

Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the first trimester of 2018

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1. Reviews

OCCUPATIONAL EXPOSURE TO EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS AND THE RISK OF ALS: A SYSTEMATIC REVIEW AND META-ANALYSIS.

Huss A, Peters S, Vermeulen R.

Bioelectromagnetics. 2018 Feb;39(2):156-163.

The authors performed a meta-analysis to examine associations of occupational exposure to extremely-low frequency magnetic fields (ELF-MF) with amyotrophic lateral sclerosis (ALS). Epidemiologic studies were identified in EMBASE and MEDLINE, in reference lists and a specialist database. Studies that reported risk estimates of ALS in association with occupational ELF-MF exposure were included. Summary relative risks (RR) or odds ratios (OR) were obtained with random effect meta-analysis, and analyses were stratified by type of exposure assessment. This was done to evaluate whether observed heterogeneity between studies could be explained with differences in the way the exposure had been determined. 20 studies were included in the meta-analysis.

Overall, studies reported a slightly increased risk of ALS in those exposed to higher levels of ELF-MF compared to lower levels with a summary RR (sRR) of 1.14 (95% Confidence Interval [CI] 1.00-1.30) and for workers in electrical occupations (sRR 1.41, CI 1.05-1.92), but with large heterogeneity between studies ($I^2 > 70\%$). Self-reported exposure or occupations determined from death certificates did not show increased risks. Highest-longest types of exposure translated into increased risks of ALS if the studies had evaluated the whole occupational history, in contrast to evaluating only few points in time (e.g., from census records); sRR were 1.89 (CI 1.31-2.73, $I^2 0\%$) and 1.06 (CI 0.75-1.57, $I^2 76\%$), respectively.

Conclusions: In this meta-analysis, an increased risk of ALS was observed in workers occupationally exposed to ELF-MF. Results of studies depended on the quality of the exposure assessment.

2. Residential exposure

REPRESENTATIVE SURVEY ON IDIOPATHIC ENVIRONMENTAL INTOLERANCE ATTRIBUTED TO ELECTROMAGNETIC FIELDS IN TAIWAN AND COMPARISON WITH THE INTERNATIONAL LITERATURE.

Huang PC, Cheng MT, Guo HR.

Environ Health. 2018 Jan 15;17(1):5.

Electromagnetic hypersensitivity refers to health effects attributed to electromagnetic fields (EMF) exposure and has been formally named "idiopathic environmental intolerance attributed to electromagnetic fields" (IEI-EMF) by the World Health Organization. Because of the growing use of cell phones, IEI-EMF has become a global

public health concern. A survey in 2007 in Taiwan showed that the prevalence rate of IEI-EMF was 13.3%, which is higher than rates in studies conducted previously. The survey also found that the rate was higher in women. To evaluate whether the prevalence rate of IEI-EMF is increasing and to verify the higher risk in women, the authors conducted a nationwide questionnaire survey using the same methods as the 2007 survey to assess the change in the prevalence rate of IEI-EMF in Taiwan. They also conducted a review of the literature and a meta-analysis to evaluate the changes in the prevalence rate around the world.

On the basis of the representative sample of 3303 participants, The authors found that the prevalence rate of IEI-EMF in Taiwan declined from 13.3% to 4.6% over a period of 5 years. The literature review also found the prevalence rates in other countries to be decreasing, instead of increasing as predicted previously. The meta-analysis of the data from the literature showed that women are more likely to have IEI-EMF than men, with an odds ratio of 1.19 (95% confidence interval: 1.01-1.40).

Conclusions: The prevalence rate of IEI-EMF has been declining, instead of increasing as predicted previously. Women are more likely to report having IEI-EMF than men. Further studies to explore the causes leading to the declines may help the public, scientific community, and government deal with idiopathic intolerance to other environmental exposures.

RESIDENTIAL MOBILITY AND CHILDHOOD LEUKEMIA.

Amoon AT, Oksuzyan S, Crespi CM, Arah OA, Cockburn M, Vergara X, Kheifets L.

Environ Res. 2018 Mar 22;164:459-466.

Studies of environmental exposures and childhood leukemia studies do not usually account for residential mobility. Yet, in addition to being a potential risk factor, mobility can induce selection bias, confounding, or measurement error in such studies. The authors attempt to disentangle the effect of mobility, using data collected for California Powerline Study (CAPS). They analyzed data from a population-based case-control study of childhood leukemia using cases who were born in California and diagnosed between 1988 and 2008 and birth certificate controls. They used stratified logistic regression, case-only analysis, and propensity-score adjustments to assess predictors of residential mobility between birth and diagnosis, and account for potential confounding due to residential mobility.

Children who moved tended to be older, lived in housing other than single-family homes, had younger mothers and fewer siblings, and were of lower socioeconomic status. Odds ratios for leukemia among non-movers living <50 meters (m) from a 200+ kilovolt line (OR: 1.62; 95% CI: 0.72-3.65) and for calculated fields ≥ 0.4 microTesla (OR: 1.71; 95% CI: 0.65-4.52) were slightly higher than previously reported overall results. Adjustments for propensity scores based on all variables predictive of mobility, including dwelling type, increased odds ratios for leukemia to 2.61 (95% CI: 1.76-3.86) for living < 50 m from a 200 + kilovolt line and to 1.98 (1.11-3.52) for calculated fields. Individual or propensity-score adjustments for all variables, except dwelling type, did not materially change the estimates of power line exposures on childhood leukemia.

Conclusion: The residential mobility of childhood leukemia cases varied by several sociodemographic characteristics, but not by the distance to the nearest power line or calculated magnetic fields. Mobility appears to be an unlikely explanation for the associations observed between power lines exposure and childhood leukemia.

3. Occupational exposure

OCCUPATIONAL EXTREMELY LOW FREQUENCY MAGNETIC FIELDS (ELF-MF) EXPOSURE AND HEMATOLYMPHOPOIETIC CANCERS - SWISS NATIONAL COHORT ANALYSIS AND UPDATED META-ANALYSIS.

Huss A, Spoerri A, Egger M, Kromhout H, Vermeulen R; Swiss National Cohort. *Environ Res.* 2018 Mar 24;164:467-474.

Previous studies have examined risks of leukaemia and selected lymphoid malignancies in workers exposed to extremely low frequency magnetic fields (ELF-MF). Most studies evaluated hematolymphopoietic malignancies as a combined category, but some analyses suggested that effects may be contained to some specific leukaemia or lymphoma subtypes, with inconsistent results. The authors examined exposure to ELF-MF and mortality 1990-2008 from different types of hematolymphopoietic cancers in the Swiss National Cohort, using a job exposure matrix for occupations recorded at censuses 1990 and 2000. They analysed 3.1 million workers exposed at different levels to ELF-MF: ever-high, only-medium, only-low exposure using Cox proportional hazard models. They evaluated risk of death from acute myeloid leukaemia (AML), chronic myeloid leukaemia, lymphoid leukaemia, diffuse large B-cell lymphomas, follicular lymphoma, Waldenström's macroglobulinemia, multiple myeloma and Hodgkin lymphoma.

Mortality from hematolymphopoietic cancers was not associated with exposure to ELF-MF with the exception of an increase in ever-high exposed men of myeloid leukaemias (HR 1.31, 95% CI 1.02-1.67), and AML (HR 1.26, 95%CI 0.93-1.70). If workers had been high exposed during their vocational training and at both censuses, these HR increased to 2.24 (95%CI 0.91-5.53) and 2.75 (95%CI 1.11-6.83), respectively.

Conclusions: This analysis provided no convincing evidence for an increased risk of death from a range of hematolymphopoietic cancers in workers exposed to high or medium levels of ELF magnetic fields. However, an increased risk of acute myeloid leukaemia was observed in workers exposed to high levels for a longer duration. Observed risks are in line with meta-analysed previous reports on ELF-MF exposure and AML risk, with a summary relative risk of 1.21 (95%CI 1.08-1.37).

CASE-CONTROL STUDY ON OCCUPATIONAL EXPOSURE TO EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELDS AND THE ASSOCIATION WITH MENINGIOMA.

Carlberg M, Koppel T, Ahonen M, Hardell L. *Biomed Res Int.* 2018 Jan 3;2018:5912394.

Exposure to extremely low-frequency electromagnetic fields (ELF-EMF) was in 2002 classified as a possible human carcinogen, Group 2B, by the International Agency for

Research on Cancer at WHO based on an increased risk for childhood leukemia. In case-control studies on brain tumors during 1997-2003 and 2007-2009 the authors assessed lifetime occupations in addition to exposure to different agents. The INTEROCC ELF-EMF Job-Exposure Matrix was used for associating occupations with ELF-EMF exposure (μT) with meningioma. Cumulative exposure (μT -years), average exposure (μT), and maximum exposed job (μT) were calculated.

No increased risk for meningioma was found in any category. For cumulative exposure in the highest exposure category $8.52+ \mu\text{T}$ years odds ratio (OR) = 0.9, 95% confidence interval (CI) = 0.7-1.2, and p linear trend = 0.45 were calculated. No statistically significant risks were found in different time windows.

Conclusions: Occupational ELF-EMF was not associated with an increased risk for meningioma.

4. Human experimental studies : /

5. Exposure assessment

WORKERS' EXPOSURE TO ELECTRIC FIELDS DURING THE TASK 'MAINTENANCE OF AN OPERATING DEVICE OF CIRCUIT BREAKER FROM A SERVICE PLATFORM' AT 110-KV SUBSTATIONS.

Korpinen L, Pääkkönen R.

Int J Occup Saf Ergon. 2018 Feb 26:1-4.

The objective of the study was to investigate occupational exposure to electric fields during the task 'maintenance of an operating device of circuit breaker from a service platform' at 110-kV substations. The aim was also to compare the results to Directive 2013/35/EU. At 16 substations, 255 electric field measurements were performed. The highest mean value of the electric fields was $9.6 \text{ kV}\cdot\text{m}^{-1}$. At 63% of substations the maximum values were over $10.0 \text{ kV}\cdot\text{m}^{-1}$, and at 31% of the substations the 75th percentiles were over $10.0 \text{ kV}\cdot\text{m}^{-1}$, which is the low action level (AL) according to Directive 2013/35/EU.

Conclusions: All measured values were below the high AL ($20.0 \text{ kV}\cdot\text{m}^{-1}$). In the future, it is important to take into account that the measurements were only taken at Finnish 110-kV substations; therefore, it is not possible to generalize these results to other countries and different types of substations.

6. Leukaemia studies

MATERNAL EXPOSURE TO PESTICIDES, PATERNAL OCCUPATION IN THE ARMY/POLICE FORCE, AND CYP2D6*4 POLYMORPHISM IN THE ETIOLOGY OF CHILDHOOD ACUTE LEUKEMIA.

Ferri GM, Guastadisegno CM, Intranuovo G, Cavone D, Birtolo F, Cecinati V, Pappalardi B, Corsi P, Vimercati L, Santoro N.

J Pediatr Hematol Oncol. 2018 Feb 9.

Epidemiologic studies have suggested that parental occupations, pesticide use, environmental factors, and genetic polymorphism are involved in the etiology of

childhood acute leukemia (CAL). In total, 116 cases of CAL and 162 controls were recruited and submitted to blood drawing to assess the presence of genetic polymorphisms. Parental occupations, pesticides exposure, and other potential determinants were investigated. Increased risk for CAL was associated with prenatal maternal use of insecticides/rodenticides (odds ratio [OR]=1.87; 95% confidence intervals [CI], 1.04-3.33), with subjects living <100 m from pesticide-treated fields (OR=3.21; 95% CI, 1.37-7.53) and with a paternal occupation as traffic warden/policeman (OR=4.02; 95% CI, 1.63-9.87). Associations were found between CAL and genetic polymorphism of CYP2D6*4 for homozygous alleles (mutant type/mutant type: OR=6.39; 95% CI, 1.17-34.66).

Conclusions: Despite the small sample size, maternal prenatal exposure to pesticides, paternal occupation as a traffic warden/police officer, and CYP2D6*4 polymorphism could play a role in the etiology of CAL.

CHILDHOOD LEUKAEMIA NEAR NUCLEAR SITES IN BELGIUM, 2002-2008.

Bollaerts K, Simons K1, Van Bladel L, De Smedt T, Sonck M, Fierens S, Poffijn A, Geraets D, Gosselin P, Van Oyen H, Francart J, Van Nieuwenhuyse A.
Eur J Cancer Prev. 2018 Mar;27(2):184-191.

This paper describes an ecological study investigating whether there is an excess incidence of acute leukaemia among children aged 0-14 years living in the vicinity of the nuclear sites in Belgium. Poisson regression modelling was carried out for proximity areas of varying sizes. In addition, the hypothesis of a gradient in leukaemia incidence with increasing levels of surrogate exposures was explored by means of focused hypothesis tests and generalized additive models. For the surrogate exposures, three proxies were used, that is, residential proximity to the nuclear site, prevailing winds and simulated radioactive discharges, on the basis of mathematical dispersion modelling. No excess incidence of acute leukaemia was observed around the nuclear power plants of Doel or Tihange nor around the nuclear site of Fleurus, which is a major manufacturer of radioactive isotopes in Europe. Around the site of Mol-Dessel, however, two- to three-fold increased leukaemia incidence rates were found in children aged 0-14 years living in the 0-5, 0-10 and the 0-15 km proximity areas. For this site, there was evidence for a gradient in leukaemia incidence with increased proximity, prevailing winds and simulated radioactive discharges, suggesting a potential link with the site that needs further investigation.

Conclusions: An increased incidence of acute leukaemia in children aged 0-14 years was observed around one nuclear site that hosted reprocessing activities in the past and where nuclear research activities and radioactive waste treatment are ongoing.