Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the first trimester of 2015

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

1. Reviews

SCIENTIFIC COMMITTEE ON EMERGING AND NEWLY IDENTIFIED HEALTH RISKS (SCENIHR): POTENTIAL HEALTH EFFECTS OF EXPOSURE TO ELECTROMAGNETIC FIELDS.
SCENIHR, 27 January 2015.
http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf

The purpose of this Opinion is to update the SCENIHR Opinions of 19 January 2009 'Health effects of exposure to EMF' and 6 July 2009 'Research needs and methodology to address the remaining knowledge gaps on the potential health effects of EMF' in the light of newly available information since then, and to give special consideration to areas where important knowledge gaps were identified in the previous Opinion.

Health effects from Extremely Low Frequency (ELF) EF and MF.

The new epidemiological studies are consistent with earlier findings of an increased risk of childhood leukaemia with estimated daily average exposures above 0.3 to 0.4 μT. As stated in the previous Opinions, no mechanisms have been identified and no support is existing from experimental studies that could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation.

Epidemiological studies do not provide convincing evidence of an increased risk of neurodegenerative diseases, including dementia, related to power frequency MF exposure. Furthermore, they show no evidence for adverse pregnancy outcomes in relation to ELF MF. The studies concerning childhood health outcomes in relation to maternal residential ELF MF exposure during pregnancy involve some methodological issues that need to be addressed. They suggest implausible effects and need to be replicated independently before they can be used for risk assessment. Recent results do not show an effect of the ELF fields on the reproductive function in humans.

Studies investigating possible effects of ELF exposure on the power spectra of the waking EEG are too heterogeneous with regard to applied fields, duration of exposure, and number of considered leads, and statistical methods to draw a sound conclusion. The same is true for behavioral outcomes and cortical excitability.

Overall, existing studies do not provide convincing evidence for a causal relationship between ELF MF exposure and self-reported symptoms.

2. Residential exposure

CHILDHOOD LEUKEMIA AND 50 HZ MAGNETIC FIELDS: FINDINGS FROM THE ITALIAN SETIL CASE-CONTROL STUDY.

Salvan A, Ranucci A, Lagorio S, Magnani C; SETIL Research Group.

Int J Environ Res Public Health. 2015 Feb 16;12(2):2184-204.

The authors report on an Italian case-control study on childhood leukemia and exposure to extremely low frequency magnetic fields (ELF-MF). Eligible for inclusion were 745 leukemia cases, aged 0-10 years at diagnosis in 1998-2001, and 1475 sex- and age-matched population controls. Parents of 683 cases and 1044 controls (92% vs. 71%) were interviewed. ELF-MF measurements (24-48 h), in the child's bedroom of the dwelling inhabited one year before diagnosis, were available for 412 cases and 587 controls included in the main conditional regression analyses. The magnetic field induction was 0.04 μT on average (geometric mean), with 0.6% of cases and 1.6% of controls exposed to >0.3 μT. The impact of changes in the statistical model, exposure metric, and data-set restriction criteria was explored via sensitivity analyses. No exposure-disease association was observed in analyses based on continuous exposure, while analyses based on categorical variables were characterized by incoherent exposure-outcome relationships.

Conclusions: These results may be affected by several sources of bias and they are non-informative at exposure levels >0.3 μT. Nonetheless, the study may contribute to future meta- or pooled analyses. Furthermore, exposure levels among population controls are useful to estimate attributable risk.

EVERYDAY EXPOSURE TO POWER FREQUENCY MAGNETIC FIELDS AND ASSOCIATIONS WITH NON-SPECIFIC PHYSICAL SYMPTOMS.

Bolte JF, Baliatsas C, Eikelboom T, van Kamp I.

Environ Pollut. 2015 Jan;196:224-9.

The aim of this study was to investigate the association between exposure to extremely low frequency magnetic fields (ELF MF), or power frequency fields, and non-specific physical symptoms (NSPS). In a cross-sectional study, personal exposure to ELF MF was measured for 99 adults selected in and around Amsterdam, the Netherlands in 2009-2010. They were scored on 16 NSPS. As a cut-off point for the individual 24-h time weighted average exposure the 80-percentile (0.09 mT) was chosen. As only one man scored “moderately high” on the somatisation scale against nine women, we decided to proceed analyses only with the 48 women. The crude odds ratio (OR) for women was 8.50 (CI 95%: 1.73-46.75), suggesting that for women environmental exposure to ELF MF is associated with an increased score on NSPS.

Conclusions: As this is an exploratory cross-sectional study in a relatively small sample, no conclusions regarding causality can be drawn.

SYMPTOM REPORTING AFTER THE INTRODUCTION OF A NEW HIGH-VOLTAGE POWER LINE: A PROSPECTIVE FIELD STUDY.

Porsius JT, Claassen L, Smid T, Woudenberg F, Petrie KJ, Timmermans DR.

Environ Res. 2015 Apr;138:112-7.

The present study is the first to prospectively investigate whether self-reported health complaints and causal beliefs increase after the construction of a new power line.

The authors used a quasi-experimental design with two pretests before and two posttests after a new HVPL was put into operation. Residents living near (0-300m, n=229; 300-500m, n=489) and farther away (500-2000m, n=536) participated in the study. Linear mixed models were fitted to test whether symptom reports and beliefs that power lines caused health complaints increased more in residents living close to the new line compared to residents living farther away.

A significantly ($p<.05$) larger increase from baseline in symptom reports and causal beliefs was found in residents living within 300m from the new power line when compared to residents living farther away. While symptom reports did not differ at baseline, the belief that a power line could cause these symptoms was at baseline already stronger for residents living close compared to residents living farther away.

Conclusions: The authors found a negative impact of a new HVPL on health perceptions of nearby residents, even before the line was put into operation.

3. Occupational exposure

CASE-CONTROL STUDY OF OCCUPATIONAL EXPOSURE TO ELECTRIC SHOCKS AND MAGNETIC FIELDS AND MORTALITY FROM AMYOTROPHIC LATERAL SCLEROSIS IN THE US, 1991-1999.

Vergara X, Mezei G, Kheifets L.

J Expo Sci Environ Epidemiol. 2015 Jan;25(1):65-71.

The authors investigated the relationship between occupational exposure to electric shocks (ES) and magnetic fields (MF) and amyotrophic lateral sclerosis (ALS) using 1991-1999 US mortality data. For each of the 5886 included ALS deaths, 10 controls-matched on sex-, age-, year- and region-were selected from among other deaths. Usual occupation as reported on death certificates was linked to job-exposure matrices for ES and MF. Education and electric occupations were associated with moderately increased ALS risks (odds ratio (OR)=1.85, 95% confidence interval (CI)=1.67, 2.04; OR=1.23, 95% CI=1.04, 1.47, respectively). For ES, ALS mortality OR were 0.73 (95% CI=0.67, 0.79) for high and 0.90 (95% CI=0.84, 0.97) for medium exposure compared with low exposure. For MF, ALS ORs were 1.09 (95% CI=1.00, 1.19) for high and 1.09 (95% CI=0.96, 1.23) for medium exposure as compared with low exposure. For electric occupations, ALS ORs were insensitive to adjustments for ES, MF or both.

Conclusions: Consistent with previous publications, an association between electric occupations and ALS was observed. Findings do not support occupational exposure to ES or MF as an explanation.

OCCUPATIONAL EXPOSURE TO MAGNETIC FIELDS AND ELECTRIC SHOCKS AND RISK OF ALS: THE SWISS NATIONAL COHORT.

Huss A, Spoerri A, Egger M, Kromhout H, Vermeulen R; Swiss National Cohort.

Amyotroph Lateral Scler Frontotemporal Degener. 2015 Mar;16(1-2):80-5.

Amyotrophic lateral sclerosis (ALS) has been associated with exposures in so-called 'electrical occupations'. It is unclear if this possible link may be explained by exposure to extremely low-frequency magnetic fields (ELF-MF) or by electrical shocks. We evaluated ALS mortality in 2000-2008 and exposure to ELF-MF and electrical shocks in the Swiss National Cohort, using job exposure matrices for occupations at censuses 1990 and 2000. We compared 2.2 million workers with high or medium vs. low exposure to ELF-MF and electrical shocks using Cox proportional hazard models. Results showed that mortality from ALS was higher in people who had medium or high ELF-MF exposure in both censuses (HR 1.55 (95% CI 1.11-2.15)), but closer to unity for electrical shocks (HR 1.17 (95% CI 0.83-1.65)). When both exposures were included in the same model, the HR for ELF-MF changed little (HR 1.56), but the HR for electric shocks was attenuated to 0.97.

Conclusions: There was an association between exposure to ELF-MF and mortality from ALS among workers with a higher likelihood of long-term exposure.

EXTREMELY LOW-FREQUENCY MAGNETIC FIELD EXPOSURE, ELECTRICAL SHOCKS AND RISK OF PARKINSON'S DISEASE.

van der Mark M, Vermeulen R, Nijssen PC, Mulleners WM, Sas AM, van Laar T, Kromhout H, Huss A.

Int Arch Occup Environ Health. 2015 Feb;88(2):227-34.

Previous studies did not provide strong evidence for an increased Parkinson's disease (PD) risk after exposure to extremely low-frequency magnetic fields (ELF-MF), but were limited in their scope to address other exposures related to the use of electricity such as electrical shocks. The authors evaluated the associations of PD with exposure to ELF-MF, electrical shocks and having worked in "electrical occupations." They conducted a hospital-based case-control study, including 444 PD patients and 876 age- and sex-matched controls. Occupational histories were collected in telephone interviews and were linked to job-exposure matrices on ELF-MF exposure and on electrical shocks. In addition, questions on use of household appliances involving ELF-MF exposure, experienced electrical shocks and potential confounders were asked.

No association of PD risk with any of the evaluated exposures related to electricity was observed. However, quite consistently reduced risk estimates across the majority of the exposure categories explored were observed. Given the results of the previous studies and the absence of any postulated mechanism, this is unlikely to represent a true protective effect of ELF-MF or electrical shocks on the occurrence of PD.

Conclusions: The results of this study suggest that no association exists between PD and exposure to ELF-MF, electrical shocks or having worked in "electrical occupations."

4. Exposure assessment

TYPICAL EXPOSURE OF CHILDREN TO EMF: EXPOSIMETRY AND DOSIMETRY.
Valič B, Kos B, Gajšek P.
Radiat Prot Dosimetry. 2015 Jan;163(1):70-80.

A survey study with portable exposimeters, worn by 21 children under the age of 17, and detailed measurements in an apartment above a transformer substation were carried out to determine the typical individual exposure of children to extremely low-frequency electromagnetic field. In total, portable exposimeters were worn for >2400 h. The average exposure was determined to be low compared with ICNIRP reference levels: 0.29 μT. However, some of the volunteers were more exposed: the highest realistic exposure, to which children could be exposed for a prolonged period of time, was 1.35 μT. In the typical exposure scenario, the extremely low frequency exposure is <0.03 % of the corresponding basic restriction. In the worst-case situation, the extremely low frequency exposure is <0.11 % of the basic restriction. Analysis of the exposures and the individual's perception of being exposed/unexposed to an ELF magnetic field showed that it is impossible to estimate the individual exposure to an ELF magnetic field based only on the information provided by the individuals, as they do not have enough knowledge and information to properly identify the sources in their vicinity.

Conclusions: The exposure was determined to be very low compared with ICNIRP reference levels.

SURVEY OF RESIDENTIAL POWER-FREQUENCY MAGNETIC FIELDS IN MELBOURNE, AUSTRALIA.
Karipidis KK.
Radiat Prot Dosimetry. 2015 Jan;163(1):81-91.

Pooled analyses of epidemiological studies have reported an association between prolonged residential exposure to power-frequency magnetic fields of >0.4 μT and an increased risk in childhood leukaemia. In order to compare residential magnetic fields in Australia with those in other countries, a survey was conducted in 296 randomly selected homes in Melbourne. Magnetic fields were assessed by performing spot measurements throughout the house and 24-h measurements in rooms where children spend large amounts of time. Children's exposure in Australia was generally comparable with that in other countries with average fields of 0.05-0.06 μT (95 % CI 0.05-0.06 μT). Prolonged exposure of >0.4 μT was shown in ∼2 % of the homes (95 % CI 0.2-3.6 %) mainly being due to close proximity of the house to transmission lines.

Conclusions: Based on the results of this survey, the public health impact of a causal association between residential magnetic fields and childhood leukaemia is expected to be small.

EXAMPLES OF OCCUPATIONAL EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS AT 110-KV GAS-INSULATED SUBSTATIONS (GISS).

Korpinen L, Pääkkönen R.

Radiat Prot Dosimetry. 2015 Feb;163(3):394-7.

The objectives of the study were to present examples of occupational exposure to electric and magnetic fields at gas-insulated substations (GISs) and to analyse the exposure according to the new European Directive 2013/35/EU. The aim was also to describe the details of the measurements of this study at GISs. Electric and magnetic fields were measured (45 measurements in total) at two GISs in the Tampere region of Finland. Inside the GISs, magnetic field values varied from 0.4 to 43.0 μT, and electric fields from 5 to 90 V m(-1). In the cable room of GIS B, the maximum value was 250 μT (very near the cables). The values did not exceed the low or high action levels of the new Directive 2013/35/EU.

Conclusions: It can be stated that at 110-kV GISs, workers are not exposed to electromagnetic fields (EMFs) higher than the new European Directive 2013/35/EU.

5. Leukaemia studies

A REVIEW AND META-ANALYSIS OF OUTDOOR AIR POLLUTION AND RISK OF CHILDHOOD LEUKEMIA.

Filippini T, Heck JE, Malagoli C, Giovane CD, Vinceti M.

J Environ Sci Health C Environ Carcinog Ecotoxicol Rev. 2015 Jan 2;33(1):36-66.

To date, the etiology of childhood leukemia remains largely unknown. Few risk factors (genetic susceptibility, infections, ionizing radiation, etc.) have been clearly identified, but they appear to explain only a small proportion of cases. Considerably more uncertain is the role of other environmental risk factors, such as indoor and outdoor air pollution. This study sought to summarize and quantify the association between traffic-related air pollution and risk of childhood leukemia, and further examined results according to method of exposure assessment, study quality, leukemia subtype, time period, and continent where studies took place. After a literature search yielded 6 ecologic and 20 case-control studies, the studies were scored based on the Newcastle-Ottawa Scale. The studies assessed residential exposure to pollutants from motorized traffic by computing traffic density in the neighboring roads or vicinity to petrol stations, or by using measured or modeled nitrogen dioxide and benzene outdoor air levels. Because heterogeneity across studies was observed, random-effects summary odds ratios (OR) and 95% confidence intervals (CI) were reported. Whenever possible stratified analyses comparing acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML) were additionally conducted. Limiting the analysis to high-quality studies (Newcastle-Ottawa Scale ≥ 7), those using traffic density as the exposure assessment metric showed an increase in childhood leukemia risk in the highest exposure category (OR = 1.07, 95% CI 0.93-1.24). However, evidence of publication bias was observed. Results for NO2 exposure and benzene showed an OR of 1.21 (95% CI 0.97-1.52) and 1.64 (95% CI 0.91-2.95) respectively. When stratifying by leukemia type, the results based upon NO2 were 1.21 (95% CI 1.04-1.41) for ALL and 1.06 (95% CI 0.51-2.21) for AML; based upon benzene were 1.09 (95% CI 0.67-1.77) for ALL and

2.28 (95% CI 1.09-4.75) for AML. Estimates were generally higher for exposures in the postnatal period compared to the prenatal period, and for European studies compared to North American studies.

Conclusions: Overall, these results support a link between ambient exposure to traffic pollution and childhood leukemia risk, particularly due to benzene.

CHILDHOOD ACUTE LYMPHOBLASTIC LEUKAEMIA AND INDICATORS OF EARLY IMMUNE STIMULATION: THE ESTELLE STUDY (SFCE).

Ajrouche R, Rudant J, Orsi L, Petit A, Baruchel A, Lambilliotte A, Gambart M, Michel G, Bertrand Y, Ducassou S, Gandemer V[1], Paillard C, Saumet L, Blin N, Hémon D, Clavel J.

Br J Cancer. 2015 Mar 17;112(6):1017-26.

Factors related to early stimulation of the immune system (breastfeeding, proxies for exposure to infectious agents, normal delivery, and exposure to animals in early life) have been suggested to decrease the risk of childhood acute lymphoblastic leukaemia (ALL).

The national registry-based case-control study, ESTELLE, was carried out in France in 2010-2011. Population controls were frequency matched with cases on age and gender. The participation rates were 93% for cases and 86% for controls. Data were obtained from structured telephone questionnaires administered to mothers. Odds ratios (OR) were estimated using unconditional regression models adjusted for age, gender, and potential confounders.

In all, 617 ALL and 1225 controls aged ≥1 year were included. Inverse associations between ALL and early common infections (OR=0.8, 95% confidence interval (CI): 0.6, 1.0), non-first born (≥3 vs 1; OR=0.7, 95% CI: 0.5, 1.0), attendance of a day-care centre before age 1 year (OR=0.7, 95% CI: 0.5, 1.0), breastfeeding (OR=0.8, 95% CI: 0.7, 1.0), and regular contact with pets (OR=0.8, 95% CI: 0.7, 1.0) in infancy were observed.

Conclusions: These results support the hypothesis that conditions promoting the maturation of the immune system in infancy have a protective role with respect to ALL.