Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the fourth trimester of 2005.

Dr. Maurits De Ridder  
Occupational and Environmental Health Section  
Ghent University

1. Reviews

NON-CANCER EMF EFFECTS RELATED TO CHILDREN.  
Feychting M.  

Potential adverse effects of electromagnetic field exposure on the developing child have been discussed during the last decades. Effects during fetal development could have major consequences and possibly lead to various adverse pregnancy outcomes. This study summarizes the evidence on adverse pregnancy outcomes in relation to extremely low frequency (ELF) and radiofrequency (RF) exposures and briefly discusses other potential health effects, excluding cancer, following childhood exposures to these fields. Most studies of ELF exposures have not demonstrated any consistent risk increases for adverse pregnancy outcomes, but limitations in the exposure assessment methods and very limited power to study high exposure levels prevent any conclusions. Findings of an increased risk of spontaneous abortion in relation to maximum magnetic field exposures in two studies need to be confirmed. Studies of RF exposure have mostly been limited to physiotherapists and although some positive findings have been reported, no specific type of malformation or other adverse outcome has been consistently reported. Different types of symptoms and effects on cognitive function in relation to both ELF and RF fields have been reported in adults, but scientific studies have not confirmed that these symptoms are caused by the electromagnetic fields. No information is available for children.

DO MAGNETIC FIELDS CAUSE INCREASED RISK OF CHILDHOOD LEUKEMIA VIA MELATONIN DISRUPTION?  
Henshaw D.L., Reiter R.J.  

Epidemiological studies have reported associations between exposure to power frequency magnetic fields and increased risk of certain cancer and noncancer illnesses. For childhood leukemia, a doubling of risk has been associated with exposures above 0.3/0.4 microT. Here, we propose that the melatonin hypothesis, in which power frequency magnetic fields suppress the nocturnal production of melatonin in the pineal gland, accounts for the observed increased risk of childhood leukemia. Such melatonin disruption has been shown in animals, especially with exposure to electric and/or rapid on/off magnetic fields. Equivocal evidence has been obtained from controlled laboratory magnetic field exposures of volunteers, although the exposure conditions are generally atypical of neighborhood exposures. In contrast, support for the hypothesis is found in the body of studies showing magnetic field disruption of melatonin in human populations chronically exposed to both electric and magnetic fields associated with electricity distribution. Further support comes from the observation that melatonin is highly protective of oxidative damage to the human haemopoietic system. Aspects of the hypothesis are amenable to further investigation.
Based on the epidemiological association between residential exposure to extremely low frequency-magnetic fields (ELF-MF) and childhood leukaemia, the International Agency for Research on Cancer classified ELF-MF as a possible human carcinogen. Since clear supportive laboratory evidence is lacking and biophysical plausibility of carcinogenicity of MFs is questioned, a causal relationship between childhood leukaemia and magnetic field exposure is not established. Among the alternative explanations, selection bias in epidemiological studies of MFs seems to be the most plausible hypothesis. In reviewing the epidemiological literature on ELF-MF exposure and childhood leukaemia, the authors found evidence both for and against the existence of selection bias. To evaluate the potential for selection bias, they examined the relationship of socioeconomic status to subject participation and exposure to MFs. They find that, often, reporting of selection processes in itself is biased and incomplete, making the interpretation and evaluation of a potential for bias difficult. However, if present, such a bias would have wide implications for case-control studies in general. Even if present, selection bias may not necessarily explain the entire association between magnetic exposure and childhood leukaemia.

2. Occupational exposure

Nichols L, Sorahan T.

The mortality experienced by a cohort of 83,923 employees of the former Central Electricity Generating Board of England and Wales was investigated for the period 1973-2002. All employees had worked for at least 6 months with some employment between 1973 and 1982. Standardized mortality ratios (SMRs) were used to assess mortality in the total cohort and in three sub-cohorts: power station workers, substation and transmission workers and workers at non-operational locations. These classifications were based on the place of work of the first known job. Overall mortality was significantly below that expected, based on national rates [males: observed (Obs) 18,773, expected (Exp) 22,497.9, SMR 83; females: Obs 1122, Exp 1424.9, SMR 79]. Statistically significant deficits of deaths were also found for most of the major disease groupings. However, significant excesses of deaths were found in male power station workers for cancer of the pleura (Obs 129, Exp 30.3, SMR 426) and in male workers from non-operational locations for cancer of the brain (Obs 55, Exp 36.0, SMR 153). There was also a non-significant excess of deaths from cancer of the breast in male power station workers (Obs 10, Exp 5.3, SMR 190). Conclusions: Mortality was exceptionally low for most causes of death but late health effects from earlier asbestos exposure were still in evidence.
The Swedish Family-Cancer Database was used to calculate standardized incidence ratios for different social classes and occupational groups. The overall standardized incidence ratio was close to unity between different socioeconomic groups, except for female manual workers with a significantly decreased risk. Among male occupations, increased risks were noted for sales agents, seamen, and chemical process workers. Electrical workers had a nearly significant lower risk (SIR = 0.7; CI = 0.45 – 1.00). For female occupations, increased risks were observed among mechanics, iron and metalware workers, hairdressers, and launderers and dry cleaners. Conclusions: The present study suggests that socioeconomic/occupational factors have a minor effect on the risk of leukemia. Occupational groups with possible exposure to organic solvents and other chemicals such as chemical process workers, mechanics, iron and metalware workers, and launderers and dry cleaners may entail true risk for leukemia.

Prospective Study of Occupation and Amyotrophic Lateral Sclerosis Mortality.


Occupational exposures are suspected of contributing to the risk of amyotrophic lateral sclerosis (ALS), but results of epidemiologic studies have been inconsistent. The authors prospectively assessed the relation between occupation and ALS mortality among more than 1 million participants in the Cancer Prevention Study II of the American Cancer Society. Follow-up from 1989 through 2002 identified 507 ALS deaths among men and 430 among women. Adjusted rate ratios were calculated by using Mantel-Haenszel weights and Cox proportional hazards. Among men, elevated ALS mortality was found for programmers (rate ratio = 4.55, 95% confidence interval: 1.46, 14.2; p = 0.009) and laboratory technicians (rate ratio = 1.96, 95% confidence interval: 1.04, 3.66; p = 0.04). Occupations previously associated with increased risk of ALS for which no increased risk was found included farmers, electricians, and welders, although the numbers of electricians (eight ALS deaths) and welders (two ALS deaths) were small. Among women, only machine assemblers had significantly increased ALS mortality (rate ratio = 2.81, 95% confidence interval: 1.05, 7.53; p = 0.04).

Conclusion: Results, which suggest that male programmers and laboratory technicians and female machine assemblers may be at increased risk of death from ALS, should be interpreted cautiously, however, because they are based on small numbers.

Occupational Exposures and Male Infertility.


The purpose of this study was to determine the association between male occupational exposures and infertility. A retrospective case-control study was performed using data collected between 1991 and 1997 at nine US clinical sites as part of a previously conducted large multicenter trial. Cases were defined as infertile
males whose partner had an infertility evaluation with normal results, and controls were defined as fertile males whose partner became pregnant within 2 years. Exposures were assessed by means of self-report questionnaires. Bivariate, stratified, and multivariable analyses were performed. A total of 650 infertile cases and 698 fertile controls were compared. In the final model, a protective association with infertility was observed for occupational exposures to radiation (odds ratio=0.21, 95% confidence interval: 0.06, 0.77) and video display terminals (odds ratio=0.30, 95% confidence interval: 0.13, 0.68). No significant associations were noted between infertility and exposure to shift work, metal fumes, electromagnetic fields, solvents, lead, paint, pesticides, work-related stress, or vibration. Overall, no clear, clinically important associations between occupational exposures and male infertility could be identified in this study.

3. Experimental human research

EFFECT OF A LOW INTENSITY MAGNETIC FIELD ON HUMAN MOTOR BEHAVIOR.
Legros A., Beuter A.

Extremely low frequency (ELF) magnetic fields (MF) are omnipresent in our modern daily environment, but their effects on humans are still not clearly established. The aim of this study was to determine the effect of a 50 Hz, 1,000 microT MF centered at the level of the head on human index finger micro-displacements. Twenty-four men recruited among the personnel of the French company, Electricite de France (EDF), completed the experiment. Their postural and kinetic tremors were recorded under four "field-on" and four "field-off" conditions, each tested during a real and a sham sequence. Eight postural and four kinetic tremor characteristics were calculated on recorded time series and were used for statistical analysis. No effect of the MF was found for kinetic tremor. Concerning postural tremor, the proportion of oscillations at low frequencies (between 2 and 4 Hz) was higher during the real than during the sham exposure sequence (P<.05). It suggests that MF could have a subtle delayed effect on human behavior, which is clearly not pathological.