Canada</p>	<p>November 2008</p>	<p>ELF</p>	<ul style="list-style-type: none">•“it is the opinion of the Federal-Provincial-Territorial Radiation Protection Committee that there is insufficient scientific evidence showing exposure to EMFs from power lines can cause adverse health effects such as cancer. Therefore, a warning to the public to avoid living near or spending time in proximity to power lines is not required.”
<p>WHO Statement Regarding EMF</p>	<p>World Health Organization</p>	<p>2007</p>	<p>ELF</p>	<ul style="list-style-type: none">•"In the area of biological effects and medical applications of non-ionizing radiation approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research."





<p><u>Non-ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields</u></p>	<p>International Agency for Research on Cancer - World Health Organization</p>	<p>2001/2002</p>	<p>ELF</p>	<ul style="list-style-type: none"> •Classified ELF as a 2B carcinogen – a possible carcinogen based on unanswered questions of the statistical association between magnetic field exposure and childhood leukemia. It should be noted that other 2B carcinogens include coffee and pickled vegetables, and are the lowest classification category in the index. IARC has found no consistent evidence that childhood EMF exposures are associated with other types of cancers or that adult EMF exposures are associated with increased risk of any kind of cancer.
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