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FactSheet



Reviewed: 11/03/2014

Magnetic Field Exposure and Cancer

Key Points

- Electric and magnetic fields (EMF) are a form of non-ionizing radiation. EMFs are invisible areas of energy produced by the movement of electrons. Extremely low frequency (ELF) EMFs are produced by power lines, wiring, and electrical appliances.
- Several early epidemiologic studies raised the possibility of an association between certain cancers, especially childhood cancers, and ELF-EMFs. Most subsequent studies have not shown such an association, but scientists continue to investigate the possibility that one exists.
- Studies of animals exposed to ELF-EMFs have not provided any indications that ELF-EMF exposure is associated with cancer, and no mechanism has been identified by which such fields could cause cancer.

1. What are electric and magnetic fields?

Electric and magnetic fields are invisible areas of energy that are produced by electricity, which is the movement of electrons, or current, through a wire.

An electric field is produced by voltage, which is the pressure used to push the electrons through the wire, much like water being pushed through a pipe. As the voltage increases, the electric field increases in strength.

A magnetic field results from the flow of current through wires or electrical devices and increases in strength as the current increases. The strength of a magnetic field decreases rapidly with increased distance from its source.

Electric fields are produced whether or not a device is turned on, but magnetic fields are produced only when current is flowing, which usually requires a device to be turned on. Power lines produce magnetic fields continuously because current is always flowing through them.

Electric and magnetic fields together are referred to as electromagnetic fields, or EMFs. There are both natural and human-made sources of EMFs. The earth's magnetic field, which causes a compass to point North, is an example of a naturally occurring EMF. Power lines, wiring, and electrical appliances, such as electric shavers, hair dryers,

computers, televisions, and electric blankets produce what are called extremely low frequency (ELF) EMFs. ELF-EMFs have frequencies of up to 300 cycles per second, or Hertz (Hz); for example, the frequency of alternating current in power lines is 50 or 60 Hz. Cell phones produce radiofrequency EMFs above the ELF range. For more information about cell phones, see the NCI Fact Sheet [Cell Phones and Cancer Risk](#).

Electric fields are easily shielded or weakened by walls and other objects, whereas magnetic fields can pass through buildings, living things, and most other materials. Consequently, magnetic fields are the component of ELF-EMFs that are usually studied in relation to their possible health effects.

2. Why are ELF-EMFs studied in relation to cancer?

Any possible health effects of ELF-EMFs would be of concern because power lines and electrical appliances are present everywhere in modern life, and people are constantly encountering these fields, both in their homes and in certain workplaces. Also, the presence of ELF-EMFs in homes means that children are exposed. Even if ELF-EMFs were to increase an individual's risk of disease only slightly, widespread exposure to ELF-EMFs could translate to meaningful increased risks at the population level.

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No mechanism by which ELF-EMFs could cause cancer has been identified. Unlike high-energy ([ionizing radiation](#)), ELF-EMFs are low energy and non-ionizing and cannot damage [DNA](#) or cells directly. Some scientists have speculated that ELF-EMFs could cause cancer through other mechanisms, such as by reducing levels of the hormone [melatonin](#). (There is some evidence that melatonin may suppress the development of certain tumors.) However, studies of animals exposed to ELF-EMFs have not provided any indications that ELF-EMF exposure is associated with cancer ([1](#), [2](#)).

3. What is the evidence for an association between magnetic field exposure and cancer in children?

Numerous [epidemiologic](#) studies and comprehensive reviews of the scientific literature have evaluated possible associations between exposure to ELF magnetic fields and risk of cancer in children ([1](#), [3](#), [4](#)). Most of the research has focused on [leukemia](#) and [brain tumors](#), the two most common cancers in children. Studies have examined associations of these cancers with living near power lines, with magnetic fields in the home, and with exposure of parents to high levels of magnetic fields in the workplace.

Exposure from power lines

Although a study in 1979 pointed to a possible association between living near electric power lines and childhood leukemia (5), more recent studies have had mixed findings. Currently, researchers conclude that there is little evidence that exposure to ELF-EMFs from power lines causes leukemia, brain tumors, or any other cancers in children (1, 6–10).

Exposure in homes

Many studies have also looked for possible associations between magnetic fields measured in homes and residences and the risk of childhood cancers, especially leukemia. Individual studies have had varying results, but most have not found an association or have found it only for those children who lived in homes with very high levels of magnetic fields, which are present in few residences (11–14).

To develop the most accurate estimates of the risks of leukemia in children from magnetic fields in the home, researchers have analyzed the combined data from many studies. In one such analysis that combined data from nine studies done in several countries, leukemia risk was increased only in those children with the highest exposure (a category that included less than 1 percent of the children); these children had a twofold excess risk of childhood leukemia (15). In another analysis that combined data from 15 individual studies, a similar increase in risk was seen in children with the highest exposure level (16). A more recent analysis of seven studies published after 2000 found a similar trend, but the increase was not statistically significant (17).

Overall, these analyses suggest that if there is any increase in leukemia risk from magnetic fields, it is restricted to children with the very highest exposure levels. But it is possible that this increase is not real, because if magnetic fields caused childhood leukemia, certain patterns would have been found, such as increasing risk with increasing levels of magnetic field exposure. Such patterns were not seen.

Another way that people can be exposed to magnetic fields in the home is from household electrical appliances. Although magnetic fields near many electrical appliances are higher than those near power lines, appliances contribute less to a person's total exposure to magnetic fields because most appliances are used only for short periods of time. Again, studies have not found consistent evidence for an association between the use of household electrical appliances and risk of childhood leukemia (18).

Parental exposure and risk in children

Several studies have examined possible associations between maternal or paternal exposure to high levels of magnetic fields before conception and/or during pregnancy and the risk of cancer in their future children. The results to date have been inconsistent (19, 20). Studies are ongoing to evaluate this question.

Exposure and cancer survival

A few studies have investigated whether magnetic field exposure is associated with [prognosis](#) or survival of children with leukemia. Several small [retrospective](#) studies of this question have yielded inconsistent results ([21–23](#)). An analysis that combined [prospective](#) data for more than 3000 children with [acute lymphoid leukemia](#) from eight countries showed that ELF magnetic field exposure was not associated with their survival or risk of [relapse](#) ([24](#)).

4. What is the evidence that magnetic field exposure is linked to cancer in adults?

Although some studies have reported associations between ELF-[EMF](#) exposure and cancer in adults, other studies have not found evidence for such associations.


The majority of [epidemiologic](#) studies have shown no relationship between [breast cancer](#) in women and exposure to ELF-EMFs in the home ([25–28](#)), although several individual studies have shown hints of an association ([29](#), [30](#)).

Several studies conducted in the 1980s and early 1990s reported that people who worked in some electrical occupations (such as power station operators and phone line workers) had higher-than-expected rates of some types of cancer, particularly [leukemia](#), [brain tumors](#), and [male breast cancer](#) ([1](#)). Some occupational studies showed very small increases in the risks of leukemia and brain cancer, but these results were based on participants' job titles and not on actual measurements of their exposures. More recent studies, including some that considered the participant's job title as well as measurements of their exposures, have not shown consistent findings of an increasing risk of leukemia, brain tumors, or female breast cancer with increasing exposure to magnetic fields at work ([29](#), [31–35](#)).

5. Where can people find additional information on EMFs?

The National Institute of Environmental Health Sciences (NIEHS) website has [information](#) about EMFs and cancer.

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