

Electromagnetic fields and public health: extremely low frequency fields and cancer

In 1996, the World Health Organization (WHO) established the International Electromagnetic Fields (EMF) Project to address the health issues associated with exposure to EMF. The EMF Project is currently reviewing research results and conducting risk assessments of exposure to static and extremely low frequency (ELF) electric and magnetic fields. WHO plans to conduct an evaluation of all health effects from ELF field exposure in 2002-3.

Whenever electricity is conducted through transmission lines, distribution lines or is used in appliances, both electric and magnetic fields exist close to the lines or appliances. The power frequency used is 50 or 60 Hz. Use of electric power has become part of everyday life. However, questions have been raised as to whether these and other ELF fields are carcinogenic.

The International Agency for Research on Cancer (IARC) -- a specialized cancer research agency of WHO -- has recently concluded the first step in WHO's health risk assessment process by classifying ELF fields with respect to the strength-of-the-evidence that they could cause cancer in humans.

This Fact Sheet updates findings of recent reviews on the health effects of static and ELF electric and magnetic fields conducted by IARC (June 2001), by the Health Council of the Netherlands (May 2001), and by an expert Advisory Group of the National Radiological Protection Board in the United Kingdom (AGNIR) (March 2001).

IARC evaluation

In June 2001, an expert scientific working group of IARC reviewed studies related to the carcinogenicity of static and ELF electric and magnetic fields. Using the standard IARC classification that weighs human, animal and laboratory evidence, ELF magnetic fields were classified as **possibly carcinogenic to humans** based on epidemiological studies of childhood leukaemia. Evidence for all other cancers in children and adults, as well as other types of exposures (i.e. static fields and ELF electric fields) was considered not classifiable either due to insufficient or inconsistent scientific information.

"Possibly carcinogenic to humans" is a classification used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals.

This classification is the weakest of three categories ("is carcinogenic to humans", "probably carcinogenic to humans" and "possibly carcinogenic to humans") used by IARC to classify potential carcinogens based on published scientific evidence. Some examples of well-known agents that have been classified by IARC are listed below:

Classification	Examples of agents
Carcinogenic to humans (usually based on strong evidence of carcinogenicity in humans)	Asbestos Mustard gas Tobacco (smoked and smokeless) Gamma radiation

Probably carcinogenic to humans

(usually based on strong evidence of carcinogenicity in animals)

Diesel engine exhaust

Sun lamps

UV radiation

Formaldehyde

Possibly carcinogenic to humans

(usually based on evidence in humans which is considered credible, but for which other explanations could not be ruled out)

Coffee

Styrene

Gasoline engine exhaust

Welding fumes

ELF magnetic fields

Do ELF fields cause cancer?

ELF fields are known to interact with tissues by inducing electric fields and currents in them. This is the only established mechanism of action of these fields. However, the electric currents induced by ELF fields commonly found in our environment are normally much lower than the strongest electric currents naturally occurring in the body such as those that control the beating of the heart.

Since 1979 when epidemiological studies first raised a concern about exposures to power line frequency magnetic fields and childhood cancer, a large number of studies have been conducted to determine if measured ELF exposure can influence cancer development, especially leukaemia in children.

There is no consistent evidence that exposure to ELF fields experienced in our living environment causes direct damage to biological molecules, including DNA. Since it seems unlikely that ELF fields could **initiate** cancer, a large number of investigations have been conducted to determine if ELF exposure can **influence** cancer promotion or co-promotion. Results from animal studies conducted so far suggest that ELF fields do not initiate or promote cancer.

However, two recent pooled analyses of epidemiological studies provide insight into the epidemiological evidence that played a pivotal role in the IARC evaluation. These studies suggest that, in a population exposed to **average** magnetic fields in excess of 0.3 to 0.4 μT , twice as many children might develop leukaemia compared to a population with lower exposures. In spite of the large number data base, some uncertainty remains as to whether magnetic field exposure or some other factor (s) might have accounted for the increased leukaemia incidence.

Childhood leukaemia is a rare disease with 4 out of 100,000 children between the age of 0 to 14 diagnosed every year. Also average magnetic field exposures above 0.3 or 0.4 μT in residences are rare. It can be estimated from the epidemiological study results that less than 1% of populations using 240 volt power supplies are exposed to these levels, although this may be higher in countries using 120 volt supplies.

The IARC review addresses the issue of whether it is feasible that ELF-EMF pose a cancer risk. The next step in the process is to estimate the likelihood of cancers in the general population from the usual exposures and to evaluate evidence for other (non-cancer) diseases. This part of the risk assessment should be finished by WHO in the next 18 months.

International guidelines

International guidelines on exposure limits for all EMF have been developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) - a non-governmental organization (NGO) in official relations with WHO and a partner in WHO's International EMF Project. While the ICNIRP guidelines for EMF exposure are based on comprehensive reviews of all the science, the limits are intended to prevent health effects related to short-term acute exposure. This is because ICNIRP considers the scientific information on potential carcinogenicity of ELF fields insufficient for establishing quantitative limits on exposure.

Some national responses

Regulatory policies for agents classified as possible carcinogens vary by country and by particular agent. The carcinogenic evaluation and classification of an agent by IARC does not automatically trigger a national regulatory response. While gasoline exhaust and coffee have been classified as possible human carcinogens, there has been a significant response by government to reduce gasoline engine exhausts, but there has not been any effort to limit intake of coffee.

In response to increasing public concern over health effects from EMF exposure, several countries have established their own scientific reviews prior to the IARC evaluation. Already in 1998, a working group examining the issue for the US National Institute of Environmental Health Sciences (NIEHS) classified ELF magnetic fields as possibly carcinogenic to humans. The US government agency has since recommended "passive regulatory action", described as continued information and education of the public and encouraging power utilities to voluntarily reduce exposure to people where possible.

In the United Kingdom, an Advisory Group on Non-Ionising Radiation recently reported to the National Radiological Protection Board (NRPB) on the topic of power frequency EMF and the risk of cancer (AGNIR, 2001). It concluded that while the evidence is currently not strong enough to justify a firm conclusion that EMF fields cause leukaemia in children, the possibility remains that intense and prolonged exposures to magnetic fields can increase the risk of leukaemia in children. Further, they provided research recommendations. The Health Council of the Netherlands, a major scientific advisory body of the Netherlands government, reached similar conclusions.

WHO's response

While the classification of ELF magnetic fields as possibly carcinogenic to humans has been made, it remains possible that there are other explanations for the observed association between exposure to ELF magnetic fields and childhood leukaemia. In particular, issues of selection bias in the epidemiological studies and exposure to other field types deserve to be rigorously examined and will likely require new studies. WHO therefore recommends a follow-up, focused research programme to provide more definitive information. Some of these studies are currently being undertaken and results are expected over the next 2-3 years.

WHO's EMF Project aims to help national authorities balance the benefits of electrical technology against possible health risks, and to help them decide what protective measures may be needed. It is especially difficult to suggest protective measures for ELF fields because we do not know what field characteristic might be involved in the development of childhood leukaemia and therefore need to be reduced, or even if it is the ELF magnetic fields that are responsible for this effect. One approach is to have voluntary policies that aim to cost-effectively reduce exposure to ELF fields. This has been discussed in the WHO Backgrounder issued March 2000.

Some precautionary measures are outlined below:

- **Government and industry:** These entities should be cognisant of the latest scientific developments and should provide the public with balanced, clear and comprehensive information on potential EMF risks, as well as suggestions for safe and low cost ways to reduce exposures. They should also promote research that will lead to better information from which assessments of health risk can be made.
- **Individuals:** Members of the general public might choose to reduce their EMF exposure by minimizing the use of certain electrical appliances or by increasing distance to the sources that can produce relatively high fields.
- **Consultation with local authorities, industry and the public when siting new power lines:** Obviously power lines must be sited to provide power to consumers. Siting decisions are often required to take into account aesthetics and public sensibilities. However, siting decisions should also consider ways to reduce peoples' exposure.
- **An effective system of health information and communication** among scientists, governments, industry and the public is needed to help raise general awareness of programmes to deal with exposure to ELF fields and reduce any mistrust and fears.

Further reading

- AGNIR (2001) Advisory Group on Non-Ionising Radiation, Power Frequency Electromagnetic Fields and the Risk of Cancer. National Radiological Protection Board (UK) 2001.
- Health Council of the Netherlands (2001). Electromagnetic fields: Annual Update 2001.
- ICNIRP (1998) International Commission on Non-Ionizing Radiation Protection Guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields (up to 300 GHz). Health Physics 74(4), 494-522.
- Portier CJ and Wolfe MS (eds.), National Institute of Environmental Health Sciences of the National Institute of Health. Assessment of health effects from exposure to power-line frequency electric and magnetic fields. NIEHS Working Group Report, Research Triangle Park, NC, USA, NIH Publication No. 98-3981, 1998.
- Repacholi M and Greenebaum B (eds.), Interaction of static and extremely low frequency electric and magnetic fields with living systems: health effects and research needs. Bioelectromagnetics 1999; 20: 133-160.
- WHO Backgrounder on Cautionary Policies, March 2000

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