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

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1. Reviews

EXTREMELY LOW FREQUENCY MAGNETIC FIELD EXPOSURE AND PARKINSON'S DISEASE-A SYSTEMATIC REVIEW AND META-ANALYSIS OF THE DATA.
Huss A, Koeman T, Kromhout H, Vermeulen R.
Int J Environ Res Public Health. 2015;12(7):7348-7356.

The objective of this study was to examine the association between occupational exposure to extremely-low-frequency magnetic fields (ELF-MF) and Parkinson's disease. The authors systematically searched publications reporting risk estimates of Parkinson's disease in workers exposed to ELF-MF. Summary relative risks were obtained with random effects meta-analysis. They included 11 studies. To assign exposure, four studies evaluated occupational records, four used census, interview or questionnaire information and three used death certificates. Risk of Parkinson's disease was not elevated in workers exposed to ELF-MF with a summary relative risk of 1.05, 95% CI 0.98-1.13.

Conclusions: Overall, there was no evidence that the exposure to ELF-MF increases the risk of Parkinson's disease.

2. Residential exposure

ACTUAL AND PERCEIVED EXPOSURE TO ELECTROMAGNETIC FIELDS AND NON-SPECIFIC PHYSICAL SYMPTOMS: AN EPIDEMIOLOGICAL STUDY BASED ON SELF-REPORTED DATA AND ELECTRONIC MEDICAL RECORDS.
Baliatsas C, Bolte J, Yzermans J, Kelfkens G, Hooiveld M, Lebret E, van Kamp I.
Int J Hyg Environ Health. 2015;218(3):331-344.

There is continuing scientific debate and increasing public concern regarding the possible effects of electromagnetic fields (EMF) on general population's health. To date, no epidemiological study has investigated the possible association between actual and perceived EMF exposure and non-specific physical symptoms (NSPS) and sleep quality, using both self-reported and general practice (GP)-registered data.

A health survey of adult (≥ 18) participants (n=5933) in the Netherlands was combined with the electronic medical records (EMRs) of NSPS as registered by general practitioners. Characterization of actual exposure was based on several proxies, such as prediction models of radiofrequency (RF)-EMF exposure, geo-coded distance to high-voltage overhead power lines and self-reported use/distance of/to indoor electrical

appliances. Perceived exposure and the role of psychological variables were also examined.

Perceived exposure had a poor correlation with the actual exposure estimates. No significant association was found between modeled RF-EMF exposure and the investigated outcomes. Associations with NSPS were observed for use of an electric blanket and close distance to an electric charger during sleep. Perceived exposure, perceived control and avoidance behavior were associated with the examined outcomes. The association between perceived exposure was stronger for self-reported than for GP-registered NSPS. There was some indication, but no consistent pattern for an interaction between idiopathic environmental intolerance (IEI-EMF) and the association between actual exposure and NSPS.

Conclusions: In conclusion, there is no convincing evidence for an association between everyday life RF-EMF exposure and NSPS and sleep quality in the population. Better exposure characterization, in particular with respect to sources of extremely low frequency magnetic fields (ELF-MF) is needed to draw more solid conclusions. The authors argue that perceived exposure is an independent determinant of NSPS.

3. Occupational exposure

OCCUPATIONAL EXPOSURES AND PARKINSON'S DISEASE MORTALITY IN A PROSPECTIVE DUTCH COHORT.
Brouwer M, Koeman T, van den Brandt PA, Kromhout H, Schouten LJ, Peters S, Huss A, Vermeulen R.
Occup Environ Med. 2015;72(6):448-455.

The authors investigated the association between six occupational exposures (ie, pesticides, solvents, metals, diesel motor emissions (DME), extremely low frequency magnetic fields (ELF-MF) and electric shocks and Parkinson's disease (PD) mortality in a large population-based prospective cohort study. The Netherlands Cohort Study on diet and cancer enrolled 58 279 men and 62 573 women aged 55-69 years in 1986. Participants were followed up for cause-specific mortality over 17.3 years, until December 2003, resulting in 402 male and 207 female PD deaths. Following a case-cohort design, a subcohort of 5 000 participants was randomly sampled from the complete cohort. Information on occupational history and potential confounders was collected at baseline. Job-exposure matrices were applied to assign occupational exposures. Associations with PD mortality were evaluated using Cox regression.

Among men, elevated HRs were observed for exposure to pesticides and ever high exposed to ELF-MF (HR 1.54, 95% CI 1.00 to 2.36). No association with exposure duration or trend in cumulative exposure was observed for any of the occupational exposures. Results among women were unstable due to small numbers of high-exposed women.

Conclusions: Associations with PD mortality were observed for occupational exposure to pesticides and ELF-MF. However, the weight given to these findings is limited by the absence of a monotonic trend with either duration or cumulative exposure.

OCCUPATIONAL EXPOSURES AND RISK OF DEMENTIA-RELATED MORTALITY IN THE PROSPECTIVE NETHERLANDS COHORT STUDY.

Koeman T, Schouten LJ, van den Brandt PA, Slottje P, Huss A, Peters S, Kromhout H, Vermeulen R.

The authors analyzed the effects of occupational exposures to solvents, pesticides, metals, extremely low frequency magnetic fields (ELF-MF), electrical shocks, and diesel motor exhaust on non-vascular dementia related mortality in the Netherlands Cohort Study (NLCS). Exposures were assigned using job-exposure matrices. After 17.3 years of follow-up, 682 male and 870 female cases were available. Analyses were performed using Cox regression.

Occupational exposure to metals, chlorinated solvents and ELF-MF showed positive associations with non-vascular dementia among men, which seemed driven by metals (hazard ratio ever high vs. background exposure: 1.35 [0.98-1.86]).

Conclusions: Consistent positive associations were found between occupational exposure to metals and non-vascular dementia.

A CROSS-SECTIONAL STUDY ON OXIDATIVE STRESS IN WORKERS EXPOSED TO EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS.

Li L, Xiong DF, Liu JW, Li ZX, Zeng GC, Li HL.

The purpose of this study was to investigate whether extremely low frequency electromagnetic field (ELF-EMF) exposure could induce oxidative stress in workers performing tour-inspection near transformers and distribution power lines.

Occupational short-term 'spot' measurements were performed. In total, 310 inspection workers exposed to ELF-EMF were selected as the exposure group and 300 logistical staff as the control group. Plasma total antioxidant capacity (T-AOC) and glutathione peroxidase (GPx) activity were tested by the colorimetric method. Superoxide dismutase (SOD) activity was tested using the xanthine oxidase method. Plasma malondialdehyde (MDA) concentration was determined with a thiobarbituric acid assay. The micronucleus cell frequency (MCF) and Micronuclei frequency (MN) were also tested for genotoxic assessment.

No significant changes of enzyme activities or MDA concentration were found. Neither the frequency of micronucleus lymphocytes nor micronuclei frequency changes were statistically significant.

Conclusion: Continual ELF-EMF exposure might not induce oxidative stress in workers from a power supply bureau.

4. Exposure assessment

This article describes a study of magnetic field exposure in electric vehicles (EVs). The magnetic field inside eight different EVs (including battery, hybrid, plug-in hybrid, and fuel cell types) with different motor technologies (brushed direct current, permanent magnet synchronous, and induction) were measured at frequencies up to 10 MHz. Three vehicles with conventional powertrains were also investigated for comparison. The measurement protocol and the results of the measurement campaign are described, and various magnetic field sources are identified. As the measurements show a complex broadband frequency spectrum, an exposure calculation was performed using the ICNIRP "weighted peak" approach.

Conclusions: Results for the measured EVs showed that the exposure reached 20% of the ICNIRP 2010 reference levels for general public exposure near to the battery and in the vicinity of the feet during vehicle start-up, but was less than 2% at head height for the front passenger position. Maximum exposures of the order of 10% of the ICNIRP 2010 reference levels were obtained for the cars with conventional powertrains.

5. Leukaemia studies

The associations between childhood acute lymphoblastic leukemia (ALL) and several proxies of early stimulation of the immune system, that is, day-care center attendance, birth order, maternally reported common infections in infancy, and breastfeeding, were investigated by using data from 11 case-control studies participating in the Childhood Leukemia International Consortium (enrollment period: 1980-2010). The sample included 7,399 ALL cases and 11,181 controls aged 2-14 years. The data were collected by questionnaires administered to the parents. Pooled odds ratios and 95% confidence intervals were estimated by unconditional logistic regression adjusted for age, sex, study, maternal education, and maternal age. Day-care center attendance in the first year of life was associated with a reduced risk of ALL (odds ratio = 0.77, 95% confidence interval: 0.71, 0.84), with a marked inverse trend with earlier age at start (P < 0.0001). An inverse association was also observed with breastfeeding duration of 6 months or more (odds ratio = 0.86, 95% confidence interval: 0.79, 0.94). No significant relationship with a history of common infections in infancy was observed even though the odds ratio was less than 1 for more than 3 infections.

Conclusions: The findings of this large pooled analysis reinforce the hypothesis that day-care center attendance in infancy and prolonged breastfeeding are associated with a decreased risk of ALL.

BREASTFEEDING AND CHILDHOOD LEUKEMIA INCIDENCE: A META-ANALYSIS AND SYSTEMATIC REVIEW.
Amitay EL, Keinan-Boker L.
JAMA Pediatr. 2015;169(6):e151025.

The objective of this study was to conduct a meta-analysis of available scientific evidence on the association between breastfeeding and childhood leukemia.

A thorough search for articles published between January 1960 and December 2014 researching the association between breastfeeding and childhood leukemia was conducted on PubMed, the Cochrane Library, and Scopus (performed in July and December 2014), supplemented by manual searches of reference lists. To be included in the meta-analyses, studies had to be case control; include breastfeeding as a measured exposure and leukemia as a measured outcome; include data on breastfeeding duration in months; and be published in a peer-reviewed journal with full text available in English.

The search identified 25 relevant studies, 18 of which met all inclusion criteria. No publication bias or heterogeneity among these 18 studies were detected. The quality of each study that met the inclusion criteria was assessed using the Newcastle-Ottawa Scale. Multiple meta-analyses were conducted using the random effect model on raw data in the StatsDirect statistical program.

The meta-analysis of all 18 studies indicated that compared with no or shorter breastfeeding, any breastfeeding for 6 months or longer was associated with a 19% lower risk for childhood leukemia (odds ratio, 0.81; 95% CI, 0.73-0.89). A separate meta-analysis of 15 studies indicated that ever breastfed compared with never breastfed was associated with an 11% lower risk for childhood leukemia (odds ratio, 0.89; 95% CI, 0.84-0.94), although the definition of never breastfed differed between studies. All meta-analyses of subgroups of the 18 studies showed similar associations. Based on current meta-analyses results, 14% to 19% of all childhood leukemia cases may be prevented by breastfeeding for 6 months or more.

Conclusions: This meta-analysis that included studies not featured in previous meta-analyses on the subject indicates that promoting breastfeeding for 6 months or more may help lower childhood leukemia incidence.

PERINATAL AND FAMILIAL RISK FACTORS FOR ACUTE LYMPHOBLASTIC LEUKEMIA IN A SWEDISH NATIONAL COHORT.
Crump C, Sundquist J, Sieh W, Winkleby MA, Sundquist K.
Cancer. 2015;121(7):1040-1047.

Perinatal factors including high birth weight have been found to be associated with acute lymphoblastic leukemia (ALL) in case-control studies. However, these findings have seldom been examined in large population-based cohort studies, and the specific contributions of gestational age and fetal growth remain unknown.

The authors conducted a national cohort study of 3,569,333 individuals without Down syndrome who were born in Sweden between 1973 and 2008 and followed for the incidence of ALL through 2010 (maximum age, 38 years) to examine perinatal and familial risk factors.

There were 1960 ALL cases with 69.7 million person-years of follow-up. After adjusting for potential confounders, risk factors for ALL included high fetal growth (incidence rate ratio [IRR] per additional 1 standard deviation, 1.07; 95% confidence interval [95% CI], 1.02-1.11 [P =.002]; and IRR for large vs appropriate for gestational age, 1.22; 95% CI, 1.06-1.40 [P =.005]), first-degree family history of ALL (IRR, 7.41; 95% CI, 4.60-11.95 [P<.001]), male sex (IRR, 1.20; 95% CI, 1.10-1.31 [P<.001]), and parental country of birth (IRR for both parents born in Sweden vs other countries, 1.13; 95% CI, 1.00-1.27 [P =.045]). These risk factors did not appear to vary by patient age at the time of diagnosis of ALL. Gestational age at birth, season of birth, birth order, multiple birth, parental age, and parental education level were not found to be associated with ALL.

Conclusions: In this large cohort study, high fetal growth was found to be associated with an increased risk of ALL in childhood through young adulthood, independent of gestational age at birth, suggesting that growth factor pathways may play an important long-term role in the etiology of ALL.

In a nationwide census-based cohort study, the authors investigated whether the incidence of childhood cancer was associated with background radiation from terrestrial gamma and cosmic rays.

Children < 16 years of age in the Swiss National Censuses in 1990 and 2000 were included. The follow-up period lasted until 2008, and incident cancer cases were identified from the Swiss Childhood Cancer Registry. A radiation model was used to predict dose rates from terrestrial and cosmic radiation at locations of residence. Cox regression models were used to assess associations between cancer risk and dose rates and cumulative dose since birth.

Among 2,093,660 children included at census, 1,782 incident cases of cancer were identified including 530 with leukemia, 328 with lymphoma, and 423 with a tumor of the central nervous system (CNS). Hazard ratios for each millisievert increase in cumulative dose of external radiation were 1.03 (95% CI: 1.01, 1.05) for any cancer, 1.04 (95% CI: 1.00, 1.08) for leukemia, 1.01 (95% CI: 0.96, 1.05) for lymphoma, and 1.04 (95% CI: 1.00, 1.08) for CNS tumors. Adjustment for a range of potential confounders had little effect on the results.

Conclusions: This study suggests that background radiation may contribute to the risk of cancer in children, including leukemia and CNS tumors.