

Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the fourth trimester of 2012

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1. Reviews

ASSOCIATION BETWEEN EXTREMELY LOW-FREQUENCY ELECTROMAGNETIC FIELDS OCCUPATIONS AND AMYOTROPHIC LATERAL SCLEROSIS: A META-ANALYSIS.

Zhou H, Chen G, Chen C, Yu Y, Xu Z.
PLoS One. 2012;7(11):e48354.

Through searching PubMed databases (or manual searching) up to April 2012 using the following keywords: "occupational exposure", "electromagnetic fields" and "amyotrophic lateral sclerosis" or "motor neuron disease", seventeen studies were identified as eligible for this meta-analysis. The associations between ELF-EMF exposure and the ALS risk were estimated based on study design (case-control or cohort study), and ELF-EMF exposure level assessment (job title or job-exposure matrix). The heterogeneity across the studies was tested, as was publication bias.

Occupational exposure to ELF-EMF was significantly associated with increased risk of ALS in pooled studies (RR=1.29, 95%CI=1.02-1.62), and case-control studies (OR=1.39, 95%CI=1.05-1.84), but not cohort studies (RR=1.16, 95% CI=0.80-1.69). In sub-analyses, similar significant associations were found when the exposure level was defined by the job title, but not the job-exposure matrix. In addition, significant associations between occupational exposure to ELF-EMF and increased risk of ALS were found in studies of subjects who were clinically diagnosed but not those based on the death certificate. Moderate heterogeneity was observed in all analyses.

Conclusions: These data suggest a slight but significant ALS risk increase among those with job titles related to relatively high levels of ELF-EMF exposure. Since the magnitude of estimated RR was relatively small, one cannot deny the possibility of potential biases at work. Electrical shocks or other unidentified variables associated with electrical occupations, rather than magnetic-field exposure, may be responsible for the observed associations with ALS.

IS THERE A RELATION BETWEEN EXTREMELY LOW FREQUENCY MAGNETIC FIELD EXPOSURE, INFLAMMATION AND NEURODEGENERATIVE DISEASES? A REVIEW OF IN VIVO AND IN VITRO EXPERIMENTAL EVIDENCE.

Mattsson MO, Simkó M.
Toxicology. 2012; 301:1-12.

Possible health consequences of exposure to extremely low frequency magnetic fields (ELF-MF) have received considerable interest during the last decades. One area of concern is neurodegenerative diseases (NDD), where epidemiological evidence suggests a correlation between MF exposure and Alzheimer's disease (AD). This review is focussing on animal and in vitro studies employing ELF-MF exposures to see if there is mechanistic support for any causal connection between NDD and MF-exposure. The hypothesis is that ELF-MF exposure can promote inflammation processes and thus influence the progression of NDD. A firm

conclusion regarding this hypothesis is difficult to draw based on available studies, since there is a lack of experimental studies that have addressed the question of ELF-MF exposure and NDD. Furthermore, the heterogeneity of the performed studies regarding, e.g., the exposure duration, the flux density, the biological endpoint and the cell type and the time point of investigation is substantial and makes conclusions difficult to draw. Nevertheless, the investigated evidence from in vivo and in vitro studies suggest that short-term MF-exposure causes mild oxidative stress (modest ROS increases and changes in antioxidant levels) and possibly activates anti-inflammatory processes (decrease in pro-inflammatory and increase in anti-inflammatory cytokines). The few studies that specifically have investigated NDDs or NDD relevant end-points show that effects of exposure are either lacking or indicating positive effects on neuronal viability and differentiation. In both immune and NDD relevant studies, experiments with realistic long-term exposures are lacking. Importantly, consequences of a possible long-lasting mild oxidative stress are thus not investigated.

Conclusion: In summary, the existing experimental studies are not adequate in answering if there is a causal relationship between MF-exposure and AD, as suggested in epidemiological studies.

ELECTROMAGNETIC FIELDS, OXIDATIVE STRESS, AND NEURODEGENERATION.

Consales C, Merla C, Marino C, Benassi B.

Int J Cell Biol. 2012;2012:683897.

Electromagnetic fields (EMFs) originating both from both natural and manmade sources permeate our environment. As people are continuously exposed to EMFs in everyday life, it is a matter of great debate whether they can be harmful to human health. On the basis of two decades of epidemiological studies, an increased risk for childhood leukemia associated with Extremely Low Frequency fields has been consistently assessed, inducing the International Agency for Research on Cancer to insert them in the 2B section of carcinogens in 2001. EMFs interaction with biological systems may cause oxidative stress under certain circumstances. Since free radicals are essential for brain physiological processes and pathological degeneration, research focusing on the possible influence of the EMFs-driven oxidative stress is still in progress, especially in the light of recent studies suggesting that EMFs may contribute to the etiology of neurodegenerative disorders. This review synthesizes the emerging evidences about this topic, highlighting the wide data uncertainty that still characterizes the EMFs effect on oxidative stress modulation, as both pro-oxidant and neuroprotective effects have been documented. Care should be taken to avoid methodological limitations and to determine the patho-physiological relevance of any alteration found in EMFs-exposed biological system.

COULD THE GEOMAGNETIC FIELD BE AN EFFECT MODIFIER FOR STUDIES OF POWER-FREQUENCY MAGNETIC FIELDS AND CHILDHOOD LEUKAEMIA?

Swanson J, Kheifets L.

J Radiol Prot. 2012; 32:413-418.

Epidemiological studies find an association between power-frequency magnetic fields and childhood leukaemia. One candidate mechanism for a causal link is effects of magnetic fields on biological reactions involving free radicals. This mechanism predicts effects from variations in static, as well as alternating, magnetic

fields, and therefore different consequences at different locations on the earth's surface due to variations in geomagnetic field. Testing this directly is problematic. Instead, the authors investigate whether geomagnetic field appears to be an effect modifier in studies of alternating magnetic fields. They find some, but rather limited and not statistically significant, evidence for this, and discuss the implications.

2. Residential exposure

ASSOCIATION BETWEEN CHILDHOOD LEUKAEMIA AND EXPOSURE TO POWER-FREQUENCY MAGNETIC FIELDS IN MIDDLE EUROPE.

Jirik V, Pekarek L, Janout V, Tomaskova H.
Biomed Environ Sci. 2012; 25:597-601.

Compared with more-developed Western countries, higher exposure levels are evident in the Czech Republic, probably because of the different types of housing. In light of this, the authors aimed to examine the association between ELF-MF exposure and childhood leukaemia in the Czech Republic.

They conducted a paired case-control study. The cases (children with leukaemia) were age- sex- and permanent residence-matched to controls (children without leukaemia). Although this limited potential bias and confounding, it also limited the number of participants.

The matched analyses included 79 case-control pairs. No significant association between ELF-MF exposure and childhood leukaemia was observed for exposures over 0.2 μT (odds ratio [OR]=0.93, confidence interval [CI]=0.45-1.93), 0.3 μT (OR=0.77, CI=0.34-1.75), or 0.4 μT (OR=0.9, CI=0.37-2.22).

Conclusion: Despite higher levels of exposure in Middle and Eastern Europe, no indication of an association between ELF-MF exposure and childhood leukaemia was determined. This in contrast to the findings of previous studies conducted in different countries.

EXTREMELY LOW-FREQUENCY MAGNETIC FIELDS AND SURVIVAL FROM CHILDHOOD ACUTE LYMPHOBLASTIC LEUKEMIA: AN INTERNATIONAL FOLLOW-UP STUDY.

Schüz J, Grell K, Kinsey S, Linet MS, Link MP, Mezei G, Pollock BH, Roman E, Zhang Y, McBride ML, Johansen C, Spix C, Hagihara J, Saito AM, Simpson J, Robison LL, Dockerty JD, Feychting M, Kheifets L, Frederiksen K.
Blood Cancer J. 2012; 2:e98.

A previous US study reported poorer survival in children with acute lymphoblastic leukemia (ALL) exposed to extremely low-frequency magnetic fields (ELF-MF) above 0.3 μT , but based on small numbers. Data from 3073 cases of childhood ALL were pooled from prospective studies conducted in Canada, Denmark, Germany, Japan, UK and US to determine death or relapse up to 10 years from diagnosis. Adjusting for known prognostic factors, the authors calculated hazard ratios (HRs) and 95% confidence intervals (CI) for overall survival and event-free survival for ELF-MF exposure categories and by 0.1 μT increases. The HRs by 0.1 μT increases were 1.00 (CI, 0.93-1.07) for event-free survival analysis and 1.04 (CI, 0.97-1.11) for overall survival. ALL cases exposed to >0.3 μT did not have a poorer event-free survival (HR=0.76; CI, 0.44-1.33) or overall survival (HR=0.96; CI, 0.49-1.89). HRs varied little by subtype of ALL.

Conclusion, ELF-MF exposure has no impact on the survival probability or risk of relapse in children with ALL.

A PROSPECTIVE STUDY OF IN-UTERO EXPOSURE TO MAGNETIC FIELDS AND THE RISK OF CHILDHOOD OBESITY.

Li DK, Ferber JR, Odouli R, Quesenberry CP Jr.
Sci Rep. 2012;2:540.

The authors conducted a prospective study to examine whether in-utero exposure to magnetic fields (MFs) increases the risk of childhood obesity. Participating women carried a meter measuring MF levels during pregnancy and 733 of their children were followed up to 13 years to collect clinically recorded information on growth patterns with 33 weight measurements per child on average. Prenatal exposure to high MF level was associated with increased risk of being obese in offspring than those with lower MF level (odds ratio = 1.69, 95% confidence interval: 1.01-2.84). The association demonstrated a dose-response relationship and was stronger (more than 2.3 fold increased risk) among children who were followed up to the end of the study. The association existed only for persistent obesity, but not for transitory (unlikely) obesity. Maternal exposure to high MF during pregnancy may be a new and previously unknown factor contributing to the world-wide epidemic of childhood obesity/overweight.

3. Occupational exposure

CASE-CONTROL STUDY OF PATERNAL OCCUPATION AND CHILDHOOD LEUKAEMIA IN GREAT BRITAIN, 1962-2006.

Keegan TJ, Bunch KJ, Vincent TJ, King JC, O'Neill KA, Kendall GM, MacCarthy A, Fear NT, Murphy MF.
Br J Cancer. 2012; 107:1652-1659.

This study investigates possible associations between paternal occupational exposure and childhood leukaemia in Great Britain.

The National Registry of Childhood Tumours provided all cases of childhood leukaemia born and diagnosed in Great Britain between 1962 and 2006. Controls were matched on sex, period of birth and birth registration subdistrict. Fathers' occupations were assigned to 1 or more of 33 exposure groups. Social class was derived from father's occupation at the time of the child's birth.

A total of 16 764 cases of childhood leukaemia were ascertained. One exposure group, paternal social contact, was associated with total childhood leukaemia (odds ratio 1.14, 1.05-1.23); this association remained significant when adjusted for social class. The subtypes lymphoid leukaemia (LL) and acute myeloid leukaemia showed increased risk with paternal exposure to social contact before adjustment for social class. Risk of other leukaemias was significantly increased by exposure to electromagnetic fields, persisting after adjustment for social class. For total leukaemia, the risks for exposure to lead and exhaust fumes were significantly <1. Occupationally derived social class was associated with risk of LL, with the risk being increased in the higher social classes.

Conclusion: These results showed some support for a positive association between childhood leukaemia risk and paternal occupation involving social contact. Additionally, LL risk increased with higher paternal occupational social class.

CANCER INCIDENCE IN UK ELECTRICITY GENERATION AND TRANSMISSION WORKERS, 1973-2008.

Sorahan T.

Occup Med (Lond). 2012; 62:496-505.

Cancer morbidity experienced by a cohort of 81 842 employees of the former Central Electricity Generating Board of England and Wales was investigated for the period 1973-2008. All employees had worked for at least 6 months with some employment between 1973 and 1982. Standardized registration ratios (SRRs) were calculated on the basis of national rates.

Overall cancer morbidity was slightly below expectation in males and females. Significant excesses were found in male workers for mesothelioma (Observed [Obs] 504, SRR 331), skin cancer (non-melanoma) (Obs 3187, SRR 107) and prostate cancer (Obs 2684, SRR 107) and in female workers for cancer of the small intestine (Obs 10, SRR 306) and nasal cancer (Obs 9, SRR 474). Brain cancers were close to expectation in males and below expectation in females. Leukaemia incidence (all types) was slightly below expectation in males and females. More detailed analyses showed important contrasts for mesothelioma and leukaemia.

Conclusions: The clear occupational excess of mesothelioma was not matched by a corresponding excess of lung cancer, and the level of asbestos-induced lung cancer in this industry must be low. Leukaemia risks declined with period from hire; confident interpretation of this finding is not possible. The excesses of cancers of the nasal cavities and small intestine are probably not occupational, though the excess of skin cancer may be due to outdoor work.

4. Human experiment

GENE EXPRESSION PROFILES IN WHITE BLOOD CELLS OF VOLUNTEERS EXPOSED TO A 50 HZ ELECTROMAGNETIC FIELD.

Kirschenlohr H, Ellis P, Hesketh R, Metcalfe J.

Radiat Res. 2012; 178:138-49.

Consistent and independently replicated laboratory evidence to support a causative relationship between environmental exposure to extremely low-frequency electromagnetic fields (EMFs) at power line frequencies and the associated increase in risk of childhood leukemia has not been obtained. In particular, although gene expression responses have been reported in a wide variety of cells, none has emerged as robust, widely replicated effects. DNA microarrays facilitate comprehensive searches for changes in gene expression without a requirement to select candidate responsive genes. To determine if gene expression changes occur in white blood cells of volunteers exposed to an ELF-EMF, each of 17 pairs of male volunteers age 20-30 was subjected either to a 50 Hz EMF exposure of $62.0 \pm 7.1 \mu\text{T}$ for 2 h or to a sham exposure ($0.21 \pm 0.05 \mu\text{T}$) at the same time (11:00 a.m. to 13:00 p.m.). The alternative regime for each volunteer was repeated on the following day and the two-day sequence was repeated 6 days later, with the exception that a null exposure ($0.085 \pm 0.01 \mu\text{T}$) replaced the sham exposure. Five

blood samples (10 ml) were collected at 2 h intervals from 9:00 to 17:00 with five additional samples during the exposure and sham or null exposure periods on each study day. RNA samples were pooled for the same time on each study day for the group of 17 volunteers that were subjected to the ELF-EMF exposure/sham or null exposure sequence and were analyzed on Illumina microarrays. Time courses for 16 mammalian genes previously reported to be responsive to ELF-EMF exposure, including immediate early genes, stress response, cell proliferation and apoptotic genes were examined in detail.

Conclusion: No genes or gene sets showed consistent response profiles to repeated ELF-EMF exposures. A stress response was detected as a transient increase in plasma cortisol at the onset of either exposure or sham exposure on the first study day. The cortisol response diminished progressively on subsequent exposures or sham exposures, and was attributable to mild stress associated with the experimental protocol.

INTERFERENCE OF LOW FREQUENCY MAGNETIC FIELDS WITH IMPLANTABLE CARDIOVERTER-DEFIBRILLATORS.

Tiikkaja M, Alanko T, Lindholm H, Hietanen M, Toivonen L, Hartikainen J.
Scand Cardiovasc J. 2012; 46:308-314.

Seventeen cardioverter-defibrillators (ICDs) were exposed to magnetic fields with different intensities produced by the Helmholtz coil system. Sinusoidal, pulse, ramp, and square-waveforms with a frequency range of 2 Hz to 1 kHz were used.

ICD malfunctions occurred in 11 of the 17 ICDs tested. The ICD malfunctions that occurred were false detections of ventricular tachycardia (6/17 ICDs) and ventricular fibrillation (3/17 ICDs), false detection of atrial tachycardia (4/6 dual chamber ICDs) and tachycardia sensing occurring during atrial or ventricular refractory periods (1/17 ICD). In most cases, no interference occurred at magnetic field levels below the occupational safety limits of the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Nevertheless, some frequencies using sine, ramp or square waveforms did interfere with certain ICDs at levels below these limits. No EMI occurred with any of the ICDs below the ICNIRP limits for public exposure.

Conclusion: Evaluation of EMI should be part of the risk assessment of an employee returning to work after an ICD implantation. The risk assessment should consider magnetic field intensities, frequencies and waveforms.

5. Exposure assessment

A COMPARISON OF MAGNETIC FIELDS INSIDE AND OUTSIDE HIGH-VOLTAGE URBAN 110-KV POWER SUBSTATIONS WITH THE EXPOSURE RECOMMENDATIONS OF THE UKRAINIAN REGULATORY AUTHORITIES.

Okun O, Shevchenko S, Korpinen L.
Radiat Prot Dosimetry. 2012; 31:856-862.

The aim of this study was to carry out theoretical investigations of power frequency magnetic fields (MFs), produced inside and outside the domain of urban 110-kV power substations and to establish a correspondence between the levels of the fields and the specified population limits as defined by Ukrainian regulations. The fields produced by high-voltage substations were studied based on the application

of the numerical finite element methodology. The investigations have shown that magnetic flux density values calculated inside and outside the considered 110-kV power substations do not reach the exposure limits specified by the Ukrainian regulations (1750 μT) and by international guidelines (ICNIRP 2010). Inside the domain of the substation, the maximum value of MFs was found under the 10-kV busbars and it equalled 420 μT .

6. Leukemia studies

LEUKEMIA RISK IN CHILDREN EXPOSED TO BENZENE AND PM(10) FROM VEHICULAR TRAFFIC: A CASE-CONTROL STUDY IN AN ITALIAN POPULATION.

Vinceti M, Rothman KJ, Crespi CM, Sterni A, Cherubini A, Guerra L, Maffei G, Ferretti E, Fabbi S, Teggi S, Consonni D, De Girolamo G, Meggiato A, Palazzi G, Paolucci P, Malagoli C.

Eur J Epidemiol. 2012; 27:781-789.

Benzene, a recognized occupational leukemogen in adults, has been hypothesized to also increase the risk of childhood leukemia. The authors carried out a population-based case-control study in a northern Italy community involving 83 cases with acute childhood leukemia diagnosed in the years 1998-2009 and 332 matched controls. They assessed residential exposure to benzene and to particulate matter $\leq 10 \mu\text{m}$ (PM(10)) from motorized traffic using geocoded residences and detailed emission and dispersion modeling. Exposure to benzene, and to a lesser extent to PM(10), appeared to be independently associated with an excess leukemia risk. When the authors stratified the study population by age and by leukemia subtype, the relative risk associated with benzene exposure was higher among children aged less than 5 years, and despite small numbers this relation appeared to be considerably stronger for acute myeloid leukemia than for acute lymphoblastic leukemia.

Conclusion: These findings suggest that exposure to low levels of benzene released from motorized traffic may increase the risk of childhood leukemia, and suggest a possible independent effect of PM(10), although unmeasured confounding due to other pollutants cannot be ruled out.

ALLERGY AND RISK OF CHILDHOOD ACUTE LYMPHOBLASTIC LEUKEMIA: A POPULATION-BASED AND RECORD-BASED STUDY.

Chang JS, Tsai YW, Tsai CR, Wiemels JL.

Am J Epidemiol. 2012; 176:970-978.

A deficit of normal immune stimulation in early childhood is a suspected risk factor for both childhood acute lymphoblastic leukemia (ALL) and allergies. The present study utilized a population-based case-control design using medical claims data from the National Health Insurance Research Database of Taiwan to evaluate the association between allergy and childhood leukemia. Eight hundred forty-six childhood ALL patients who were newly diagnosed during 2000 to 2008 and were older than 1 but less than 10 years of age were individually matched with 3,374 controls based on sex, birth date, and time of diagnosis (reference date for the controls). Conditional logistic regression was performed to assess the association between childhood ALL and allergies. An increased risk of ALL was observed with having an allergy less than 1 year before the case's ALL diagnosis (odds ratio (OR)

= 1.7, 95% confidence interval (CI): 1.5, 2.0), more than 1 year before the case's diagnosis (OR = 1.3, 95% CI: 1.1, 1.5), and before the age of 1 year (OR = 1.4, 95% CI: 1.1, 1.7).

Conclusion: These results suggest that the pathogenesis of childhood ALL and allergy share a common biologic mechanism.

INFECTIOUS ILLNESS IN CHILDREN SUBSEQUENTLY DIAGNOSED WITH ACUTE LYMPHOBLASTIC LEUKEMIA: MODELING THE TRENDS FROM BIRTH TO DIAGNOSIS.

Crouch S, Lightfoot T, Simpson J, Smith A, Ansell P, Roman E.

Am J Epidemiol. 2012; 176:402-408.

Although there is increasing evidence that immune dysregulation in children who develop acute lymphoblastic leukemia (ALL) is detectable from birth, debate about the role of infectious exposures in infancy continues. With the aim of quantifying children's infectious exposures, investigators have used a number of infection exposure proxies, but there is a lack of consistency in findings, with some markers indicating increased ALL risks and others decreased risks, the disparity being evident both within and between studies. Accordingly, the authors conducted an in-depth analysis of key infection exposure proxies used in the United Kingdom Childhood Cancer Study, a national population-based case-control study conducted over the period 1991-1996, which combined data from medical records, parental interview, and population census. This longitudinal approach revealed the marked deterioration in immune response that emerged around 5 months prior to ALL diagnosis and confirmed that infectious diagnoses in the first year of life were significantly increased ($P < 0.05$) in children who developed leukemia between 2 and 14 years of age, as well as in those who had birth orders >1 , were not breastfed, lived in deprived areas, or were diagnosed with eczema. By contrast, no association between infectious illness and preschool activity was detected, the lower infection levels among controls whose mothers reported attendance contributing to a significantly reduced ALL odds ratio.

BIRTH WEIGHT AND OTHER PERINATAL CHARACTERISTICS AND CHILDHOOD LEUKEMIA IN CALIFORNIA.

Oksuzyan S, Crespi CM, Cockburn M, Mezei G, Kheifets L.

Cancer Epidemiol. 2012; 36:e359-65.

The authors conducted a large registry-based study in California to investigate the association of perinatal factors and childhood leukemia with analysis of two major subtypes, acute lymphocytic leukemia (ALL) and acute myeloid leukemia (AML).

They linked California cancer and birth registries to obtain information on 5788 cases and 5788 controls matched on age and sex (1:1) and examined the association of birth weight, gestational age, birth and pregnancy order, parental ages, and specific conditions during pregnancy and risk of total leukemia, ALL and AML using conditional logistic regression, with adjustment for potential confounders.

The odds ratio (OR) per 1000 g increase in birth weight was 1.11 for both total leukemia and ALL. The OR were highest for babies weighing ≥ 4500 g with reference < 2500 g: 1.59 (95% CI: 1.05-2.40) and 1.70 (95% CI: 1.08-2.68) for total leukemia and ALL, respectively. For AML, increase in risk was also observed but the estimate was imprecise due to small numbers. Compared to average-for-gestational age (AGA), large-for-gestational age (LGA) babies were at slightly increased risk of total childhood leukemia (OR = 1.10) and both ALL and AML (OR

= 1.07 and OR = 1.13, respectively) but estimates were imprecise. Being small-for-gestational age (SGA) was associated with reduced risk of childhood leukemia (OR = 0.81, 95% CI: 0.67-0.97) and ALL (OR = 0.77, 95% CI: 0.63-0.94), but not AML. Being first-born was associated with decreased risk of AML only (OR = 0.70; 95% CI: 0.53-0.93). Compared to children with paternal age <25 years, children with paternal age between 35 and 45 years were at increased risk of total childhood leukemia (OR = 1.12; 95% CI: 1.04-1.40) and ALL (OR = 1.23; 95% CI: 1.04-1.47). None of conditions during pregnancy examined or maternal age were associated with increased risk of childhood leukemia or its subtypes.

Conclusions: These results suggest that high birth weight and LGA were associated with increased risk and SGA with decreased risk of total childhood leukemia and ALL, being first-born was associated with decreased risk of AML, and advanced paternal age was associated with increased risk of ALL. These findings suggest that associations of childhood leukemia and perinatal factors depend highly on subtype of leukemia.

RISK OF CHILDHOOD ACUTE LYMPHOBLASTIC LEUKAEMIA FOLLOWING PARENTAL OCCUPATIONAL EXPOSURE TO PESTICIDES.

Glass DC, Reid A, Bailey HD, Milne E, Fritschi L.

Occup Environ Med. 2012; 69:846-9.

A population-based case-control study of childhood ALL was conducted in Australia. Information about the occupational pesticide exposure of mothers and fathers was collected using job-specific modules. Information on the types and extent of pesticide exposure was collected for mothers and fathers before and around the time of conception, and also for mothers during pregnancy for the index case or control and for 1 year after birth.

Paternal occupational exposure to pesticides before or around conception was not related to increased risk of childhood ALL. There was a low prevalence of occupational exposure to pesticides among women that reduced after birth.

Conclusions: Paternal occupational exposure to pesticides was not found to be associated with an increased risk of acute lymphoblastic leukaemia in the offspring. The study was underpowered with respect to maternal exposure to pesticides.

CASE-CONTROL STUDY OF PATERNAL OCCUPATION AND CHILDHOOD LEUKAEMIA IN GREAT BRITAIN, 1962-2006.

Keegan TJ, Bunch KJ, Vincent TJ, King JC, O'Neill KA, Kendall GM, MacCarthy A, Fear NT, Murphy MF.

Br J Cancer. 2012; 107:1652-1659.

Paternal occupational exposures have been proposed as a risk factor for childhood leukaemia. This study investigates possible associations between paternal occupational exposure and childhood leukaemia in Great Britain.

The National Registry of Childhood Tumours provided all cases of childhood leukaemia born and diagnosed in Great Britain between 1962 and 2006. Controls were matched on sex, period of birth and birth registration subdistrict. Fathers' occupations were assigned to 1 or more of 33 exposure groups. Social class was derived from father's occupation at the time of the child's birth.

A total of 16 764 cases of childhood leukaemia were ascertained. One exposure group, paternal social contact, was associated with total childhood leukaemia (odds ratio 1.14, 1.05-1.23); this association remained significant when adjusted for social

class. The subtypes lymphoid leukaemia (LL) and acute myeloid leukaemia showed increased risk with paternal exposure to social contact before adjustment for social class. Risk of other leukaemias was significantly increased by exposure to electromagnetic fields, persisting after adjustment for social class. For total leukaemia, the risks for exposure to lead and exhaust fumes were significantly <1 . Occupationally derived social class was associated with risk of LL, with the risk being increased in the higher social classes.

Conclusion: These results showed some support for a positive association between childhood leukaemia risk and paternal occupation involving social contact. Additionally, LL risk increased with higher paternal occupational social class.