

# Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the fourth trimester of 2013

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## 1. Residential exposure

### **RESIDENTIAL EXPOSURE TO 50 HZ MAGNETIC FIELDS AND THE ASSOCIATION WITH MISCARRIAGE RISK: A 2-YEAR PROSPECTIVE COHORT STUDY.**

Wang Q, Cao Z, Qu Y, Peng X, Guo S, Chen L.  
*PLoS One.* 2013; 8(12):e82113.

The hypothesis of whether exposure to extremely low-frequency magnetic fields (ELF-MF) may increase miscarriage risk is controversial. A 2-year prospective cohort study was designed to study the association between exposure to 50 Hz magnetic fields (MF) and the miscarriage risk for women residing in the area of the Pearl-River Delta of China.

Two towns with densely distributed power supply constructions were selected as the study sites. From 2010 to 2012, 552 women in the region who were at approximately 8 weeks of gestation or who planned to have a baby within 1 year were selected as candidate subjects. Exposure to MF was estimated by measurements at their front doors and in the alley in front of the subjects' houses. The average exposure level was used as a cutoff point to define the exposed group. Clinical miscarriage was diagnosed by local obstetricians. Staffs from the local population and family planning service stations were responsible for the follow-up interviews every 2 months.

Four hundred and thirteen pregnant women were selected for the cohort study. The average residential exposure to MF was 0.099  $\mu$ T. No significantly increased risk of miscarriage was found to be associated with the average front-door exposure ( $p > 0.05$ ). However, miscarriage risk was found to be significantly associated with maximum alley exposure ( $p = 0.001$ ). The relative risk (RR) of miscarriage from maximum alley exposure was 2.35 (95% C.I.: 1.18-4.71). In addition, Cox regression analysis showed that the adjusted hazard ratio of maximum alley exposure for miscarriage was 1.72 (95% C.I.: 1.10-2.69).

Conclusion: Although the miscarriage incidence was shown to be positively associated with the maximum alley MF exposure, the association between miscarriage risk and the exposure to MF was not confirmed in the study. The results of this study are of interest concerning MF exposure assessment and pregnancy outcomes.

### **RISKS PERCEPTION OF ELECTROMAGNETIC FIELDS IN TAIWAN: THE INFLUENCE OF PSYCHOPATHOLOGY AND THE DEGREE OF SENSITIVITY TO ELECTROMAGNETIC FIELDS.**

Tseng MC, Lin YP, Hu FC, Cheng TJ.  
*Risk Anal.* 2013; 33(11):2002-2012.

Little is known about the perceived health risks of electromagnetic fields (EMFs) and factors associated with risk perception in non-Western countries. Psychological conditions and risk perception have been postulated as factors that facilitate the attribution of health complaints to environmental factors. This study investigated

people's perceived risks of EMFs and other environmental sources, as well as the relationships between risk perception, psychopathology, and the degree of self-reported sensitivity to EMFs. A total of 1,251 adults selected from a nationwide telephone interviewing system database responded to a telephone survey about the relationships between environmental sources and human health. The interview included questions assessing participants' psychiatric conditions and the presence and degree of sensitivity to EMFs. One hundred and seventy participants were self-identified as having sensitivity to EMFs, and 141 met the criteria for psychiatric conditions without EMF sensitivity. More than half of the survey respondents considered power lines and mobile phone base stations to affect people's health to a big extent. Higher sensitivity to EMFs, psychopathology, being female, being married, more years of education, and having a catastrophic illness had positive associations with perceived risks of EMF-related environmental sources as well as for all environmental sources combined. No moderating effect of psychopathology on the association between degree of sensitivity to EMF and risk perception was observed. Conclusions: Psychopathology had influence on general people's risk perception without having influence on the relationship between people's degree of sensitivity to EMF and risk perception.

**ELECTROMAGNETIC HYPERSENSITIVITY (EHS) IN THE MEDIA - A QUALITATIVE CONTENT ANALYSIS OF NORWEGIAN NEWSPAPERS.**

Huiberts A, Hjørnevik M, Mykletun A, Skogen JC.

*JRSM Short Rep. 2013; 4(11):1-8.*

Electromagnetic hypersensitivity (EHS) is a condition characterized by experiencing symptoms after perceived exposure to weak electromagnetic fields (EMFs). There is substantial debate concerning the aetiology of EHS, but experimental data indicate no association between EHS and actual presence of EMFs. Newspapers play a key role in shaping peoples' understanding of health-related issues. The aim of this study was to describe the content of newspaper articles concerning aetiology and treatment of EHS.

Norwegian newspaper articles published between 1 February 2006 and 11 August 2010, were identified using a comprehensive electronic media archive. The main outcome measures were statements coded according to source of information, whether it was pro or con scientific evidence on EHS aetiology, and type of intervention presented as treatment option for EHS.

Of the statements concerning EHS aetiology (n = 196), 35% (n = 69) were categorized as pro evidence, 65% (n = 127) as con evidence. Of the statements about EHS interventions assessed, 78% (n = 99) were categorized as 'radiance reduction', 4% (n = 5) as 'complementary medicine', and 18% (n = 23) as 'other'. Cognitive behavioural therapy (CBT) and psychotropic drugs were never presented as possible treatment options for EHS.

Conclusions: The newspaper media discourse of EHS aetiology and recommended treatment interventions is much in conflict with the current evidence in the field. The majority of statements concerning aetiology convey that EHS is related to the presence of weak EMFs, and radiance reduction as the most frequently conveyed measure to reduce EHS-related symptoms.

## **2. Occupational exposure**

### **OCCUPATIONAL EXPOSURE TO MAGNETIC FIELDS AND BREAST CANCER AMONG WOMEN TEXTILE WORKERS IN SHANGHAI, CHINA.**

Li W, Ray RM, Thomas DB, Yost M, Davis S, Breslow N, Gao DL, Fitzgibbons ED, Camp JE, Wong E, Wernli KJ, Checkoway H.

*Am J Epidemiol.* 2013; 178(7):1038-1045.

Exposure to magnetic fields (MFs) is hypothesized to increase the risk of breast cancer by reducing production of melatonin by the pineal gland. A nested case-cohort study was conducted to investigate the association between occupational exposure to MFs and the risk of breast cancer within a cohort of 267,400 female textile workers in Shanghai, China. The study included 1,687 incident breast cancer cases diagnosed from 1989 to 2000 and 4,702 noncases selected from the cohort. Subjects' complete work histories were linked to a job-exposure matrix developed specifically for the present study to estimate cumulative MF exposure. Hazard ratios and 95% confidence intervals were calculated using Cox proportional hazards modeling that was adapted for the case-cohort design. Hazard ratios were estimated in relation to cumulative exposure during a woman's entire working years. Conclusion: No association was observed between cumulative exposure to MFs and overall risk of breast cancer. The hazard ratio for the highest compared with the lowest quartile of cumulative exposure was 1.03 (95% confidence interval: 0.87, 1.21). Similar null findings were observed when exposures were lagged and stratified by age at breast cancer diagnosis. The findings do not support the hypothesis that MF exposure increases the risk of breast cancer.

## **3. Human experiment studies**

### **IN VITRO ASSESSMENT OF THE IMMUNITY OF IMPLANTABLE CARDIOVERTER-DEFIBRILLATORS TO MAGNETIC FIELDS OF 50/60 HZ.**

Katrib J, Nadi M, Kourtiche D, Magne I, Schmitt P, Souques M, Roth P.

*Physiol Meas.* 2013; 34(10):1281-1292.

Public concern for the compatibility of electromagnetic (EM) sources with active implantable medical devices (AIMD) has prompted the development of new systems that can perform accurate exposure studies. EM field interference with active cardiac implants (e.g. implantable cardioverter-defibrillators (ICDs)) can be critical. This paper describes a magnetic field (MF) exposure system and the method developed for testing the immunity of ICD to continuous-wave MFs. The MFs were created by Helmholtz coils, housed in a Faraday cage. The coils were able to produce highly uniform MFs up to 4000  $\mu$ T at 50 Hz and 3900  $\mu$ T at 60 Hz, within the test space. Four ICDs were tested. No dysfunctions were found in the generated MFs.

Conclusions: These results confirm that the tested ICDs were immune to low frequency MFs.

**TESTING OF COMMON ELECTROMAGNETIC ENVIRONMENTS FOR RISK OF INTERFERENCE WITH CARDIAC PACEMAKER FUNCTION.**

Tiikkaja M, Aro AL, Alanko T, Lindholm H, Sistonen H, Hartikainen JE, Toivonen L, Juutilainen J, Hietanen M.

*Saf Health Work. 2013; 4(3):156-159.*

Cardiac pacemakers are known to be susceptible to strong electromagnetic fields (EMFs). This in vivo study investigated occurrence of electromagnetic interference with pacemakers caused by common environmental sources of EMFs.

Eleven volunteers with a pacemaker were exposed to EMFs produced by two mobile phone base stations, an electrically powered commuter train, and an overhead high voltage transmission lines. All the pacemakers were programmed in normal clinically selected settings with bipolar sensing and pacing configurations.

None of the pacemakers experienced interference in any of these exposure situations. However, often it is not clear whether or not strong EMFs exist in various work environments, and hence an individual risk assessment is needed.

Conclusion: Modern pacemakers are well shielded against external EMFs, and workers with a pacemaker can most often return to their previous work after having a pacemaker implanted. However, an appropriate risk assessment is still necessary after the implantation of a pacemaker, a change of its generator, or major modification of its programming settings.

#### **4. Exposure assessment**

**MAGNETIC FIELD MEASUREMENTS NEAR STAND-ALONE TRANSFORMER STATIONS.**

Kandel S, Hareuveny R, Yitzhak NM, Ruppin R.

*Radiat Prot Dosimetry. 2013;157(4):619-622.*

Extremely low-frequency (ELF) magnetic field (MF) measurements around and above three stand-alone 22/0.4-kV transformer stations have been performed. The low-voltage (LV) cables between the transformer and the LV switchgear were found to be the major source of strong ELF MFs of limited spatial extent. The strong fields measured above the transformer stations support the assessment method, to be used in future epidemiological studies, of classifying apartments located right above the transformer stations as highly exposed to MFs.

Conclusions: The results of the MF measurements above the ground around the transformer stations provide a basis for the assessment of the option of implementing precautionary procedures.

**CURRENT DENSITIES AND TOTAL CONTACT CURRENTS ASSOCIATED WITH 400 KV POWER LINE TASKS.**

Korpinen L, Kuisti H, Elovaara J.

*Bioelectromagnetics. 2013; 34(8):641-644.*

The aim of the study was to analyze all current values from measured periods while performing tasks on 400 kV power lines. The aim was also to study the average current densities and average total contact currents caused by electric fields in 400 kV power line tasks. Two workers simulated the following tasks: (A) climbing up a portal tower, (B) climbing up a portal transposing tower, (C) working on the cross-arm of a portal tower, (D) climbing up a portal tube tower, (E) climbing up a Tannenbaum tower on the side of the energized circuit with the other circuit

unenergized, (F) climbing up a Tannenbaum tower with both circuits energized, and (G) climbing up a Donau tower. The highest average current density in the neck was 2.5 mA/m<sup>2</sup> (calculated internal electric field 31.5-63.0 mV/m), and the highest average of the contact currents was 240.0 µA.

Conclusions: All measured values at 400 kV towers were lower than the limit value of 10 mA/m<sup>2</sup> in the first version of Directive 2004/40/EC and the basic restrictions (0.1 and 0.8 V/m) of the International Commission on Non-ionizing Radiation Protection.

## **5. Leukemia studies**

### **AIR POLLUTION AND CHILDHOOD LEUKAEMIA: A NATIONWIDE CASE-CONTROL STUDY IN ITALY.**

Badaloni C, Ranucci A, Cesaroni G, Zanini G, Vienneau D, Al-Aidrour F, De Hoogh K, Magnani C, Forastiere F; SETIL Study Group.

*Occup Environ Med.* 2013; 70(12):876-883.

Leukaemia is the most common cancer in children, but its aetiology is still poorly understood. The authors tested the hypothesis that traffic-related air pollution is associated with paediatric leukaemia because of chronic exposure to several potential carcinogens.

The Italian SETIL study (Study on the aetiology of lymphohematopoietic malignancies in children) was conducted in 14 Italian regions. All incident cases of leukaemia in children aged ≤10 years from these regions (period 1998-2001) were eligible for enrolment. Two controls per case, matched on birth date, gender and region of residence were randomly selected from the local population registries. Exposure assessment at birth residence included traffic indicators (distance to main roads and length of main roads within 100 m) and estimates of pollutants concentrations (particulate matter -PM<sub>2.5</sub> and PM<sub>10</sub>- and gases -NO<sub>2</sub> and O<sub>3</sub>-) from national dispersion model and land use regression models. The association between the exposure variables and leukaemia was assessed by logistic regression analyses.

Participation rates were 91.4% among cases and 69.2% in controls; 620 cases (544 acute lymphocytic and 76 acute non-lymphocytic leukaemia) and 957 controls were included. Overall, when considering the residence at birth, 35.6% of cases and 42.4% of controls lived along busy roads, and the mean annual PM<sub>10</sub> levels were 33.3 (SD=6.3) and 33.4 µg/m<sup>3</sup> (SD=6.5), respectively. No association was found, and all ORs, independent of the method of assessment and the exposure windows, were close to the null value.

Conclusions: Using various exposure assessment strategies, air pollution appears not to affect the incidence of childhood leukaemia.

### **PRENATAL EXPOSURE TO TRAFFIC-RELATED AIR POLLUTION AND RISK OF EARLY CHILDHOOD CANCERS.**

Ghosh JK, Heck JE, Cockburn M, Su J, Jerrett M, Ritz B.

*Am J Epidemiol.* 2013; 178(8):1233-1239.

Exposure to air pollution during pregnancy has been linked to the risk of childhood cancer, but the evidence remains inconclusive. In the present study, the authors used land use regression modeling to estimate prenatal exposures to traffic exhaust and evaluate the associations with cancer risk in very young children. Participants in the

Air Pollution and Childhood Cancers Study who were 5 years of age or younger and diagnosed with cancer between 1988 and 2008 were had their records linked to California birth certificates, and controls were selected from birth certificates. Land use regression-based estimates of exposures to nitric oxide, nitrogen dioxide, and nitrogen oxides were assigned based on birthplace residence and temporally adjusted using routine monitoring station data to evaluate air pollution exposures during specific pregnancy periods. Logistic regression models were adjusted for maternal age, race/ethnicity, educational level, parity, insurance type, and Census-based socioeconomic status, as well as child's sex and birth year. The odds of acute lymphoblastic leukemia increased by 9%, 23%, and 8% for each 25-ppb increase in average nitric oxide, nitrogen dioxide, and nitrogen oxide levels, respectively, over the entire pregnancy. Second- and third-trimester exposures increased the odds of bilateral retinoblastoma. No associations were found for annual average exposures without temporal components or for any other cancer type.

Conclusions: These results lend support to a link between prenatal exposure to traffic exhaust and the risk of acute lymphoblastic leukemia and bilateral retinoblastoma.

#### **CHILDHOOD CANCER AND TRAFFIC-RELATED AIR POLLUTION EXPOSURE IN PREGNANCY AND EARLY LIFE.**

Heck JE, Wu J, Lombardi C, Qiu J, Meyers TJ, Wilhelm M, Cockburn M, Ritz B. *Environ Health Perspect.* 2013; 121(11-12):1385-1391.

The literature on traffic-related air pollution and childhood cancers is inconclusive, and little is known on rarer cancer types. The authors sought to examine associations between childhood cancers and traffic-related pollution exposure. The present study included children < 6 years of age identified in the California Cancer Registry (born 1998-2007) who could be linked to a California birth certificate (n = 3,590). Controls were selected at random from California birthrolls (n = 80,224). CALifornia LINE Source Dispersion Modeling, version 4 (CALINE4) was used to generate estimates of local traffic exposures for each trimester of pregnancy and in the first year of life at the address indicated on the birth certificate. The findings were checked by additionally examining associations with particulate matter ( $\leq 2.5 \mu\text{m}$  in aerodynamic diameter; PM<sub>2.5</sub>) pollution measured by community-based air pollution monitors, and with a simple measure of traffic density. With unconditional logistic regression, a per interquartile range increase in exposure to traffic-related pollution during the first trimester (0.0538 ppm carbon monoxide, estimated using CALINE4) was associated with acute lymphoblastic leukemia [ALL; first trimester odds ratio (OR) = 1.05; 95% CI: 1.01, 1.10]; germ cell tumors (OR = 1.16; 95% CI: 1.04, 1.29), particularly teratomas (OR = 1.26; 95% CI: 1.12, 1.41); and retinoblastoma (OR = 1.11; 95% CI: 1.01, 1.21), particularly bilateral retinoblastoma (OR = 1.16; 95% CI: 1.02, 1.33). Retinoblastoma was also associated with average PM<sub>2.5</sub> concentrations during pregnancy, and ALL and teratomas were associated with traffic density near the child's residence at birth.

Conclusions: Weak associations between early exposure to traffic pollution and several childhood cancers were found. Because this is the first study to report on traffic pollution in relation to retinoblastoma or germ cell tumors, and both cancers are rare, these findings require replication in other studies.

**LEUKAEMIA IN YOUNG CHILDREN IN THE VICINITY OF BRITISH NUCLEAR POWER PLANTS: A CASE-CONTROL STUDY.**

Bithell JF, Murphy MF, Stiller CA, Toumpakari E, Vincent T, Wakeford R.  
*Br J Cancer. 2013; 109(11):2880-2885.*

Concern about the risk of leukaemia in children living near nuclear power plants (NPPs) persists. Previous British analyses have been area based and consequently thought to be less effective than case-control studies. Cases of childhood leukaemia and non-Hodgkin lymphoma (LNHL) born and diagnosed in Great Britain between 1962 and 2007, with matched cancer-free controls, were analysed by logistic regression to estimate the risk of residential proximity at birth and diagnosis to the nearest NPP, adjusting for relevant variables. For 9821 children with LNHL under the age of 5 years, the estimated extra risk associated with residential proximity to an NPP at birth was negative-interpolated Odds Ratio (OR) at 5 km was 0.86 (0.49-1.52). The comparison of 10618 children with LNHL under five with 16760 similarly aged children with other cancers also gave a negative estimate of the extra risk of residential proximity at diagnosis-interpolated OR at 5 km was 0.86 (0.62-1.18).

Conclusion: These results show little evidence of an increase in risk of LNHL to children aged under 5 years from living in the vicinity of an NPP. Risk estimates are incompatible with comparable ones published in a recent German case-control study.

**FETAL GROWTH AND CHILDHOOD ACUTE LYMPHOBLASTIC LEUKEMIA: FINDINGS FROM THE CHILDHOOD LEUKEMIA INTERNATIONAL CONSORTIUM.**

Milne E, Greenop KR, Metayer C, Schüz J, Petridou E, Pombo-de-Oliveira MS, Infante-Rivard C, Roman E, Dockerty JD, Spector LG, Koifman S, Orsi L, Rudant J, Dessypris N, Simpson J, Lightfoot T, Kaatsch P, Baka M, Faro A, Armstrong BK, Clavel J, Buffler PA.  
*Int J Cancer. 2013; 133(12):2968-2979.*

Positive associations have been reported between the measures of accelerated fetal growth and risk of childhood acute lymphoblastic leukemia (ALL). The authors investigated this association by pooling individual-level data from 12 case-control studies participating in the Childhood Leukemia International Consortium. Two measures of fetal growth-weight-for-gestational-age and proportion of optimal birth weight (POBW)-were analysed. Study-specific odds ratios (ORs) and 95% confidence intervals (CIs) were estimated using multivariable logistic regression, and combined in fixed effects meta-analyses. Pooled analyses of all data were also undertaken using multivariable logistic regression. Subgroup analyses were undertaken when possible. Data on weight for gestational age were available for 7,348 cases and 12,489 controls from all 12 studies and POBW data were available for 1,680 cases and 3,139 controls from three studies. The summary ORs from the meta-analyses were 1.24 (95% CI: 1.13, 1.36) for children who were large for gestational age relative to appropriate for gestational age, and 1.16 (95% CI: 1.09, 1.24) for a one-standard deviation increase in POBW. The pooled analyses produced similar results. The summary and pooled ORs for small-for-gestational-age children were 0.83 (95% CI: 0.75, 0.92) and 0.86 (95% CI: 0.77, 0.95), respectively. Results were consistent across subgroups defined by sex, ethnicity and immunophenotype, and when the analysis was restricted to children who did not have high birth weight.

Conclusions: The evidence that accelerated fetal growth is associated with a modest increased risk of childhood ALL is strong and consistent with known biological mechanisms involving insulin-like growth factors.