

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

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

1. Reviews

RECENT RESEARCH ON EMF AND HEALTH RISK. TWELFTH REPORT FROM SSM'S SCIENTIFIC COUNCIL ON ELECTROMAGNETIC FIELDS, 2017.

Swedish Radiation Safety Authority's (SSM) Scientific Council, April 2018.

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<https://www.stralsakerhetsmyndigheten.se/publikationer/rapporter/stralskydd/2018/201809/>

Of recent studies on residential exposure to ELF magnetic fields and childhood leukaemia, two found decreasing risk estimates over time, but this finding is not consistent across epidemiological studies. Altogether, while it remains an open question as to what caused the decrease of observed relative risks: these studies do not alter the current interpretation of an observed association of residential exposure to ELF magnetic fields and childhood leukaemia yet absence of a causal explanation.

Research on other outcomes is scarce and does not indicate new insights for health risk assessment.

Only one human experimental study was found, exhibiting severe limitations and thus does not contribute to the knowledge about acute effects of ELF magnetic field exposure on cognitive performance.

POWER LINES AND HEALTH PART I: CHILDHOOD CANCER

Gezondheidsraad Nederland, April 18th 2018

Gezondheidsraad Nr. 2018/08. Available at: <https://www.gezondheidsraad.nl/en/task-and-procedure/areas-of-activity/gezonde-leefomgeving/power-lines-and-health-part-i-childhood-cancer>

The Electromagnetic Fields Committee of the Health Council re-analyzed the data on a possible relationship between exposure to magnetic fields generated by overhead and underground power lines and the incidence of childhood cancer. It did so in greater detail and including the most recent studies. Most studies do not measure the exact exposure of children, because that is too complex and time-consuming. Instead, some studies consider the distance between a child's residence and the power line. Because the strength of the magnetic field generated by the line decreases with increasing distance, the distance provides an indication for the magnetic field strength in the residence. In other studies, the residential magnetic field strength has been assessed by measurements or calculations, or combinations of the two.

Overall, the results indicate an increasing risk of childhood leukaemia with decreasing distance and increasing magnetic field strength. The risk estimate is higher when the

magnetic field strength is assessed more accurately. The most representative exposure estimate is the assessment of the magnetic field strength in all residences of a child between birth and diagnosis. Based on these data, the estimated leukaemia risk seems to be more than two and a half times higher in children that have been long-term exposed to an average magnetic field strength of 0.3 to 0.4 microtesla or higher compared to children that are exposed at background level. There is considerable uncertainty in this risk estimate, but the Committee considers it highly unlikely that in reality there is no increased risk. These new analyses confirm the earlier conclusions of the Health Council.

For other types of cancer in children only data are available on brain tumours and lymphomas. Only for brain tumours sufficient data are available to carry out analyses. In studies using distance as a measure of exposure, no indications for an association with brain cancer in children have been found. In studies using the magnetic field strength as an exposure metric, the risk of brain cancer seems almost 1.5 times higher in children that have been long-term exposed in their homes to magnetic field strengths averaging 0.4 microtesla or more. There is considerable uncertainty in this risk estimate and the Committee considers it more likely that the increase is a chance finding than in the case of leukaemia.

Conclusions: The analyses of the Committee provide indications of an association between exposure to magnetic fields around overhead power lines and the incidence of childhood leukaemia and possibly brain tumours. When the results are summarized in terms of the framework for assessing causality of the US Environmental Protection Agency, the Committee concludes that they are 'suggestive of a causal relationship' between magnetic field exposure and both leukaemia and brain tumours. However, the indications are weaker for brain tumours than for leukaemia. For both cancer types there is insufficient evidence for the qualification of a 'likely' or 'proven causal relationship', also because there is no supporting evidence from animal studies. Regarding the risk of childhood lymphomas, there is insufficient data to infer on causality. An influence of other factors that are associated with the presence of overhead power lines cannot be excluded. However, this has not been shown in research to date. It can also not be excluded that the observations, in particular those concerning brain tumours, are chance findings.

A META-ANALYSIS ON RESIDENTIAL EXPOSURE TO MAGNETIC FIELDS AND THE RISK OF AMYOTROPHIC LATERAL SCLEROSIS.

Röösli M, Jalilian H.

Rev Environ Health. 2018 Jun 6.

Amyotrophic lateral sclerosis (ALS) is caused by the gradual degeneration and death of motor neurons, with mostly unknown etiology. Some risk factors have been suggested for this disease including extremely low frequency magnetic fields (ELF-MF) exposure. This meta-analysis assesses the association of residential exposure to ELF-MF with the risk of ALS. Five studies have addressed the risk of ALS in relation to overhead power lines. A pooled relative risk (RR) of 0.71 [95% confidence interval (CI): 0.48, 1.07] for the most exposed population group (either <200 m distance from

high voltage power lines or $>0.1 \mu\text{T}$) was found. Little heterogeneity ($I^2=0.00\%$, $p=0.67$) and indication for publication bias (P Begg's test=0.22; P Egger's test=0.19) was seen.

Conclusions: Overall, there was no evidence for an association between residential exposure to ELF-MF and the risk of ALS, although the number of exposed cases is low.

PROXIMITY TO OVERHEAD POWER LINES AND CHILDHOOD LEUKAEMIA: AN INTERNATIONAL POOLED ANALYSIS.

Amoon AT, Crespi CM, Ahlbom A, Bhatnagar M, Bray I, Bunch KJ, Clavel J, Feychting M, Hémon D, Johansen C, Kreis C, Malagoli C, Marquant F, Pedersen C, Raaschou-Nielsen O, Rööslé M, Spycher BD, Sudan M,, Swanson J, Tittarelli A, Tuck DM, Tynes T, Vergara X, Vinceti M, Wünsch-Filho V, Kheifets L.

Br J Cancer. 2018 May 29.

Although studies have consistently found an association between childhood leukaemia risk and magnetic fields, the associations between childhood leukaemia and distance to overhead power lines have been inconsistent. The authors pooled data from multiple studies to assess the association with distance and evaluate whether it is due to magnetic fields or other factors associated with distance from lines. They present a pooled analysis combining individual-level data (29,049 cases and 68,231 controls) from 11 record-based studies. There was no material association between childhood leukaemia and distance to nearest overhead power line of any voltage. Among children living <50 m from 200 + kV power lines, the adjusted odds ratio for childhood leukaemia was 1.33 (95% CI: 0.92-1.93). The odds ratio was higher among children diagnosed before age 5 years. There was no association with calculated magnetic fields. Odds ratios remained unchanged with adjustment for potential confounders.

Conclusions: In this first comprehensive pooled analysis of childhood leukaemia and distance to power lines, a small and imprecise risk was found for residences <50 m of 200 + kV lines that was not explained by high magnetic fields. Reasons for the increased risk, found in this and many other studies, remains to be elucidated.

2. Residential exposure

REANALYSIS OF RISKS OF CHILDHOOD LEUKAEMIA WITH DISTANCE FROM OVERHEAD POWER LINES IN THE UK.

Swanson J, Bunch K.

J Radiol Prot. 2018 May 30.

A previous study of childhood leukaemia and distance to high-voltage overhead power lines in the UK has been included in an international pooled analysis. That pooled analysis used different distance categories, which has focussed attention on the effect of that choice. The authors re-analyse their previous subjects, using finer distance categories. In the 1960s and 1970s, when they principally found an elevated risk, the

risk did not fall monotonically with distance from the power line but had a maximum at 100-200 m.

Conclusions: This study weakens the evidence that any elevated risks are related to magnetic fields, and slightly strengthens the evidence for a possible effect involving residential mobility or other socioeconomic factors.

CHARACTERISTICS OF PERCEIVED ELECTROMAGNETIC HYPERSENSITIVITY IN THE GENERAL POPULATION.

Gruber MJ, Palmquist E, Nordin S.

Scand J Psychol. 2018 Aug;59(4):422-427.

Health problems evoked in the presence of electrical equipment is a concern, calling for better understanding for characteristics of electromagnetic hypersensitivity (EHS) in the general population. The present study investigated demographics, lifestyle factors, frequency and duration, coping strategies, proportion meeting clinical criteria for intolerance attributed to electromagnetic fields (EMF) and comorbidity. Using data from a large-scale population-based questionnaire study, the authors investigated persons with self-reported (n = 91) EHS in comparison to referents (n = 3,250). Middle age, female sex and poor perceived health was found to be associated with EHS. More than 50% in the EHS group reported having EMF-related symptoms more often than once a week, and the mean number of years experiencing EHS was 10.5. More than half of the EHS group reported that their symptoms started after a high-dose or long-term EMF exposure, that they actively tried to avoid EMF sources and that they mostly could affect the EMF environment. A minority of the EHS group had sought medical attention, been diagnosed by a physician or received treatment. Exhaustion syndrome, anxiety disorder, back/joint/muscle disorder, depression, functional somatic syndrome and migraine were comorbid with EHS.

Conclusions: These results provide ground for future study of these characteristic features being risk factors for development of EHS and or consequences of EHS.

3. Exposure assessment

EXPOSURE TO EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS DURING LESSONS IN SECONDARY SCHOOLS.

Silangam W, Yoosook W, Kongtip P, Kongtawelert A, Theppeang K.

Radiat Prot Dosimetry. 2018 May 1;179(3):248-252.

Schools are a significant location where children are exposed to electromagnetic fields (EMFs), which may cause adverse health effects. This cross-sectional study aimed to examine exposure levels to extremely low frequency magnetic fields (ELF-MFs) with a range of 5 Hz-32 kHz, and ELF-electric fields (ELF-EFs) with a range of 5 Hz-2 kHz in secondary schools in Bangkok, Thailand. This study was conducted in 60 classrooms from three schools during class hours. Spot measurements were taken with a Narda EFA 300 field analyzer to evaluate exposure levels.

Conclusions: This study showed that ELF-EMF exposure levels are lower than ICNIRP guidelines, while 21.67% of classrooms had a magnetic field strength above 0.2 μ T, and the main sources of ELF-EMFs were electrical equipment and electrical wiring.

4. Leukaemia studies

A CAUSAL MECHANISM FOR CHILDHOOD ACUTE LYMPHOBLASTIC LEUKAEMIA.

Greaves M.

Nat Rev Cancer. 2018 May 21.

In this Review, the author presents evidence supporting a multifactorial causation of childhood acute lymphoblastic leukaemia (ALL), a major subtype of paediatric cancer. ALL evolves in two discrete steps. First, in utero initiation by fusion gene formation or hyperdiploidy generates a covert, pre-leukaemic clone. Second, in a small fraction of these cases, the postnatal acquisition of secondary genetic changes drives conversion to overt leukaemia. Epidemiological and modelling studies endorse a dual role for common infections. Microbial exposures earlier in life are protective but, in their absence, later infections trigger the critical secondary mutations. Risk is further modified by inherited genetics, chance and, probably, diet.

Conclusions: Childhood ALL can be viewed as a paradoxical consequence of progress in modern societies, where behavioural changes have restrained early microbial exposure. This engenders an evolutionary mismatch between historical adaptations of the immune system and contemporary lifestyles. Childhood ALL may be a preventable cancer.

MATERNAL RESIDENTIAL PESTICIDE USE AND RISK OF CHILDHOOD LEUKEMIA IN COSTA RICA.

Hyland C, Gunier RB, Metayer C, Bates MN, Wesseling C, Mora AM.

Int J Cancer. 2018 Apr 15.

Evidence suggests that early-life exposure to pesticides inside the home may be associated with childhood leukemia, however data from Latin American countries are limited. The authors examined whether self-reported maternal residential pesticide use and nearby pesticide applications-before and after child's birth-were associated with acute lymphoblastic leukemia (ALL) in the Costa Rican Childhood Leukemia Study (CRCLS), a population-based case-control study (2001-2003). Cases (n = 251 ALL) were diagnosed between 1995 and 2000 (age <15 years at diagnosis) and were identified through the Costa Rican Cancer Registry and National Children's Hospital. Population controls (n = 577) were drawn from the National Birth Registry. Unconditional logistic regression models adjusted for child sex, birth year, and socioeconomic status were fitted to estimate the exposure-outcome associations and also stratified by child sex. The authors observed that self-reported maternal insecticide use inside the home in the year before pregnancy, during pregnancy, and while breastfeeding was associated with increased odds of ALL among boys [adjusted Odds Ratio (aOR) = 1.63 (95% confidence interval [95% CI]: 1.05-2.53), 1.75 (1.13-

2.73), and 1.75 (1.12-2.73), respectively. They also found evidence of exposure-response relationships between more frequent maternal insecticide use inside the home and increased odds of ALL among boys and girls combined. Maternal report of pesticide applications on farms or companies near the home during pregnancy and at any time period were also associated with ALL.

Conclusions: This study in Costa Rica highlights the need for education to minimize pesticide exposures inside and around the home, particularly during pregnancy and breastfeeding.

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 May;40(4):e207-e214.

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.

SOCIOECONOMIC STATUS AND CHILDHOOD CANCER INCIDENCE: A POPULATION-BASED MULTILEVEL ANALYSIS.

Kehm RD, Spector LG, Poynter JN, Vock DM, Osypuk TL.

Am J Epidemiol. 2018 May 1;187(5):982-991.

The etiology of childhood cancers remains largely unknown, especially regarding environmental and behavioral risk factors. Unpacking the association between socioeconomic status (SES) and incidence may offer insight into such etiology. The authors tested associations between SES and childhood cancer incidence in a population-based case-cohort study (source cohort: Minnesota birth registry, 1989-2014). Cases, ages 0-14 years, were linked from the Minnesota Cancer Surveillance System to birth records through probabilistic record linkage. Controls were 4:1 frequency matched on birth year (2,947 cases and 11,907 controls). Associations of

individual-level (maternal education) and neighborhood-level (census tract composite index) SES were tested using logistic mixed models. In crude models, maternal education was positively associated with incidence of acute lymphoblastic leukemia (odds ratio (OR) = 1.10, 95% confidence interval (CI): 1.02, 1.19), central nervous system tumors (OR = 1.12, 95% CI: 1.04, 1.21), and neuroblastoma (OR = 1.15, 95% CI: 1.02, 1.30). Adjustment for established risk factors-including race/ethnicity, maternal age, and birth weight-substantially attenuated these positive associations. Similar patterns were observed for neighborhood-level SES. Conversely, higher maternal education was inversely associated with hepatoblastoma incidence (adjusted OR = 0.70, 95% CI: 0.51, 0.98).

Conclusions: Overall, beyond the social patterning of established demographic and pregnancy-related exposures, SES is not strongly associated with childhood cancer incidence.