Control Number: 55067

Item Number: 501

Request to Intervene in PUC Docket No. 55067

The following information must be submitted by the person requesting to intervene in this proceeding. This completed form will be provided to all parties in this docket. **If you DO NOT want to be an intervenor, but still want to file comments, please complete the "Comments" page.**

For USPS, send one copy to:

Public Utility Commission of Texas
Central Records
P.O. Box 13326
Austin, TX 78711-3326

For all other delivery or courier services, send one copy to:

Public Utility Commission of Texas
Central Records
1701 N. Congress Ave.
Austin, TX 78701

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First Name: CHRISTEN Last Name: POWERS

Phone Number: 817-504-6146 Fax Number: N/A

Address, City, State: 1244 WESTERN YARROW AVE., JUSTIN TEXAS 76247

Email Address: CHRISTENKAYPOWERS@GMAIL.COM

I am requesting to intervene in this proceeding. As an INTERVENOR, I understand the following:

- I am a party to the case;
- I am required to respond to all discovery requests from other parties in the case;
- If I file testimony, I may be cross-examined in the hearing;
- If I file any documents in the case, I will have to provide a copy of that document to every other party in the case; and
- I acknowledge that I am bound by the Procedural Rules of the Public Utility Commission of Texas (PUC) and the State Office of Administrative Hearings (SOAH).

Please check one of the following:

☑ I own property with a habitable structure located near one or more of the utility's proposed routes for a transmission line.

☐ One or more of the utility's proposed routes would cross my property.

☐ Other. Please describe and provide comments. You may attach a separate page, if necessary.

SEE ATTACHED

Signature of person requesting intervention:

Christen K. Powers Date: 7-17-2023

Effective: April 8, 2020

July 18, 2023
RE: Request to Intervene in PUC Docket No. 55067

To Whom It May Concern:

Our home is within the 520ft boundary of a proposed route.

We are in a new build and had no prior knowledge of this proposal until July 2023. **Perrin Elementary School,** which is currently under construction, runs along the same line and would also be affected.

According to the City of Justin, Texas, there are sixty alternate routes for Oncor to choose from. **We implore you to choose a route that:**

- Neither runs through downtown Justin
- Nor runs along the train tracks at Wildflower Ranch neighborhood
- is the least populated option.

I have attached multiple medical and scientific studies which show consistent exposure to power lines is unsafe for humans.

I would call your attention, specifically, to the attached study from the British Medical Journal published June 2, 2005, in which their conclusion states:

> ***Conclusions*** *There is an association between childhood leukaemia and proximity of home address at birth to high voltage power lines, and the apparent risk extends to a greater distance than would have been expected from previous studies.*

This particular study expanded the area of research past the 500 feet commonly used in the U.S. The BMJ study reveals that negative side effects are still seen in humans past the distance marked as "safe" on a meter. The distance should be closer to 600 meters, not 500 feet.

In addition, this finding gives context to why U.S. results are lower and appear harmless. A U.S. control group is often still within 600m of the transmission lines in question, and therefore the children studied are still within the range of exposure. They are not a true control group who should be beyond 600m distance. **This information combined with multiple other scientific published studies proves that power lines are NOT safe for residential areas.**

WE MUST KEEP POWER LINES OUT OF WILDFLOWER RANCH AND THE SURROUNDING AREAS.

Regards,

James Allen and Christen Powers
1244 Western Yarrow Avenue, Justin TX 76247

among others.

Read full author bio

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Jacqueline DeMarco

Contributing Writer at Orchard

Based in the Bay Area, Jacqueline has over eight years of experience covering real estate, personal finances, and money management. Her writing has been featured in

safe or how much exposure leads to health issues.

If you have your heart set on a property near power lines and are concerned about potential health effects, you can contact your local electric utility company to request an on-site reading to better understand what the properties EMF levels are like before you buy.

Even if there aren't power lines directly over your property, if you are concerned about potential health effects, you may want to know just how much of a distance you want to keep between you and the power lines. Once you know what type of power lines are nearby, you can determine just how far your property needs to be from them to avoid potential EMF effects.

- 133 kV Power lines: 100 feet distance
- 230 kV Power lines: 150 feet distance
- 345 kV Power lines: 250 feet distance
- 550 kV Power: 350 feet distance

Bollocks

Once you're 500 feet away, it's no longer possible to measure the EMF effect of power lines, so you should be able to rest a little easier knowing you're a good distance from them.

Even though power lines negatively impact the value of a property, they don't necessarily make or break your ability to sell a home.

What are the health effects of living near power lines?

There is widespread concern about the health effects of the electromagnetic fields (EMFs) that are generated by power lines. Unfortunately, studies have not been able to disprove these concerns. On the flip side, no research has indicated that these concerns are valid either. The World Health Organization (WHO) and other major agencies have looked into this issue and have yet to confirm adverse health consequences caused by the EMFs associated with power lines.

There are rumors that EMFs cause cancer, miscarriages, birth defects, heart abnormalities, and other health issues, but there is no conclusive evidence to support

property values.

- **They're not aesthetically pleasing.** Power lines aren't super attractive and block nice views.
- **People have health concerns.** There are widespread concerns that the electromagnetic radiation generated by power lines causes cancer. Even though scientific research has yet to strongly confirm these claims, these fears are very damaging to property values.
- **There are restrictions.** You need to plan landscaping and certain construction projects around power lines. If a power line goes directly over your property, you may run into a lot of annoying property restrictions to accommodate them.
- **Noise can be an issue**. If you buy a home very close to power lines, you may be stuck listening to humming noises on an ongoing basis.

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Use our home sale calculator to estimate your net proceeds.

Expected Home Sale Price ⓘ

$250,000

Estimated Net Proceeds

$221,875

ignore, in some cases the benefits that come along with living near them may truly be worth it to a homebuyer.

Pros

- **They make a property more affordable.** Those that struggle to afford a home in an expensive area may find buying in neighborhoods with power lines more attainable. While your resale value may be worth less than other homes in the area, you'll also spend less when it comes time to buy the home. Plus, the less your house costs, the less your property taxes are. That said, Orchard may be able to help you to afford a more expensive home by turning you into a cash buyer.
- **You'll have less competition.** In a competitive housing market, buyers may find that homes near power lines are easier to place a successful offer on. Some unsightly power lines may be worth not getting caught up in a bidding war.
- **Avoid high HOA fees**. Power lines tend to be a fixture in older neighborhoods, which usually have lower HOA fees than newer neighborhoods, if they have them at all. If you want to save on housing costs, you may appreciate not paying HOA fees in perpetuity.

Cons

How much do power lines decrease value?

How much power lines decrease the value of a home varies, but many studies have been done on this issue and can give you a ballpark idea of what to expect.

A 2018 study from the Journal of Real Estate Research found that vacant lots near high-voltage power lines sell for 44.9% less than equivalent lots that aren't located near power lines. If you take a step back, a lot that is located within 1,000 feet of transmission lines tends to sell for 17.9% less.

Other studies confirm similar numbers, but of course a home value is determined by many factors.

Pros and cons of living near power lines

The main reason why power lines make your property worth less is simply because most people don't like how they look. Not only are power lines not super aesthetically pleasing, but they tend to block views. Sound plays just as big of a factor as sight. If a property is too close to a power line, the residents have to listen to the humming sound they produce when trying to relax in their own backyard.

While these concerns may be easy to overlook for some, one aspect of power lines that many can't ignore is the rumored health concerns. We'll break these health concerns down shortly, but for now it's worth noting that no research has proven any solid links between the proximity to power lines and medical issues.

One of the biggest hurdles when you live near power lines is quite burdensome. If a home sits right under power lines, there will be restrictions regarding how the homeowner can utilize their property. Landscaping especially causes complications, because trees can become tangled with power lines.

There are certain real estate "rules" we tend to take at face value without looking into the issue on our own. One of these rules is that you don't want to buy a house near power lines. You may have heard warnings all your life about how power lines decrease the value of a property and in this case, the rumors are true. You should expect property that is located by power lines to sell for significantly less than similar homes not near property lines.

The effects of power lines on property values may be enough to scare some potential buyers off, so let's look at why power lines damage property values, how much value one should expect to lose, and if health issues truly are a concern.

Do power lines decrease property value?

The short answer? Yes, power lines decrease property value. Whether or not that fact is truly as bad as it seems is something we'll examine

Selling a Home › Preparing to Sell

Power lines and property value: What you need to know

Written By: Jacqueline DeMarco
Updated December 14, 2022

In this article:

57. Gao H, Aresu M, Vergnaud AC, et al. Personal radio use and cancer risks among 48,518 British police officers and staff from the Airwave Health Monitoring Study. *British Journal of Cancer* 2019; 120(3):375–378. [PubMed Abstract]

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Related Resources

Cell Phones and Cancer Risk

Reviewed: May 30, 2022

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studies that explains these findings. It also found that the epidemiologic studies on radiofrequency exposure do not show an increased risk of brain tumors or other cancers of the head and neck region, although the possibility of an association with acoustic neuroma remains open (59).

Where can people find additional information on EMFs?

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

The Occupational Safety and Health Administration website has information about workplace exposures to ELF-EMF.

The US Environmental Protection Agency website has information on power lines and other sources of EMF.

The European Commission also has general information on EMF.

The World Health Organization website also has information on EMF.

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Workplace exposures to radiofrequency radiation. A limited number of studies have evaluated risks of cancer in workers exposed to radiofrequency radiation. A large study of U.S. Navy personnel found no excess of brain tumors among those with a high probability of exposure to radar (including electronics technicians, aviation technicians, and fire control technicians); however, nonlymphocytic leukemia, particularly acute myeloid leukemia, was increased in electronics technicians in aviation squadrons, but not in Navy personnel in the other job categories (52). A case–control study among U.S. Air Force personnel found the suggestion of an increased risk of brain cancer among personnel who maintained or repaired radiofrequency or microwave-emitting equipment (53). A case–control study found the suggestion of an increased risk of death from brain cancer among men occupationally exposed to microwave and/or radiofrequency radiation, with all of the excess risk among workers in electrical and electronics jobs involving design, manufacture, repair, or installation of electrical or electronics equipment (54). There was no evidence that electrical utility workers who were exposed to pulsed electromagnetic fields produced by power lines were more likely to develop brain tumors or leukemia than the general population (55). Employees of a large manufacturer of wireless communication products were not more likely to die from brain tumors or cancers of the hematopoietic or lymphatic system than the general population (56). A large prospective study among police officers in Great Britain found no evidence for an association between radiofrequency EMF exposure from personal radio use and the risk of all cancers combined (57). A large multinational population-based case–control study found no clear evidence that occupational exposures to radiofrequency radiation are associated with increased risks of glioma or meningioma (58).

What do expert organizations conclude about the cancer risk from EMFs?

In 2002, the International Agency for Research on Cancer (IARC), a component of the World Health Organization, appointed an expert Working Group to review all available evidence on static and extremely low frequency electric and magnetic fields (13). The Working Group classified ELF-EMFs as "possibly carcinogenic to humans," based on limited evidence from human studies in relation to childhood leukemia. Static electric and magnetic fields and extremely low frequency electric fields were determined "not classifiable as to their carcinogenicity to humans" (13).

In 2015, the European Commission Scientific Committee on Emerging and Newly Identified Health Risks reviewed electromagnetic fields in general, as well as cell phones in particular. It found that, overall, epidemiologic studies of extremely low frequency fields show an increased risk of childhood leukemia with estimated daily average exposures above 0.3 to 0.4 μT, although no mechanisms have been identified and there is no support from experimental

Exposure from cell phone base stations. Few studies have examined cancer risk in children living close to cell phone base stations or radio or television transmitters. Mobile phone base stations transmit and receive radiofrequency signals to and from mobile phones near the station. None of the studies that estimated exposures on an individual level found an increased risk of pediatric tumors (33–35).

Parental exposure and risk in offspring. 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 (36, 37). This question requires further evaluation.

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 (38–40). An analysis that combined prospective data for more than 3,000 children with acute lymphoid leukemia from eight countries showed that ELF magnetic field exposure was not associated with their survival or risk of relapse (41).

What have studies shown about possible associations between non-ionizing EMFs and cancer in adults?

Many studies have examined the association between non-ionizing EMF exposure and cancer in adults, of which few studies have reported evidence of increased risk (1).

Residential exposures. The majority of epidemiologic studies have shown no relationship between breast cancer in women and exposure to extremely low frequency EMFs (ELF-EMFs) in the home (42–45), although a few individual studies have suggested an association; only one reported results that were statistically significant (46).

Workplace exposures to ELF radiation. Several studies conducted in the 1980s and early 1990s reported that people who worked in some electrical occupations that exposed them to ELF radiation (such as power station operators and telephone line workers) had higher-than-expected rates of some types of cancer, particularly leukemia, brain tumors, and male breast cancer (13). Most of the results were based on participants' job titles and not on actual measurements of their exposures. More recent studies, including some that considered exposure measurements as well as job titles, have generally not shown an increasing risk of leukemia, brain tumors, or female breast cancer with increasing exposure to magnetic fields at work (46–51).

Several studies have analyzed the combined data from multiple studies of power line exposure and childhood leukemia:

- A pooled analysis of nine studies reported a twofold increase in risk of childhood leukemia among children with exposures of 0.4 μT or higher. Less than 1% of the children in the studies experienced this level of exposure (26).
- A meta-analysis of 15 studies observed a 1.7-fold increase in childhood leukemia among children with exposures of 0.3 μT or higher. A little more than 3% of children in the studies experienced this level of exposure (27).
- More recently, a pooled analysis of seven studies published after 2000 reported a 1.4-fold increase in childhood leukemia among children with exposures of 0.3 μT or higher. However, less than one half of 1% of the children in the studies experienced this level of exposure (28).

For the two pooled studies and the meta-analysis, the number of highly exposed children was too small to provide stable estimates of the dose–response relationship. This means that the findings could be interpreted to reflect linear increases in risk, a threshold effect at 0.3 or 0.4 μT, or no significant increase.

The interpretation of the finding of increased childhood leukemia risk among children with the highest exposures (at least 0.3 μT) is unclear.

Exposure from electrical appliances. Another way that children can be exposed to magnetic fields 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 for only short periods of time. And moving even a short distance from most electrical appliances reduces exposure dramatically. Again, studies have not found consistent evidence for an association between the use of household electrical appliances and risk of childhood leukemia (29).

Exposure to Wi-Fi. In view of the widespread use of Wi-Fi in schools, the UK Health Protection Agency (now part of Public Health England) has conducted the largest and most comprehensive measurement studies to assess exposures of children to radiofrequency electromagnetic fields from wireless computer networks (30, 31). This agency concluded that radiofrequency exposures were well below recommended maximum levels and that there was "no reason why Wi-Fi should not continue to be used in schools and in other places" (32).

A review of the published literature concluded that the few high-quality studies to date provide no evidence of biological effects from Wi-Fi exposures (7).

Power lines and electrical appliances that emit non-ionizing EMFs are present everywhere in homes and workplaces. For example, wireless local networks are nearly always "on" and are increasingly commonplace in homes, schools, and many public places.

No mechanism by which ELF-EMFs or radiofrequency radiation could cause cancer has been identified. Unlike high-energy (ionizing) radiation, EMFs in the non-ionizing part of the electromagnetic spectrum 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.

Studies of animals have not provided any indications that exposure to ELF-EMFs is associated with cancer (10–13). The few high-quality studies in animals have provided no evidence that Wi-Fi is harmful to health (8).

Although there is no known mechanism by which non-ionizing EMFs could damage DNA and cause cancer, even a small increase in risk would be of clinical importance given how widespread exposure to these fields is.

What have studies shown about possible associations between non-ionizing EMFs and cancer in children?

Numerous epidemiologic studies and comprehensive reviews of the scientific literature have evaluated possible associations between exposure to non-ionizing EMFs and risk of cancer in children (13–15). (Magnetic fields are the component of non-ionizing EMFs that are usually studied in relation to their possible health effects.) 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. No consistent evidence for an association between any source of non-ionizing EMF and cancer has been found.

Exposure from power lines. Although a study in 1979 pointed to a possible association between living near electric power lines and childhood leukemia (16), more recent studies have had mixed findings (17–25). Most of these studies did not find an association or found one only for those children who lived in homes with very high levels of magnetic fields, which are present in few residences.

day or the day of the week (lower exposures on the weekends or at night) (1). A study that used using personal portable exposure meters to assess exposures to different sources of radiofrequency EMFs among children in Europe found that the single largest contributor to the total radiofrequency EMF exposure was the proximity to base stations (5).

In general, exposures decrease with increasing distance from the source (6). Exposures among maintenance workers have been found to vary depending on their tasks, the type of antenna, and the location of the worker in relation to the source (1). Cumulative exposures of such workers are very difficult to estimate.

- **Televisions and computer screens** produce electric and magnetic fields at various frequencies, as well as static electric fields. The liquid crystal displays found in some laptop and desktop computers do not produce substantial electric or magnetic fields. Modern computers have conductive screens that reduce static fields produced by the screen to normal background levels.
- **Wireless local area networks**, commonly known as Wi-Fi. These are specific types of wireless networking systems and an increasingly common source of radiofrequency radiation. Wireless networks use radio waves to connect Wi-Fi–enabled devices to an access point that is connected to the internet, either physically or through some form of data connection. Most Wi-Fi devices operate at radiofrequencies that are broadly similar to cell phones, typically 2.4 to 2.5 GHz, although in recent years Wi-Fi devices that operate at somewhat higher frequencies (5, 5.3, or 5.8 GHz) have appeared (7). Radiofrequency radiation exposure from Wi-Fi devices is considerably lower than that from cell phones (8). Both sources emit levels of radiofrequency radiation that are far below the guideline of 10 W/m^2 as specified by the International Commission on Non-Ionizing Radiation Protection (3).
- **Digital electric and gas meters, also known as "smart meters."** These devices, which operate at about the same radiofrequencies as cell phones, transmit information on consumption of electricity or gas to utility companies. Smart meters produce very low level fields that sometimes cannot be distinguished from the total background radiofrequency radiation levels inside a home (9).

For household appliances and other devices used in the home that require electricity, magnetic field levels are highest near the source of the field and decrease rapidly the farther away the user is from the source. Magnetic fields drop precipitously at a distance of about 1 foot from most appliances. For computer screens, at a distance of 12–20 inches from the screen that most persons using computers sit, magnetic fields are similarly dramatically lower.

Why are non-ionizing EMFs studied in relation to cancer?

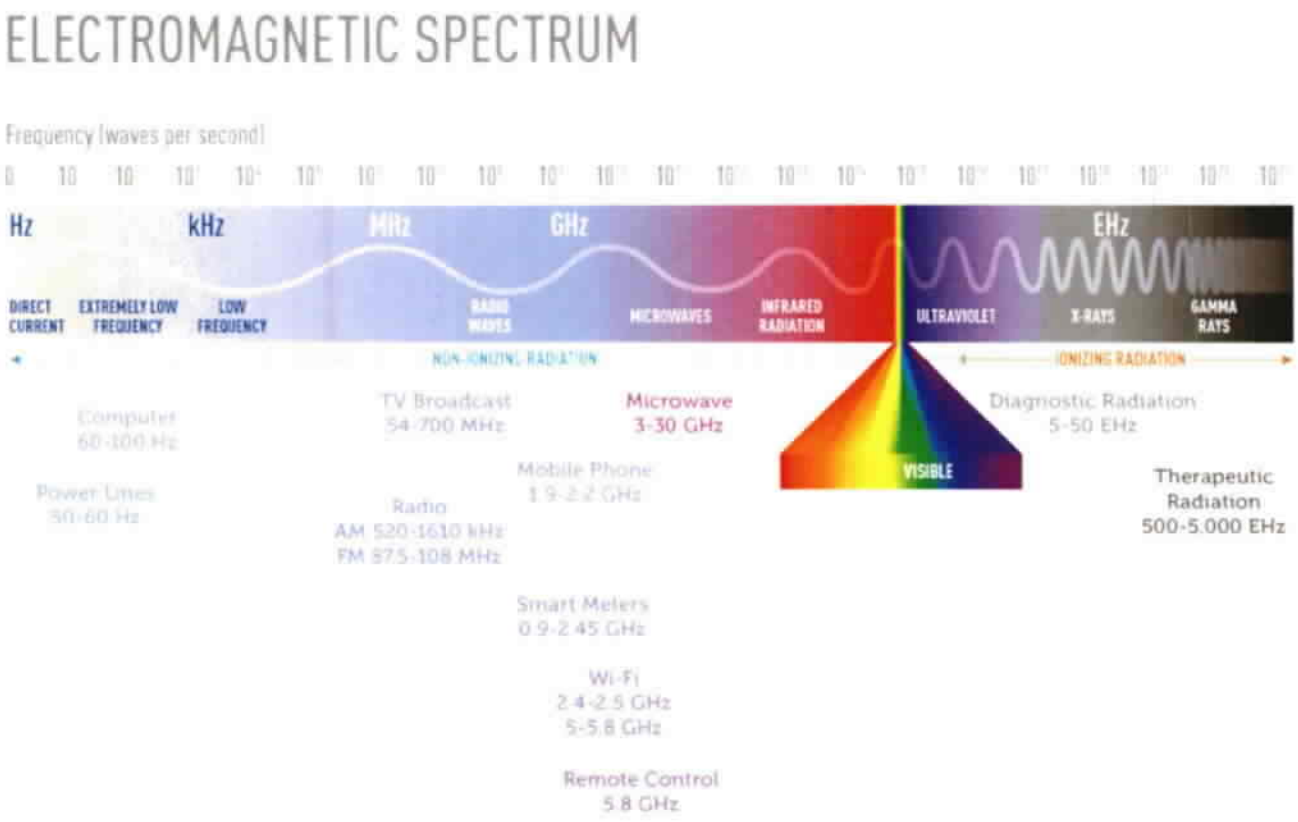
Extremely low frequency EMFs (ELF-EMFs). Sources of ELF-EMFs include power lines, electrical wiring, and electrical appliances such as shavers, hair dryers, and electric blankets.

Radiofrequency radiation. The most common sources of radiofrequency radiation are wireless telecommunication devices and equipment, including cell phones, smart meters, and portable wireless devices, such as tablets and laptop computers (1). In the United States, cell phones currently operate in a frequency range of about 1.8 to 2.2 GHz (2). (For more information about cell phones, see the NCI fact sheet Cell Phones and Cancer Risk.)

Other common sources of radiofrequency radiation include:

- **Radio and television signals.** AM/FM radios and older VHF/UHF televisions operate at lower radiofrequencies than cell phones. Radio signals are AM (amplitude-modulated) or FM (frequency-modulated). AM radio is used for broadcasting over very long distances, whereas FM radio covers more localized areas. AM signals are transmitted from large arrays of antennas that are placed at high elevation on sites that are off limits to the general public because exposures close to the source can be high. Maintenance workers could receive substantial radiofrequency exposures from AM radio antennas, but the general public would not. FM radio antennas and TV broadcasting antennas, which are much smaller than AM antennas, are generally mounted at the top of high towers. Radiofrequency exposures near the base of these towers are below guideline limits (3), so exposure of the general population is very low. Sometimes small local radio and TV antennas are mounted on the top of a building; access to the roof of such buildings is usually controlled.
- **Radar, satellite stations, magnetic resonance imaging (MRI) devices, and industrial equipment.**These operate at somewhat higher radiofrequencies than cell phones (1).
- **Microwave ovens** used in homes, which also operate at somewhat higher radiofrequencies than cell phones (1). Microwave ovens are manufactured with effective shielding that has reduced the leakage of radiofrequency radiation from these appliances to barely detectable levels.
- **Cordless telephones**, which can operate on analogue or DECT (Digital Enhanced Cordless Telecommunications) technology and typically emit radiofrequencies similar to those of cell phones. However, because cordless phones have a limited range and require a nearby base, their signal strengths are generally much lower than those of cell phones (1).
- **Cell phone base stations.** Antenna towers or base stations, including those for mobile phone networks and for broadcasting for radio and for television, emit various types of radiofrequency energy. Because the majority of individuals in the general population are exposed only intermittently to base stations and broadcast antennas, it is difficult to estimate exposures for a population (4). The strength of these exposures varies based on the population density of the region, the average distance from the source, and the time of

(Hz), and radiofrequency EMFs range from 3 kilohertz (3 kHz, or 3,000 Hz) to 300 gigahertz (300 GHz, or 300 billion Hz). Radiofrequency radiation is measured in watts per meter squared (W/m^2).



The electromagnetic spectrum represents all of the possible frequencies of electromagnetic energy. It ranges from extremely long wavelengths (extremely low frequency exposures such as those from power lines) to extremely short wavelengths (x-rays and gamma rays) and includes both non-ionizing and ionizing radiation.

What are common sources of non-ionizing EMFs?

There are both natural and human-made sources of non-ionizing EMFs. The earth's magnetic field, which causes the needle on a compass to point North, is one example of a naturally occurring EMF.

Human-made EMFs fall into both the ELF and radiofrequency categories of non-ionizing part of the electromagnetic spectrum. These EMFs can come from a number of sources.

NATIONAL CANCER INSTITUTE

Electromagnetic Fields and Cancer

What are electric and magnetic fields?

Electric and magnetic fields are invisible areas of energy (also called radiation) 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. Electric fields are measured in volts per meter (V/m).

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 increasing distance from its source. Magnetic fields are measured in microteslas (μT, or millionths of a tesla).

Electric fields are produced whether or not a device is turned on, whereas 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 fields are easily shielded or weakened by walls and other objects, whereas magnetic fields can pass through buildings, living things, and most other materials.

Electric and magnetic fields together are referred to as electromagnetic fields, or EMFs. The electric and magnetic forces in EMFs are caused by electromagnetic radiation. There are two main categories of EMFs:

- Higher-frequency EMFs, which include x-rays and gamma rays. These EMFs are in the ionizing radiation part of the electromagnetic spectrum and can damage DNA or cells directly.
- Low- to mid-frequency EMFs, which include static fields (electric or magnetic fields that do not vary with time), magnetic fields from electric power lines and appliances, radio waves, microwaves, infrared radiation, and visible light. These EMFs are in the non-ionizing radiation part of the electromagnetic spectrum and are not known to damage DNA or cells directly. Low- to mid-frequency EMFs include extremely low frequency EMFs (ELF-EMFs) and radiofrequency EMFs. ELF-EMFs have frequencies of up to 300 cycles per second, or hertz

Am J Epidemiol. 1979 Mar;109(3):273-84. doi: 10.1093/oxfordjournals.aje.a112681.

Electrical wiring configurations and childhood cancer

N Wertheimer, E Leeper

PMID: 453167 DOI: 10.1093/oxfordjournals.aje.a112681

Abstract

An excess of electrical wiring configurations suggestive of high current-flow was noted in Colorado in 1976--1977 near the homes of children who developed cancer, as compared to the homes of control children. The finding was strongest for children who had spent their entire lives at the same address, and it appeared to be dose-related. It did not seem to be an artifact of neighborhood, street congestion, social class, or family structure. The reason for the correlation is uncertain; possible effects of current in the water pipes or of AC magnetic fields are suggested.

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electric fields (OR = 0.9) under high power use conditions were related to total cancers. Wire codes associated with higher magnetic fields were more common among case than control homes. The odds ratio to contrast very high and high to very low, low, and buried wire codes was 1.5 (95% Cl = 1.0–2.3) for total cases, with consistency across cancer subgroups except for brain cancer (OR = 2.0) and lymphomas (OR = 0.8). Contrasts of very high to buried wire code homes produced larger, less precise odds ratios of 2.3 for total cases, 2.9 for leukemias, and 3.3 for lymphomas. Adjusted estimates for measured fields and wire codes did not differ from crude results, indicating an absence of confounding. Limitations to the study are nonresponse (especially for field measurements), differential mobility of cases and controls, and a presumably nondifferential exposure misclassification from the use of imperfect surrogates for long-term magnetic field exposure history. In spite of these concerns, the results encourage further examination of the carcinogenic potential from this form of nonionizing radiation.

Keywords: brain neoplasms, child, electromagnetic fields, leukemia

Topic: brain tumors, cancer, exposure, bone wires, colorado, epidemiologic studies, internship and residency, leukemia, lymphoma, radiation, nonionizing, telephone, soft tissue sarcomas, childhood cancer, misclassification, medical residencies, control groups, mobility, exposure domain

Issue Section: ORIGINAL CONTRIBUTIONS

JOURNAL ARTICLE

CASE-CONTROL STUDY OF CHILDHOOD CANCER AND EXPOSURE TO 60-HZ MAGNETIC FIELDS

DAVID A. SAVITZ ✉, HOWARD WACHTEL, FRANK A. BARNES, ESTHER M. JOHN, JIRI G. TVRDIK

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Published: 01 July 1988 **Article history** ▾

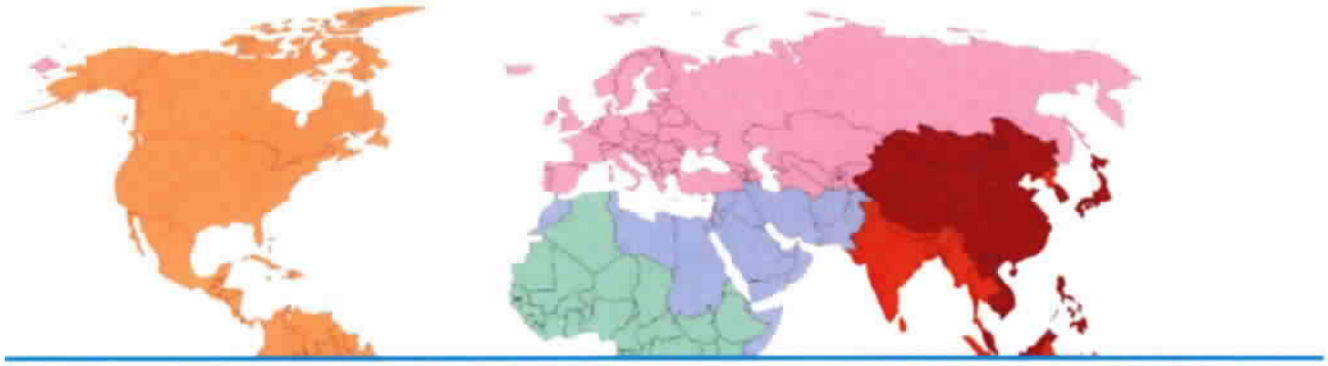
Abstract

Concern with health effects of extremely low frequency magnetic fields has been raised by epidemiologic studies of childhood cancer in relation to proximity to electric power distribution lines. This case-control study was designed to assess the relation between residential exposure to magnetic fields and the development of childhood cancer. Eligible cases consisted of all 356 residents of the five-county 1970 Denver, Colorado Standard Metropolitan Statistical Area aged 0–14 years who were diagnosed with any form of cancer between 1976 and 1983. Controls were selected by random digit dialing to approximate the case distribution by age, sex, and telephone exchange area. Exposure was characterized through in-home electric and magnetic field measurements under low and high power use conditions and wire configuration codes, a surrogate measure of long-term magnetic field levels. Measured magnetic fields under low power use conditions had a modest association with cancer incidence: a cutoff score of 2.0 milligauss resulted in

Funding

Funding is provided by contributions from WHO member states.

Participating countries & entities



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- **incorporate the research results into WHO's Environmental Health Criteria monographs where formal health risk assessments will be made on exposure to EMF,**
- **facilitate the development of internationally acceptable standards for EMF exposure,**
- **provide information on the management of EMF protection programmes for national and other authorities, including monographs on EMF risk perception, communication and management, and**
- **provide advice to national authorities, other institutions, the general public and workers, about any hazards resulting from EMF exposure and any needed mitigation measures.**

Project activities

The mandate of the the International EMF Project is to assess the health and environmental effects of exposure to static and time varying electric and magnetic fields in the frequency range 0 - 300 GHz. For the purposes of the EMF Project, this range is divided into: static (0 Hz), extremely low frequency (ELF, >0-300 kHz), intermediate frequencies (IF, >300Hz to 10MHz), and radiofrequency (RF, 10 MHz-300 GHz) fields.

The EMF Project is located at the World Health Organization (WHO) headquarters in Geneva, Switzerland, since this is the only United Nations organization with a clear mandate to investigate detrimental health effects from exposure of people to non-ionizing radiation. The project is part of the Department of Environment, Climate Change and Health (EHC) in the Healthier Populations (UHC) cluster.

Brochure

23 MAY 2005

Electromagnetic fields project

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World Health Organization

The International EMF Project

investigates health effects of electromagnetic fields

advises national authorities on EMF radiation protection

THE SPECTRUM

People all over the world are exposed to electromagnetic fields (EMF) to varying degrees, and the levels of exposure will increase as technology advances further. These EMF are found in the non-ionizing part of the electromagnetic spectrum (between 0 and 300 GHz) and are emitted from common sources such as power lines and cellular phones. They are different to ionizing radiations, such as X-rays and gamma rays, which have enough energy to break molecular bonds.

www.who.int/emf/

As part of its charter to protect public health, WHO established the International EMF Project in 1996. The project is overseen by an advisory committee consisting of representatives of 8 international organizations, 8 independent scientific institutions and more than 50 national governments, providing a global perspective. The scientific work is conducted in collaboration with the International Commission on Non-Ionizing Radiation Protection (ICNIRP). All activities are coordinated and facilitated by the WHO Secretariat.

Membership in the Project is open to any WHO Member State government, i.e. department of health, or representatives of other national institutions concerned with radiation protection.

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WHO

RESEARCH

To develop a solid base of scientific evidence

regarding the potential health risks of exposure to EMF, the International EMF Project:

- Evaluates the scientific literature
- Identifies gaps in knowledge requiring further research
- Promotes a research agenda for researchers and funding agencies, focusing on the potential long-term health effects of mobile phone use, and on the possible link between childhood leukaemia and exposure to magnetic fields from electric power

INFORMATION

To facilitate dialogue between stakeholders

by providing clear and unbiased information about the current scientific knowledge, the International EMF Project:

- Offers web-based access to a wide range of information resources
- Provides a database for researchers on current EMF research projects
- Convenes meetings on cutting-edge topics

STANDARDS

To help countries

set their national EMF legislation and regulations, and to promote the same high level of health protection to all people, the International EMF Project:

- Provides a unique database of EMF exposure standards worldwide
- Offers model legislation to protect against EMF exposure
- Encourages harmonization of EMF standards

KNOWLEDGE

No major public health risks have emerged from several decades of EMF research, but uncertainties remain.

The challenges...

- There is no clear understanding if and how EMF, at the low levels emitted by common appliances, might cause damage to cells
- If a common EMF exposure were found to cause a disease, it would likely be a rare one. Demonstrating such a relationship would require complex population studies
- New EMF emitting technologies are constantly being introduced on the market, resulting in different types of exposure

The way forward...

A global research effort is key to clarifying health risks. This will enable public policies that protect human health while allowing technological progress.

WHO'S INTERNATIONAL EMF PROJECT STRATEGY FOR DEALING WITH EMF RISK

Concerns have been expressed that exposure to extremely low frequency (ELF) magnetic fields at power frequencies (50/60 Hz) could lead to an increased incidence of cancer in children and other adverse health effects. The evidence comes primarily from residential epidemiological studies. These studies suggest that children exposed to ELF magnetic fields have an associated increased risk of leukaemia.

Radio frequency (RF) fields are used to great benefits in many facets of everyday life, such as radio and TV transmission, telecommunications (eg mobile telephones), diagnosis and treatments of disease and in industry for heating and sealing materials. With the rapid introduction of mobile telecommunications devices, especially among the general public, there has been a focus on the problems associated with near field RF exposure to the head from the small radiating antenna of mobile phones. In addition, concerns persist that exposure to pulsed and amplitude modulated RF fields may cause specific health effects.

As societies develop, greater use of certain technologies leads to increasing exposure to static electric and magnetic fields. This is especially the case in industry, transport, power transmission, research and medicine. Possible health effects from static fields have never been properly assessed. Given the rapid expansion of medical devices and imminent introduction, potentially on a large scale, of magnetic levitation transport systems that use strong static magnetic fields, any health impacts need to be properly assessed.

As part of its charter to protect public health and in response to public concern over health effects of EMF exposure, the World Health Organization (WHO) established the International EMF Project in 1996 to assess the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz. The EMF Project encourages focused research to fill important gaps in knowledge and to facilitate the development of internationally acceptable standards limiting EMF exposure

Project objectives

Key objectives of the Project are to:

- **provide a coordinated international response to concerns about possible health effects of exposure to EMF,**
- **assess the scientific literature and make a status report on health effects,**
- **identify gaps in knowledge needing further research to make better health risk assessments,**
- **encourage a focused research programme in conjunction with funding agencies,**

World Health Organization

The International EMF Project

The International EMF Project has been established to assess health and environmental effects of exposure to static and time varying electric and magnetic fields in the frequency range 0-300 GHz.

Background

Potential health effects of exposure to static and time varying electric and magnetic fields need scientific clarification. Electromagnetic fields of all frequencies represent one of the most common and fastest growing environmental influences, about which there is anxiety and speculation are spreading. EMF exposure now occurs to varying degrees to all populations of the world, and the levels will continue to increase with advancing technology. Thus, even a small health consequence from EMF exposure could have a major public health impact.

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Transco other than JS in his capacity as author and does not necessarily represent National Grid Transco's views

- Ethical approval The Childhood Cancer Research Group has local ethics committee approval and, through membership of the UK Association of Cancer Registries, has approval from the Patient Information Advisory Group with respect to cancer registration function.

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View Abstract

estimate), at birth about 80 000 would have lived within 199 m of a line and 320 000 between 200 and 599 m. Thus, of the 400-420 cases of childhood leukaemia occurring annually, about five would be associated with high voltage power lines, though this estimate is imprecise. We emphasise again the uncertainty about whether this statistical association represents a causal relation.

What is already known on this topic

Power frequency magnetic fields, produced by the electric power system, are "possibly carcinogenic"

A pooled analysis of case-control studies found that children living in homes with high magnetic fields (> 0.4 μT) had twice the risk of childhood leukaemia

High voltage power lines are one source of these fields

What this study adds

A UK study of 29 000 cases of childhood cancer, including 9700 cases of leukaemia, found a raised risk of childhood leukaemia in children who lived within 200 m of high voltage lines at birth compared with those who lived beyond 600m (relative risk 1.7)

There was also a slightly increased risk for those living 200-600 m from the lines at birth (relative risk 1.2, P for trend < 0.01); as this is further than can readily be explained by magnetic fields it may be due to other aetiological factors associated with power lines

Acknowledgments

We are grateful to colleagues at the Childhood Cancer Research Group and at National Grid Transco for help with this study and to cancer registries and the United Kingdom Children's Cancer Study Group for notification of cases of childhood cancer.

Footnotes

- Contributors GD was responsible for overall direction of the study and publication. GD and JS had the initial idea and designed the study. TV and MEK collected information on cases and controls and carried out the statistical analysis. JS assessed exposures. GD and JS are guarantors

- Funding This study was undertaken as part of a project funded by the United Kingdom Department of Health Radiation Protection Programme. The Childhood Cancer Research Group also receives funding from the Department of Health and the Scottish Ministers. The views expressed here are those of the authors and not necessarily those of the Department of Health and the Scottish Ministers. National Grid Transco provided staff time but no other funding.

- Competing interests JS is employed by National Grid Transco and worked on this project with their permission. A written contract exists between the Childhood Cancer Research Group and National Grid Transco specifying that the Childhood Cancer Research Group has complete control over the conduct, interpretation, and publication of this study; this paper has not been approved by anyone in National Grid

The results are highly significant but could nevertheless be due to chance—for example, if the leukaemia controls are not sufficiently representative of the relevant population. Some support for this explanation can be derived from the different distance distributions observed for the leukaemia and non-leukaemia controls in Table 1. Comparison of the leukaemia cases with the latter still suggests that there is an increased risk for leukaemia but it is much lower than that found using the matched controls. We emphasise, however, that the use of the matched controls is the most appropriate approach.

Six of the studies included in the pooled analysis referred to above[2] contain, or have been extended to include, analyses of proximity to power lines.[7 10 14] Of these, one, a previous UK study,[10] with 1582 cases of leukaemia diagnosed during 1992-6 (most of which will be contained within our 9700), found a relative risk of 1.42 (0.85 to 2.37) for acute lymphocytic leukaemia within 400 m for 275 and 400 kV lines; this supports our results. Studies in Canada[11] and Sweden[7] also found increased risks for childhood leukaemia (Canada: relative risk 1.8 (0.7 to 4.7) for residence within 100 m of transmission lines of 50 kV or more, and 1.3 within 50 m; Sweden: 2.9 (1.0 to 7.3) for residence £ 50 m versus 101-300 m from 220 and 400 kV power lines, with no increase for other childhood cancers). Studies from Denmark,[12] Norway,[13] and the United States[14] found relative risks below 1.0 but were based on smaller numbers. None of these estimates relates to distances as great as ours; some used a reference category that is within the distance where we found an increased risk.

Our study concerned home address at birth, whereas much previous magnetic field epidemiology has concerned address at other times. Half of the children with leukaemia in this study had the same address at diagnosis as at birth; we have no corresponding information for the control group.

The most obvious explanation of the association with distance from a line is that it is indeed a c
exposure to magnetic fields. For magnetic fields in the home the pooled analysis by Ahlbom e
risk of 2.00 (1.27 to 3.13) for exposures ≥0.4 μT versus < 0.1 μT; the risks for fields < 0.4 μT we
level.[2] Another pooled analysis, including additional studies, found a similar result with a thresh
the power lines we investigated, the magnetic field falls to 0.4 μT at an average of about 60 m from
on calculations using one year of recorded loads for a sample of 42 lines). Our increased risk seems to extend to at least 200 m, and at that distance typical calculated fields from power lines are < 0.1 μT, and often < 0.01 μT—that is, less than the average fields in homes from other sources. Thus our results do not seem to be compatible with the existing data on the relation between magnetic fields and risk. The estimated relative risk was more closely related to the reciprocal of the distance from the line than to the square of the reciprocal of the distance.

Conclusions

While few children in England and Wales live close to high voltage power lines at birth, there is a slight tendency for the birth addresses of children with leukaemia to be closer to these lines than those of matched controls. An association between childhood leukaemia and power lines has been reported in several studies, but it is nevertheless surprising to find the effect extending so far from the lines. We have no satisfactory explanation for our results in terms of causation by magnetic fields or association with other factors. Neither the association reported here nor previous findings relating to level of exposure to magnetic fields are supported by convincing laboratory data or any accepted biological mechanism.

Assuming that the higher risk in the vicinity of high voltage lines is indeed a consequence of proximity to the lines we can estimate the attributable annual number of cases of childhood leukaemia in England and Wales. The annual incidence of childhood leukaemia in England and Wales is about 42 per million; the excess relative risks at distances of 0-199 m and 200-599 m are about 0.69 and 0.23, respectively, giving excess rates of 28 and 10 per million. (These two estimates allow for the fact that the incidence for England and Wales is itself partly based on cases occurring in the vicinity of power lines.) We estimate that of the 9.7 million children in the population (2003

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We examined the possibility that the relation between distance and risk of leukaemia is a consequence of a relation between distance and socioeconomic status. We used the Carstairs deprivation index to allocate a measure of socioeconomic status to the census ward in which each child was living at birth.4 The results in **Table 4** confirm the previously reported association between affluence and risk of childhood leukaemia (P for trend < 0.01).5 Adjustment for socioeconomic status had no effect on the relative risks for distance (**Table 3**).

Table 4
Relative risks for categories of socioeconomic status

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Power lines produce small air ions through a process known as "corona." Fews et al suggest that this could lead to health effects when winds blow the ions away from the line.6 We have made an initial test of this hypothesis using a simple model suggested by Preece et al (personal communication), assuming the prevailing wind is from the south west. The case-control ratio was no greater downwind than upwind of power lines, so, using this admittedly oversimplified approach, we have no evidence to support this hypothesis.

Discussion

To date this is the largest study of childhood cancer and power lines, with roughly twice the num' living close to power lines than in the next largest study.7 We found that the relative risk of leuk (95% confidence interval 1.13 to 2.53) for children whose home address at birth was within 20 power line compared with those more than 600 m from the nearest line. For 200-600 m the rela (1.02 to 1.49). The finding that the increased leukaemia risk apparently extends so far from the lin .n view of the very low level of magnetic field that could be produced by power lines at these distances.

Possible explanations for findings

There is no obvious source of bias in the choice of cases or controls. The study is based on records of childhood cancer in England and Wales over most of the period that the National Grid has existed. Registration for childhood cancer is nearly complete, and it seems improbable that the likelihood of registration is related to proximity of birth address to transmission lines. Controls were selected from registers compiled through the legally required process of birth registration. No participation by cases or controls was required. We calculated distances without knowing case-control status, and we were able to include 88% of the eligible cases, each with a matched control.

Populations near power lines may have different characteristics from the rest of the population. In our control data there is a slight tendency in urban areas for greater affluence (measured by the Carstairs index) closer to lines, though in rural areas there is no clear trend. There is known to be a positive association between affluence and rates of childhood leukaemia. However, adjustment for socioeconomic status of the census ward of birth address did not explain our finding. Population mixing has been associated with childhood leukaemia,8 but in our cases individual mobility, measured by changes of postcode between birth and diagnosis, was no more common for those whose home at birth was closer to the lines. Other characteristics of the population (for instance parity, which has sometimes been found to be associated with childhood leukaemia9) may vary with proximity to power lines, but we do not have the data to determine whether these explain our result.

and furthest points of the building from the line, using large scale maps. We aimed to obtain a complete set of accurate distances for all subjects within 600 m of a line, a distance chosen to be well beyond that at which the magnetic field from the line is thought to be important.

Statistical analysis

We used conditional logistic regression on the matched case-control pairs to calculate relative risks and χ^2 values.

Results

Table 1 shows the distribution of distances from the nearest line for cases, subdivided into leukaemia, central nervous system/brain, and "other," and for matched controls. Most (97%) of these distances were ≥600 m. The relative risk is an estimate of the incidence compared with that at distances ≥ 600 m. For leukaemia, at each distance category < 600 m the relative risks are greater than 1.0; there is some evidence that the risk varies according to distance from the line, though there is no smooth trend. For the other diagnoses, our data suggest no increased risk.

Table 1

Distance of address at birth from nearest National Grid line for cases and controls in each diagnostic group, and estimated relative risk (RR)

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In general, emanations from a line source are expected to reduce in strength as the reciprocal o magnetic field from a power line generally falls as the inverse square of distance, or sometime For each diagnostic group, we tested whether the risk is some function of distance (d) from th 2), using three models: that the risk depends on the rank of the distance band, the reciprocal of , or the inverse square ($1/d^2$). There were no significant results for central nervous system/brain tumo other tumours." For leukaemia, the results of two of the trend analyses were significant ($P < 0.01$); these analyses suggest the risk might depend either on the rank of the distance category or on the reciprocal of distance. The latter seems more plausible. We therefore retabulated the results for leukaemia at intervals corresponding to roughly equal intervals of $1/d$ (**Table 3**). This change in the grouping of the data does not change the pattern of relative risk estimates shown in **Table 1** or the significance of the test for trend with $1/d$. For simplicity we also analysed risk of leukaemia in bands 0-199 m and 200-599 m. The risks relative to ≥ 600 m were 1.69 and 1.23; the trend with $1/d$ was significant ($P < 0.01$).

Table 2

Tests of hypotheses relating trends in relative risks to alternative measures of proximity to nearest line (based on the eight distance categories* in table 1). Figures are χ^2 for trend (with 1 df) and P value

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Table 3

Relative risk (RR) estimates for leukaemia using revised distance categories (see text)

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previous studies. About 4% of children in England and Wales live within 600 m of high voltage lines at birth. If the association is causal, about 1% of childhood leukaemia in England and Wales would be attributable to these lines, though this estimate has considerable statistical uncertainty. There is no accepted biological mechanism to explain the epidemiological results; indeed, the relation may be due to chance or confounding.

Introduction

The electric power system produces extremely low frequency electric and magnetic fields. Since 1979 there has been concern that these fields may be associated with cancer.1 Concern has concentrated on magnetic rather than electric fields and on childhood leukaemia in particular. A pooled analysis of nine studies that met specified quality criteria found that children living in homes with 24 hour average fields of ≥0.4 μT have twice the risk of leukaemia.2 In 2001 the International Agency for Research on Cancer classified extremely low frequency magnetic fields as "possibly carcinogenic" on the basis of "limited" epidemiological evidence and "inadequate" evidence from animals.

Magnetic fields in homes arise mainly from low voltage distribution wiring, house wiring, and domestic appliances. Only a small fraction of homes are close to high voltage overhead power lines (transmission lines), but in these homes the power line is likely to be the main source of magnetic field.

We investigated whether proximity of home address at birth to transmission lines in England and Wales is associated with increased risks of childhood cancer. It is not known which period of life, if any, is relevant to induction of cancer by magnetic fields. Previous research has considered address at diagnosis or throughout some specified period. Over half (55%) of cases of childhood leukaemia and 43% of other cancers in childhood occur by the age of 5 years.

Methods

Cases and controls

Children aged 0-14 years with cancer (malignant neoplasms and tumours of the central nervous system) in England, Scotland, and Wales, ascertained through several sources including the National Cancer Registration System and the UK Children's Cancer Study Group, are included in the National Registry of Childhood Tumours at the Childhood Cancer Research Group.

We identified nearly 33 000 cases of childhood cancer in children born in England and Wales, 1962-95, and diagnosed in England, Wales, or Scotland over the same period. We obtained birth information for just over 31 000 cases, 1700 having been excluded because the child was adopted or the birth record could not be traced. For each case we selected from birth registers a control matched for sex, date of birth (within six months), and birth registration district. Registration districts vary greatly in size and are frequently redefined; there are currently about 400. We attempted to find the postcode and approximate grid reference of the address at birth for all cases and controls, but this was not always possible. The final dataset comprised 29 081 matched case-control pairs (9700 for leukaemia) that we could map with respect to transmission lines.

Calculation of distance from power lines

We looked at overhead power lines forming the National Grid in England and Wales—that is, all 275 and 400 kV overhead lines (the highest voltages used) plus a small fraction of 132 kV lines, about 7000 km altogether. We obtained the grid references of all 21 800 pylons concerned from the records of National Grid Transco. Using the postcode at birth we identified subjects living within 1 km of a transmission line. For 93% of these addresses we obtained, from the Ordnance Survey product AddressPoint, a 0.1 m grid reference and hence calculated the shortest distance to any of the transmission lines that had existed in the year of birth, re-creating previous locations of lines when necessary and possible. For calculated distances less than 50 m, we took the average of the nearest

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Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study

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Abstract

Objective To determine whether there is an association between distance of home address at birth from high voltage power lines and the incidence of leukaemia and other cancers in children in England and Wales.

Design Case-control study.

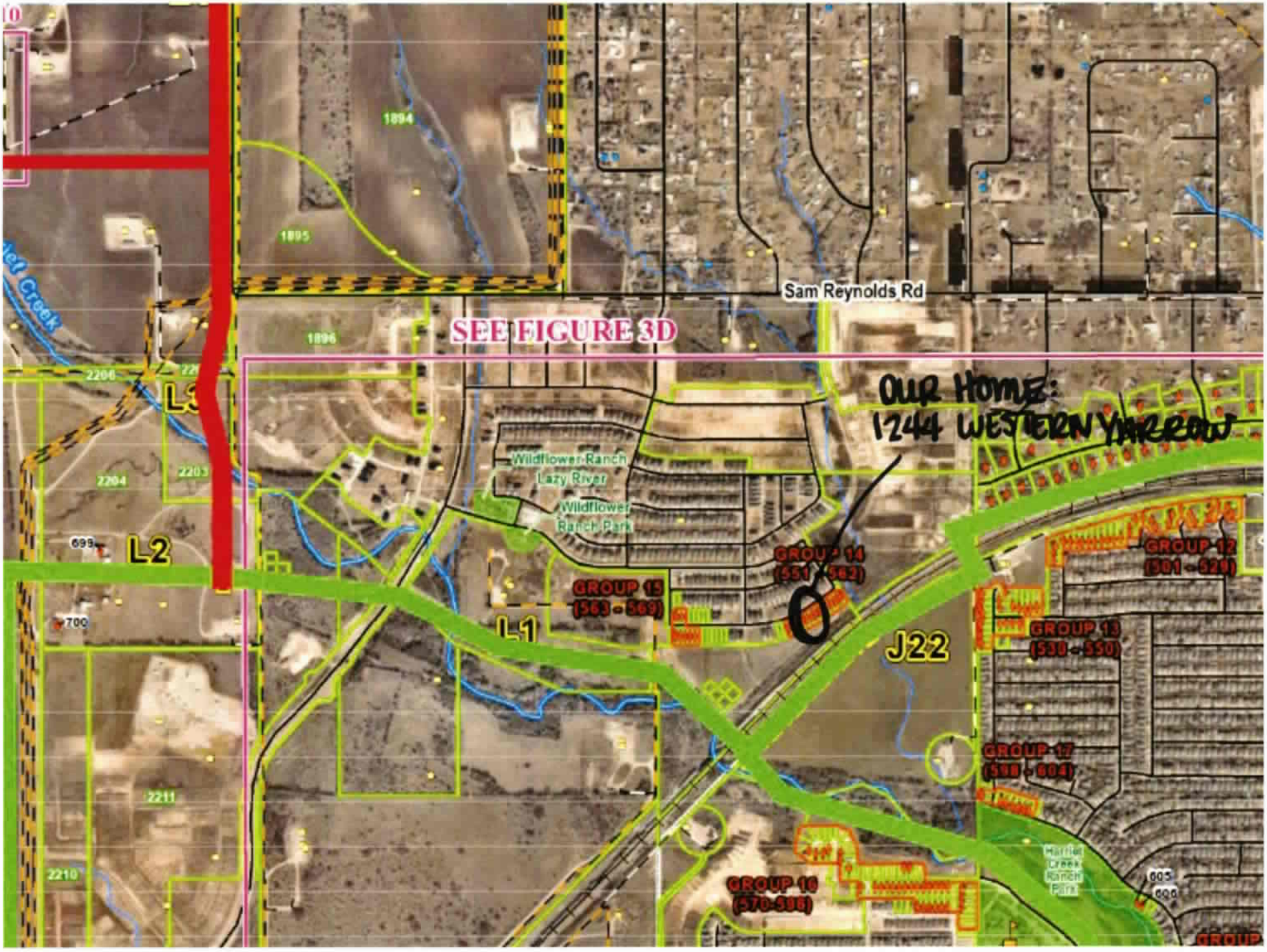
Setting Cancer registry and National Grid records.

Subjects Records of 29 081 children with cancer, including 9700 with leukaemia. Children were aged 0-14 years and born in England and Wales, 1962-95. Controls were individually matched for sex, approximate date of birth, and birth registration district. No active participation was required.

Main outcome measures Distance from home address at birth to the nearest high voltage overhead power line in existence at the time.

Results Compared with those who lived > 600 m from a line at birth, children who lived within 200 m had a relative risk of leukaemia of 1.69 (95% confidence interval 1.13 to 2.53); those born between 200 and 600 m had a relative risk of 1.23 (1.02 to 1.49). There was a significant ($P < 0.01$) trend in risk in relation to the reciprocal of distance from the line. No excess risk in relation to proximity to lines was found for other childhood cancers.

Conclusions There is an association between childhood leukaemia and proximity of home address at birth to high voltage power lines, and the apparent risk extends to a greater distance than would have been expected from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Sam Reynolds Rd
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Wildflower Ranch
Lazy River
Wildflower
Ranch Park
L1
L2
L3
J22
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(501 - 526)
GROUP 13
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GROUP 14
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