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Magnetic Field Exposure and Cancer: Questions and Answers

Key Points

- Electric and magnetic fields (EMF) are areas of energy that surround any electrical device. EMFs are produced by power lines, electrical wiring, and appliances (see Question 1).
- Electric fields are easily shielded or weakened by walls and other objects, whereas magnetic fields are not. Since magnetic fields are more likely to penetrate the body, they are the component of EMFs that are usually studied in relation to cancer (see Question 1).
- Overall, there is limited evidence that magnetic fields cause childhood leukemia, and there is inadequate evidence that these magnetic fields cause other cancers in children (see Question 2).
- Studies of magnetic field exposure from power lines and electric blankets in adults show little evidence of an association with leukemia, brain tumors, or breast cancer (see Question 3).
- Past studies of occupational magnetic field exposure in adults showed very small increases in leukemia and brain tumors. However, more recent, well-conducted studies have shown inconsistent associations with leukemia, brain tumors, and breast cancer (see Question 4).

1. What are electric and magnetic fields?

Electricity is the movement of electrons, or current, through a wire. The type of electricity that runs through power lines and in houses is alternating current (AC). AC power produces two types of fields (areas of energy)—an electric field and a magnetic field. 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. These two fields together are referred to as electric and magnetic fields, or EMFs.

Both electric and magnetic fields are present around appliances and power lines. However, electric fields are easily shielded or weakened by walls and other objects, whereas magnetic fields can pass through buildings, humans, and most other materials. Since magnetic fields are most likely to penetrate the body, they are the component of EMFs that are usually studied in relation to cancer.

The focus of this fact sheet is on extremely low-frequency magnetic fields. Examples of devices that emit these fields include power lines and electrical appliances, such as electric shavers, hair dryers, computers, televisions, electric blankets, and heated waterbeds. Most electrical appliances have to be turned on to produce a magnetic field. The strength of a magnetic field decreases rapidly with increased distance from the source.

2. Is there a link between magnetic field exposure at home and cancer in children?

Numerous epidemiological (population) studies and comprehensive reviews have evaluated magnetic field exposure and risk of cancer in children (1, 2). Since the two most common cancers in children are leukemia and brain tumors, most of the research has focused on these two types. A study in 1979 pointed to a possible association between living near electric power lines and childhood leukemia (3).



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Among more recent studies, findings have been mixed. Some have found an association; others have not. These studies are discussed in the following paragraphs. Currently, researchers conclude that there is limited evidence that magnetic fields from power lines cause childhood leukemia, and that there is inadequate evidence that these magnetic fields cause other cancers in children (2). Researchers have not found a consistent relationship between magnetic fields from power lines or appliances and childhood brain tumors.

In one large study by the National Cancer Institute (NCI) and the Children's Oncology Group, researchers measured magnetic fields directly in homes (4). This study found that children living in homes with high magnetic field levels did not have an increased risk of childhood acute lymphoblastic leukemia. The one exception may have been children living in homes that had fields greater than 0.4 microtesla (μT), a very high level that occurs in few residences. Another study conducted by NCI researchers reported that children living close to overhead power lines based on distance measurements were not at greater risk of leukemia (5).

To estimate more accurately the risks of leukemia in children from magnetic fields resulting from power lines, researchers pooled (combined) data from many studies. In one pooled study that combined nine well-conducted studies from several countries, including a study from the NCI, a twofold excess risk of childhood leukemia was associated with exposure to magnetic fields above 0.4 μT (6). In another pooled study that combined 15 studies, a similar increased risk was seen above 0.3 μT (7). It is difficult to determine if this level of risk represents a real increase or if it results from study bias. Such study bias can be related to the selection of study subjects or possibly to other factors that relate to levels of magnetic field exposure. If magnetic fields caused childhood leukemia, certain patterns would have been found such as increasing risk with increasing levels of magnetic field exposure.

Another way that people can be exposed to magnetic fields is from household electrical appliances. Several studies have investigated this relationship (2). Although magnetic fields near many electrical appliances are higher than near power lines, appliances contribute less to a person's total exposure to magnetic fields. This is because most appliances are used only for short periods of time, and most are not used close to the body, whereas power lines are always emitting magnetic fields.

In a detailed evaluation, investigators from NCI and the Children's Oncology Group examined whether the use of household electrical appliances by the mother while pregnant and later by the child increased the risk of childhood leukemia. Although some appliances were associated with childhood leukemia, researchers did not find any consistent pattern of increasing risk with increasing years of use or how often the appliance was used (8). A few other studies have reported mostly inconsistencies or no relation between appliances and risk of childhood cancer.

Occupational exposure of mothers to high levels of magnetic fields during pregnancy has been associated with childhood leukemia in a Canadian study (9). Similar studies need to be done in other populations to see if this is indeed the case.

3. Is there a link between magnetic field exposure in the home and cancer in adults?

Although several studies have looked into the relationship of leukemia, brain tumors, and breast cancer in adults exposed to magnetic fields in the home, there are only a few large studies with long-term, magnetic field measurements. No consistent association between magnetic fields and leukemia or brain tumors has been established.

The majority of epidemiological studies have shown no relationship between breast cancer in women and magnetic fields from electrical appliances. Recent studies of breast cancer and magnetic fields in the home have included direct and indirect magnetic field measurements. These studies mostly found no association between breast cancer in females and magnetic fields from power lines or electric blankets (10, 11, 12, 13). A Norwegian study found a risk for exposure to magnetic fields in the home (14), and a study in African-American women found that use of electric bedding devices may increase breast cancer risk (15).

4. Is there a link between magnetic field exposure at work and cancer in adults?

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 (2). Some occupational studies showed very small increases in risk for leukemia and brain cancer, but these results were based on job titles and not actual measurements. More recently conducted studies that have included both job titles and

individual exposure measurements have no consistent finding of an increasing risk of leukemia, brain tumors, or female breast cancer with increasing exposure to magnetic fields at work (14, 16, 17, 18).

5. What have scientists learned from animal experiments about the relationship between magnetic field exposure and cancer?

Animal studies have not found that magnetic field exposure is associated with increased risk of cancer (2). The absence of animal data supporting carcinogenicity makes it biologically less likely that magnetic field exposures in humans, at home or at work, are linked to increased cancer risk.

6. Where can people find additional information on EMFs?

The National Institute of Environmental Health Sciences (NIEHS) Web site has information about EMFs and cancer, as well as information and publications related to the EMF Research and Public Information Dissemination (RAPID) Program. NIEHS can be contacted at:

Address: National Institute of Environmental Health Sciences
Post Office Box 12233
Research Triangle Park, NC 27709
Telephone: 919-541-3345
TTY: 919-541-0731
E-mail: webcenter@niehs.nih.gov
Internet Web site: <http://www.niehs.nih.gov>

Note: Information about cancer risk and EMFs emitted from hand-held cellular phones (i.e., microwave frequencies) can be found in the NCI fact sheet *Cellular Telephone Use and Cancer Risk*, which is available at <http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones> on the Internet.

Selected References

1. Ahlbom A, Cardis E, Green A, Linet M, Savitz D, Swerdlow A. Review of the epidemiologic literature on EMF and health. *Environmental Health Perspectives* 2001; 109(6): 911-933.
2. World Health Organization, International Agency for Research on Cancer. Volume 80: Non-ionizing radiation, Part 1, Static and extremely low-frequency (ELF) electric and magnetic fields. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. 2002: Lyon, France.
3. Wertheimer N, Leeper E. Electrical wiring configurations and childhood cancer. *American Journal of Epidemiology* 1979; 109(3): 273-284.
4. Linet MS, Hatch EE, Kleinerman RA, et al. Residential exposure to magnetic fields and acute lymphoblastic leukemia in children. *The New England Journal of Medicine* 1997; 337(1): 1-7.
5. Kleinerman RA, Kaune WT, Hatch EE, et al. Are children living near high voltage power lines at increased risk of acute lymphocytic leukemia? *American Journal of Epidemiology* 2000; 15: 512-515.
6. Ahlbom A, Day N, Feychting M, et al. A pooled analysis of magnetic fields and childhood leukaemia. *British Journal of Cancer* 2000; 83(5): 692-698.
7. Greenland S, Sheppard AR, Kaune WT, Poole C, Kelsh MA. A pooled analysis of magnetic fields, wire codes, and childhood leukemia. Childhood Leukemia-EMF Study Group. *Epidemiology* 2000; 11(6): 624-634.
8. Hatch EE, Linet MS, Kleinerman RA, et al. Association between childhood acute lymphoblastic leukemia and use of electrical appliances during pregnancy and childhood. *Epidemiology* 1998; 9(3): 234-245.
9. Infante-Rivard C, Deadman JE. Maternal occupational exposure to extremely low frequency magnetic fields during pregnancy and childhood leukemia. *Epidemiology* 2003; 14: 437-441.
10. Schoenfeld ER, O'Leary ES, Henderson K, et al. Electromagnetic fields and breast cancer on Long Island: A case-control study. *American Journal of Epidemiology* 2003; 158: 47-58.

11. London SJ, Pagoda JM, Hwang KL et al. Residential magnetic field exposure and breast cancer risk: A nested case-control study from a multi-ethnic cohort in Los Angeles, California. *American Journal of Epidemiology* 2003; 158: 969–980.
12. Davis S, Mirick DK, Stevens RG. Residential magnetic fields and the risk of breast cancer. *American Journal of Epidemiology* 2002; 155: 446–454.
13. Kabat GC, O'Leary ES, Schoenfeld ER, et al. Electric blanket use and breast cancer on Long Island. *Epidemiology* 2003; 14(5): 514–520.
14. Kliukiene J, Tynes T, Andersen A. Residential and occupational exposures to 50-Hz magnetic fields and breast cancer in women: A population-based study. *American Journal of Epidemiology* 2004; 159(9): 852–861.
15. Zhu K, Hunter S, Payne-Wilks K, et al. Use of electric bedding devices and risk of breast cancer in African-American women. *American Journal of Epidemiology* 2003; 158: 798–806.
16. Tynes T, Haldorsen T. Residential and occupational exposure to 50 Hz magnetic fields and hematological cancers in Norway. *Cancer Causes & Control* 2003; 14: 715–720.
17. Labreche F, Goldberg MS, Valois M-F, et al. Occupational exposures to extremely low frequency magnetic fields and postmenopausal breast cancer. *American Journal of Industrial Medicine* 2003; 44: 643–652.
18. Willett E, McKinney PA, Fear NT, et al. Occupational exposure to electromagnetic fields and acute leukaemia: Analysis of a case-control study. *Occupational and Environmental Medicine* 2003; 60: 577–583.

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Related NCI materials and Web pages:

- National Cancer Institute Fact Sheet 3.72, *Cellular Telephone Use and Cancer Risk* (<http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones>)

How can we help?

We offer comprehensive research-based information for patients and their families, health professionals, cancer researchers, advocates, and the public.

- **Call** NCI's Cancer Information Service at 1-800-4-CANCER (1-800-422-6237)
- **Visit** us at <http://www.cancer.gov> or <http://www.cancer.gov/espanol>
- **Chat** using LiveHelp, NCI's instant messaging service, at <http://www.cancer.gov/livehelp>
- **E-mail** us at cancergovstaff@mail.nih.gov
- **Order** publications at <http://www.cancer.gov/publications> or by calling 1-800-4-CANCER
- **Get help** with quitting smoking at 1-877-44U-QUIT (1-877-448-7848)

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