

Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the third trimester of 2016

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

1. Reviews

GENETIC DAMAGE IN HUMANS EXPOSED TO EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELDS.

Maes A, Verschaeve L.

Arch Toxicol. 2016;90(10):2337-2348.

The classification of extremely low-frequency magnetic fields by the International Agency for Research on Cancer in the group of 'possible human carcinogens' (group 2B) is essentially based on epidemiologic evidence showing an association between MF exposures and childhood leukaemia. Despite many in vitro and in vivo investigations, there is no established causal relationship yet. However, human cytogenetic biomonitoring studies that were conducted in the past show predominantly positive results, i.e. increased cytogenetic damage in peripheral blood lymphocytes or buccal cells of ELF-MF-exposed subjects. This is important given the established link between observed cytogenetic damage in cells of people and an increased cancer risk. The authors here conducted an evaluation of the published investigations and found that many of the studies clearly have shortcomings, which often prevent any firm conclusion.

Conclusions: As a matter of fact, there are reasons to believe that effects are not that impressive. However, the totality of the studies cannot simply be disregarded warranting further caution and the application, to a certain extent, of the precautionary principle.

SYSTEMATIC REVIEW OF THE EXPOSURE ASSESSMENT AND EPIDEMIOLOGY OF HIGH-FREQUENCY VOLTAGE TRANSIENTS.

de Vocht F, Olsen RG.

Front Public Health. 2016;4:52.

Conclusions of epidemiological studies describing adverse health effects as a result of exposure to electromagnetic fields are not unanimous and often contradictory. It has been proposed that an explanation could be that high-frequency voltage transients [dirty electricity (DE)] which are superimposed on 50/60-Hz fields, but are generally not measured, are the real causal agent. DE has been linked to many different health and wellbeing effects, and on the basis of this, an industry selling measurement and filtering equipment is growing. The authors reviewed the available peer-reviewed evidence for DE as a causal agent for adverse human health effects. A literature search was performed in the Cochrane Library, PubMed, Web of Science, Google Scholar, and additional publications were obtained from reference lists and from the gray literature. This search resulted in 25 publications; 16 included primary epidemiological and/or exposure data. All studies were reviewed by both authors independently, and including a re-review of studies included in a review of data available up to July 31, 2009 by one of the authors. DE has been measured differently in different studies and comparison data are not available. There is no evidence for 50 Graham/Stetzer (GS) units as a safety threshold being anything more than arbitrary. The epidemiological evidence on human health effects of DE is primarily based on, often re-used, case descriptions. Quantitative

evidence relies on self-reporting in non-blinded interventions, ecological associations, and one cross-sectional cohort study of cancer risk, which does not point to DE as the causal agent.

Conclusions: The available evidence for DE as an exposure affecting human health at present does not stand up to scientific scrutiny.

2. Residential exposure

MATERNAL EXPOSURE TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS: ASSOCIATION WITH TIME TO PREGNANCY AND FOETAL GROWTH.

Eskelinen T, Roivainen P, Mäkelä P, Keinänen J, Kauhanen O, Saarikoski S, Juutilainen J.

Environ Int. 2016;94: 620-625.

Data on reproductive and developmental effects of extremely low frequency magnetic fields (ELF MFs) are inconclusive. This study tested the hypothesis that maternal exposure to ELF MFs is associated with increased time to pregnancy (TTP), reduced birthweight or small for gestational age (SGA).

The study cohort consisted of 373 mothers who gave birth between 1990 and 1994 in Kuopio University Hospital, Finland. To increase prevalence of high ELF MF exposure, women living in buildings near known ELF MF sources were included. Maternal exposure to ELF MF before and during pregnancy was assessed with short term measurements in residences and questionnaires. Associations between ELF MF exposure and TTP, low birth weight and SGA were analysed by logistic regression (or linear regression for continuous variables), adjusting for factors known to be associated with the selected pregnancy outcomes, such as maternal smoking, alcohol consumption and socioeconomic status. The MF exposure of the mothers was slightly higher than in Finnish residences in general, but very high exposures ($>0.4\mu\text{T}$) were rare. No consistent association of ELF MF with TTP, birth weight or SGA was found.

Conclusions: ELF MF exposure is not likely to be associated with TTP or prenatal growth at residential exposure levels that were observable in this study.

3. Human experimental studies

DISTURBED SLEEP IN INDIVIDUALS WITH IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS (IEI-EMF): MELATONIN ASSESSMENT AS A BIOLOGICAL MARKER.

Andrianome S, Hugueville L, de Seze R, Hanot-Roy M, Blazy K, Gamez , Selmaoui B.

Bioelectromagnetics. 2016;37:175-182.

Individuals who suffer from idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) complain of a variety of adverse health effects. Troubled sleep remains a recurrent and common symptom in IEI-EMF individuals. Melatonin, a circadian hormone, plays a major role in the sleep process. In this study, the authors compared levels of melatonin between a sensitive group (IEI-EMF, $n=30$) and a non-sensitive control group (non IEI-EMF, $n=25$) without exposure to electromagnetic sources. Three questionnaires were used to evaluate the subjective quality and sleep quantity: the Epworth Sleepiness Scale, the Pittsburgh Sleep Quality Index and the Spiegel Sleep Inventory. Melatonin was quantified in saliva and its major metabolite 6-sulfatoxymelatonin (aMT6s) in urine. Melatonin levels were compared by a two-way analysis of variance at various times between the control and IEI-EMF group.

Conclusions: Despite significantly different sleep scores between the two groups, with a lower score in the IEI-EMF group ($P < 0.001$), no statistical difference was found between the two groups for saliva melatonin ($P > 0.05$) and urine aMT6s ($P > 0.05$).

4. Exposure assessment

REVIEW OF STUDIES CONCERNING ELECTROMAGNETIC FIELD (EMF) EXPOSURE ASSESSMENT IN EUROPE: LOW FREQUENCY FIELDS (50 HZ-100 KHZ).

Gajšek P, Ravazzani P, Grellier J, Samaras T, Bakos J, Thuróczy G.

Int J Environ Res Public Health. 2016;13(9).

The authors aimed to review the findings of exposure assessment studies done in European countries on the exposure of the general public to low frequency electric and magnetic fields (EMFs) of various frequencies. The study shows that outdoor average extremely low frequency magnetic fields (ELF-MF) in public areas in urban environments range between 0.05 and 0.2 μT in terms of flux densities, but stronger values (of the order of a few μT) may occur directly beneath high-voltage power lines, at the walls of transformer buildings, and at the boundary fences of substations. In the indoor environment, high values have been measured close to several domestic appliances (up to the mT range), some of which are held close to the body, e.g., hair dryers, electric shavers. Common sources of exposure to intermediate frequencies (IF) include induction cookers, compact fluorescent lamps, inductive charging systems for electric cars and security or anti-theft devices. No systematic measurement surveys or personal exposimetry data for the IF range have been carried out and only a few reports on measurements of EMFs around such devices are mentioned.

Conclusions: According to the available European exposure assessment studies, three population exposure categories were classified by the authors regarding the possible future risk analysis. This classification should be considered a crucial advancement for exposure assessment, which is a mandatory step in any future health risk assessment of EMFs exposure.

OCCUPATIONAL EXPOSURE TO ELECTRIC AND MAGNETIC FIELDS DURING TASKS AT GROUND OR FLOOR LEVEL AT 110 KV SUBSTATIONS IN FINLAND.

Korpinen L, Pääkkönen R.

Int J Occup Saf Ergon. 2016;22(3):384-388.

The aim was to investigate occupational exposure to electric and magnetic fields during tasks at ground or floor level at 110 kV substations in Finland and to compare the measured values to Directive 2013/35/EU. Altogether, 347 electric field measurements and 100 magnetic field measurements were performed. The average value of all electric fields was 2.3 kV/m (maximum 6.4 kV/m) and that of magnetic fields was 5.8 μT (maximum 51.0 μT).

Conclusions: It can be concluded that the electric and magnetic field exposure at ground or floor level is typically below the low action levels of Directive 2013/35/EU. The transposition of the directive will not create new needs to modify the work practice of the evaluated tasks, which can continue to be performed as before. However, for workers with medical implants, the exposure may be high enough to cause interference.

5. Leukaemia studies

EFFECTS OF MATERNAL DIET DURING PREGNANCY ON THE RISK OF CHILDHOOD ACUTE LYMPHOBLASTIC LEUKEMIA: A SYSTEMATIC REVIEW.

Abiri B, Kelishadi R, Sadeghi H, Azizi-Soleiman F.

Nutr Cancer. 2016 Oct;68(7):1065-72.

Acute lymphoblastic leukemia (ALL) is the most common type of leukemia in children that can be affected by maternal diet. The aim of this study was to evaluate maternal dietary risk factors of ALL. The authors searched MEDLINE, Cochrane Library, Springer Link, Wiley Online, Science Direct, Mosby, ISI Web of Science, OVID, ProQuest, and Scopus from database inception until February 2, 2016. Two reviewers scanned titles, abstracts, and keywords of articles after excluding duplicates. Case-control studies evaluating the relationship between maternal diet during pregnancy and childhood ALL were included. The search resulted in 2,940 papers, of which 11 full-text articles met the criteria for inclusion in the review and were analyzed. The finding of these studies suggest that maternal diet composed largely of vegetables, fruits, and protein sources before and during pregnancy can reduce the risk of ALL in offspring. Maternal alcohol intake had no effect. Nevertheless, inherent limitations of case-control studies like measurement error, random error, recall bias, and selection bias preclude conclusive evidence.

Conclusions: Persuading pregnant women to follow a healthy diet rich in fruits, vegetables, and protein may reduce the risk of childhood ALL. Avoiding alcohol intake seems prudent.

TRAFFIC-RELATED AIR POLLUTION AND CHILDHOOD ACUTE LEUKEMIA IN OKLAHOMA.

Janitz AE, Campbell JE, Magzamen S, Pate A, Stoner JA, Peck JD.

Environ Res. 2016;148:102-111.

Ambient air pollution has been classified as a Group 1 carcinogen, but studies have not established whether traffic-related air pollution is associated with leukemia. The goal of this study was to determine if children with acute leukemia had higher odds of exposure to traffic-related air pollution at birth compared to controls.

The authors conducted a case-control study using the Oklahoma Central Cancer Registry to identify cases of acute leukemia in children diagnosed before 20 years of age between 1997 and 2012 (n=307). Controls were selected from birth certificates and matched to cases on week of birth (n=1013). Using a novel satellite-based land-use regression model of nitrogen dioxide (NO₂) and estimating road density based on the 2010 US Census, the association between traffic-related air pollution and childhood leukemia was evaluated using conditional logistic regression.

The odds of exposure to the fourth quartile of NO₂ (11.19-19.89ppb) were similar in cases compared to controls after adjustment for maternal education (OR: 1.08, 95% CI: 0.75, 1.55). These estimates were stronger among children with acute myeloid leukemia (AML) than acute lymphoid leukemia, with a positive association observed among urban children with AML (4th quartile odds ratio: 5.25, 95% confidence interval: 1.09, 25.26). While no significant association with road density was observed, male cases had an elevated odds of exposure to roads at 500m from the birth residence compared to controls (OR: 1.39, 95% CI: 0.93, 2.10), which was slightly attenuated at 750m.

Conclusions: Although no association overall between NO₂ or road density was observed, this was the first study to observe an elevated odds of exposure to NO₂ among children with AML compared to controls suggesting further exploration of traffic-related air pollution and AML is warranted.

A TASK-BASED ASSESSMENT OF PARENTAL OCCUPATIONAL EXPOSURE TO ORGANIC SOLVENTS AND OTHER COMPOUNDS AND THE RISK OF CHILDHOOD LEUKEMIA IN CALIFORNIA.

Metayer C, Scelo G, Kang AY, Gunier RB, Reinier K, Lea S, Chang JS, Selvin S, Kirsch J, Crouse V, Does M, Quinlan P, Hammond SK.

Environ Res. 2016;151:174-183.

Data on parental occupational exposures and risk of childhood leukemia lack specificity. Using 19 task-based job modules, the authors examined the relationship between occupational exposure to organic solvents and other compounds and the risk of leukemia in children.

Latino (48%) and non-Latino (52%) children with acute lymphoblastic leukemia (ALL; n=670), acute myeloid leukemia (AML; n=104), and controls (n=1021) were enrolled in a study in California (2000-2008). Logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs), adjusted for socio-demographic factors.

Among children with non-Latino fathers, none of the exposures evaluated were associated with risks of ALL and AML. In contrast, exposure to any organic solvents in Latino fathers was associated with an increased risk of childhood ALL (OR=1.48; 95% CI: 1.01-2.16); in multivariable analyses, the OR for chlorinated hydrocarbons was 2.28 (95% CI: 0.97-5.37) while the ORs were close to one for aromatic hydrocarbons, glycol ethers, and other hydrocarbon mixtures. The authors also observed an increased risk of ALL with exposure to combustion exhaust/polycyclic aromatic hydrocarbons (PAHs) (ORs=1.70; 95% CI: 1.16-2.57, and 1.46; 95% CI: 0.94-2.26 with and without adjustment for chlorinated hydrocarbons, respectively). Moderately elevated risks of ALL were seen with exposure to metals, paints, and wood dust, although not statistically significant. An increased risk was reported for asbestos based on small numbers of exposed Latino fathers. No associations were reported between maternal exposures to any exposures and childhood ALL and AML.

Conclusions: These data support associations between paternal occupational exposures to chlorinated hydrocarbons, combustion exhaust, metals, and possibly asbestos and the risk of ALL in the children of Latino fathers only.