

# Magnetic fields of high voltage power lines and risk of cancer in Finnish adults: nationwide cohort study

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## Abstract

**Objective**—To investigate the risk of cancer in association with magnetic fields in Finnish adults living close to high voltage power lines.

**Design**—Nationwide cohort study.

**Subjects**—383 700 people who lived during 1970–89 within 500 metres of overhead power lines of 110–400 kV in a magnetic field calculated to be  $\geq 0.01 \mu\text{T}$ . Study subjects were identified by record linkages of nationwide registers.

**Main outcome measures**—Numbers of observed and expected cases of cancer, standardised incidence ratios, and incidence rate ratios adjusted for sex, age, calendar year, and social class—for example, by continuous cumulative exposure per  $1 \mu\text{T}$  year—with 95% confidence intervals from multiplicative models for all cancers combined and 21 selected types.

**Results**—Altogether 8415 cases of cancer were observed (standardised incidence ratio 0.98; 95% confidence interval 0.96 to 1.00) in adults. All incidence rate ratios for both sexes combined were non-significant and between 0.91 and 1.11. Significant excesses were observed in multiple myeloma in men (incidence rate ratio 1.22) and in colon cancer in women (1.16).

**Conclusions**—Typical residential magnetic fields generated by high voltage power lines do not seem to be related to the risk of overall cancer in adults. The previously suggested associations between extremely low frequency magnetic fields and tumours of the nervous system, lymphoma, and leukaemia in adults and breast cancer in women were not confirmed.

## Introduction

The epidemiological evidence for a carcinogenic effect of magnetic fields comes from three parallel lines of research: firstly, studies on childhood cancer in the vicinity of power lines<sup>1–3</sup>; secondly, studies on adult cancer in relation to electrical occupations or measured magnetic fields from occupational sources<sup>4–7</sup>; and, thirdly, studies on adult cancer in relation to magnetic fields from non-occupational sources including power lines.<sup>8–10</sup>

Eleven epidemiological studies have so far been published on adult cancer in relation to residential magnetic fields. Of them, seven studies with conflicting results and at most modest increases in risk have assessed exposures to power lines<sup>11–17</sup> and four to electric blankets.<sup>18–21</sup> Three studies have included all types of cancer<sup>11,17,21</sup> whereas four were restricted to haematological malignancies or leukaemia,<sup>12–14,22</sup> one included both leukaemia and brain tumours,<sup>23</sup> two were on breast cancer in women,<sup>15,24</sup> and one was limited to testicular cancer.<sup>16</sup>

We investigated the effect of 50 Hz magnetic fields on the occurrence of several types of cancer. High voltage power lines were chosen as the source of magnetic fields merely because there were existing documents from power companies that allowed the retrospective estimation of exposure to magnetic fields. A nationwide exposure register was created on personal exposures to 50 Hz magnetic fields from high voltage power lines over a

period of 20 years (1970–89) in Finland, which made it possible to investigate several types of cancer in one population based cohort study. We present the results on the relation between magnetic fields of high voltage power lines and risk of cancer in adults.

## Subjects and methods

### ASSESSMENT OF EXPOSURE

The exposure assessment of this study was based on calculations of the average annual magnetic fields (magnetic field densities) separately for each of the years 1970–89 at all buildings located closer than 500 metres from 110 kV, 220 kV, and 400 kV overhead power lines in Finland. The baseline exposure data included the locations of buildings (exact coordinates included in the Central Population Register) and power lines (in basic maps, scale 1:20 000), as well as the voltage, apparent power, and tower types of the 110–400 kV power lines (from power company records). These data cover about 18 000 km—that is, 90% of the total length of respective power lines in Finland.

In the calculation of magnetic fields, variables such as current, typical spatial locations of phase conductors in power lines, and the shortest distance to the central point of the building were taken into account. Currents were calculated from operational/nominal voltages and apparent powers of all power lines. The exposure assessment is more thoroughly described in earlier publications.<sup>25–27</sup>

### RECORD LINKAGES

Further data collection was based exclusively on the linkages of nationwide registers (that is, person and building data files of the Central Population Register, Population Census 1970, and Finnish Cancer Registry). The study cohort consisted of all people who had lived in a building with a calculated magnetic field of  $\geq 0.01$  microtesla ( $\mu\text{T}$ ) for any period between the years 1970–89. This means that the study population comprised both people with clearly increased exposures to residential magnetic fields of power lines and those who had been exposed only to typical residential background levels. The group with least cumulative exposure ( $<0.2 \mu\text{T}$  years) served as the internal reference group in some of the cancer analyses. As the result of several successive record linkages, the summary data files of the study ended up including the following information: dates of birth and death, sex, residential history with dates of moving in and out of the building, history of exposure with calculated average annual magnetic fields for each of the calendar years between 1970–89, social class, and cancer data including primary sites, histological codes, and dates of diagnosis for all incident primary tumours.

The following primary sites of cancer were selected to be studied: overall cancer, stomach (code 151 in the *International Classification of Diseases*, seventh revision), colon (153), rectum and rectosigmoid (154), pancreas (157), larynx and epiglottis (161), lung and trachea (162.0–1), breast in women (170), uterine corpus (172), ovary (175), prostate (177), testis (178), kidney (180), bladder, ureter, and urethra (181), melanoma of the skin (190), non-melanoma of the skin (191; excludes basal cell carcinomas), nervous system (193), thyroid

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# Magnetic Fields And Cancer In People Residing Near Swedish High Voltage Power Lines

**Kenneth Olden**



## **Magnetic Fields And Cancer In People Residing Near Swedish High Voltage Power Lines:**

**Magnetic Fields and Cancer in People Residing Near Swedish High Voltage Power Lines** Maria Feychting, Anders Ahlbom, 1994-05-01 A study aimed at testing the hypothesis that exposure to magnetic fields of the type generated by high voltage power lines increases cancer incidence This case control study was based on the population comprised of everyone who lived on property located within 300 meters from any of the 220 and 400 kv power lines in Sweden during the period from 1960 through 1985 90 charts and tables

**Non-ionizing Radiation** IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, International Agency for Research on Cancer, 2002 This publication represents the views and expert opinions of an IARC Working Group on the Evaluation of Carcinogenic Risks to Humans which met in Lyon 19-26 June 2001

**Electric and magnetic fields: invisible risks?** Sagan, 1996-05-01 The book determines that risks of EMF exposure are small compared to the already existing incidence of cancer in the population Five international studies completed since 1992 are excerpted and summarized The consensus of these reviews appears to be a general skepticism regarding the relationship of EMFs to human health effects particularly cancer

This treatise on electromagnetic fields EMF attempts to unravel the complex problem of how these fields affect humans and animals a challenge which has recently come under intense public scrutiny This book provides the reader with the knowledge to make an informed rational decision about the possible dangers inherent in our everyday contact with electric power

Handbook of Biological Effects of Electromagnetic Fields, Third Edition - 2 Volume Set Charles Polk, Elliot Postow, 1995-12-21 The first edition of this book has been recognized as the standard reference on biological effects of electric and magnetic fields from DC to microwaves But much has changed in this science since the book's original publication in 1986 With contributions from eighteen leading researchers this latest edition includes authoritative discussions of many new developments and will quickly become the new must have resource handbook Dielectric properties of biological tissue are thoroughly examined followed by chapters on physical mechanisms and biological effects of static and extremely low frequency magnetic fields New chapters on topics that were treated very briefly in the first edition now receive extensive treatment These topics include electric and magnetic fields for bone and soft tissue repair electroporation and epidemiology of ELF health effects The chapter on computer methods for predicting field intensity has been substantially revised to describe new numerical techniques developed within the last few years and includes calculations of power absorbed in the human head from cellular telephones The chapter discussing experimental results on RF interaction with living matter now contains information on effects of very high power very short duration pulses A new appendix on safety standards is based on the latest publications of governmental as well as quasi governmental organizations such as the U S Council on Radiation Protection in the United States Europe and Australia With all its revisions this updated version of the CRC Handbook of Biological Effects of Electromagnetic Fields provides the most comprehensive overview available of this rapidly changing science

*Assessment of Health Effects from Exposure to*

*Power-line Frequency Electric and Magnetic Fields* ,1998

### **Biological Effects of Magnetic and Electromagnetic**

**Fields** S. Ueno,2007-07-23 The International Symposium on Biological Effects of Magnetic and Electromagnetic Fields was held from September 3-4 1993 at Kyushu University in Fukuoka Japan Originally it was only intended to be an informal gathering of many scientists who had accepted my invitation to visit Kyushu University after the XXIVth General Assembly of the International Union of Radio Science URSI held in Kyoto prior to our symposium However since so many distinguished scientists were able to come it was decided that a more formal symposium would be possible It was a very productive symposium and as a result many of the guests consented that it would be a good idea to gather all the information put forth at the meeting and have it published In addition although they were unfortunately unable to attend the symposium many other distinguished scientists had also expressed their wish to contribute to this effort and in so doing help to increase understanding in this as yet relatively immature field of science The question of both positive and negative effects of magnetic and electromagnetic fields on biological systems has become more and more important in our world today as they

*NIEHS Report on Health Effects from Exposure to Power-line Frequency Electric and Magnetic Fields* ,1999

### **Biological Effects of Electric and Magnetic Fields**

David O. Carpenter, Sinerik Ayrapetyan,2012-12-02 Recent concerns over the possible hazards of electrical and magnetic fields in the home and workplace are comprehensively addressed within this book The chapters contain detailed research on the biological effects of electric and magnetic fields and evidence for and against any interaction of electromagnetic fields EMFs and biological systems The relative risk of exposure to EMFs Putative behavioral and neural effects of EMFs EMF effects on cells Power Frequency Magnetic Fields and Public Health William F. Horton, Saul Goldberg,1995-06-27 The prospect that electromagnetic fields EMFs may foster disease is an alarming thought one which raises such questions as What are these invisible forces How are they produced Is there conclusive evidence that they are harmful to the human body How do we protect ourselves against possible harm from them This book addresses these and other questions about magnetic fields bringing together in a single reference source the scientific background current status of health research and means to reduce the impact of EMFs in our environment Important information is provided for developing policies and procedures related to human interaction with magnetic fields The authors describe the concept of prudent avoidance emphasizing its value as a tool in the design construction and valuation of homes offices retail facilities and factories The book provides theory computer simulation results measured data and recommendations for magnetic field management all of which are useful as a power system design and construction resource The authors have compiled an impressive summary of the studies findings and reports done in the past 15 years in the areas of human health effects which might be attributed to exposure to power frequency magnetic fields Wherever appropriate throughout text the authors provide examples to illustrate concepts and include end of chapter exercises with solutions to help readers solidify their understanding of the material presented Originally designed as a textbook this is also

an excellent reference in the areas of environmental engineering city and regional planning and electrical engineering

Electromagnetic Fields United States. General Accounting Office,1994 Niehs Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields Kenneth Olden,1999-11 Describes the analysis and conclusions of the National Institute of Environmental Health Sciences NIEHS regarding possible health effects from ELF EMF magnetic field exposures The NIEHS carried out a hazard evaluation of ELF EMF exposure that examined both historical and novel scientific evidence on possible health and biological effects at a series of open scientific meetings The scientific evidence suggesting that ELF EMF exposures pose any health risk is weak and there is a lack of connection between the human data and the experimental data animal and mechanistic **Epidemiology of Electromagnetic Fields** Martin Roosli,2014-06-03

This book gives an overview of the epidemiological methods used to research the effects of electromagnetic fields EMFs on human health The first part of the book introduces epidemiological concepts and principles providing appropriate examples and tips for practical usage The second part details the state of scientific knowledge for some controversial issues in EMF research while the third part considers how novelty the steep increase of radiofrequency RF EMF exposure from wireless communications and other challenges affect risk assessment today **Questions and Answers about Electric and**

**Magnetic Fields Associated with the Use of Electric Power** DIANE Publishing Company,1997-03 Electric power is a fact of life however with it come certain precautions that are also well known Recently a new question has emerged Does electric power have anything to with cancer This document provides answers to common questions about the possible health effects of Electric Magnetic Fields EMF s Defines basic electrical terms describes EMF s discusses recent scientific studies Describes what the gov t is doing to address public concerns about EMF s Addresses questions people have about their own exposure to EMF s Lists publications hotlines tech ref s Maglev Deployment Program, Programmatic EIS ,2001

Kwajalein Atoll, U.S. Army Proposed Actions Including Proposed Strategic Defense Initiative Activities, Prepared by U.S. Army Strategic Defense Command ,1989 Cancer: Causes and Prevention V.K. And M. Ahluwala,2005 **Environmental Health Perspectives** ,2004 Cumulated Index Medicus ,1994 Methodologies for Community Health Assessment in Areas of Concern ,2001 Risks to Students in School ,1995 Every day school aged children encounter a wide variety of hazards that occur both outside and inside schools This document presents findings of a report that examined the scientific data on the risks for student injury and illness in the school environment The information is designed to help administrators set priorities for reducing risks to students The report focuses on the risks that students between 5 to 18 years old encounter while they are at school on the school grounds at school related activities and traveling to and from school Key findings include 1 The two leading causes of death in school aged children are motor vehicles and firearms however relatively few of these deaths occur in schools or on school buses 2 quite often the relative safety of schools on a national average basis is unknown and 3 schools contribute to the risks of injury or illness in school aged children however little is known about

schools contribution to nonfatal illness and injury Finally national data particularly for environmental hazards were usually inadequate to assess the risks to students Data are presented for incidence of unintentional injuries including playground related school athletics transportation school bus related pedestrian injuries along with data for intentional injuries including school associated violent deaths and weapons Information is presented for illness caused by environmental hazards such as asbestos and lead and for those that arise from exposure to infectious agents Suggestions for comparing and managing risks are offered References accompany each chapter Eight figures and 35 tables are included LMI

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In some sort of driven by information and connectivity, the power of words has be more evident than ever. They have the ability to inspire, provoke, and ignite change. Such could be the essence of the book **Magnetic Fields And Cancer In People Residing Near Swedish High Voltage Power Lines**, a literary masterpiece that delves deep in to the significance of words and their impact on our lives. Published by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book is key themes, examine its writing style, and analyze its overall affect readers.

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