

Overview of the epidemiologic studies on the health effects of ELF magnetic and electric fields published in the fourth trimester of 2009

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1. Reviews

ELECTROMAGNETIC FIELDS AND EPIDEMIOLOGY: AN OVERVIEW INSPIRED BY THE FOURTH COURSE AT THE INTERNATIONAL SCHOOL OF BIOELECTROMAGNETICS.

Schüz J, Lagorio S, Bersani F.

Bioelectromagnetics. 2009; 30(7): 5115-24.

The fourth course at the International School of Bioelectromagnetics addressed various aspects of the epidemiology of exposure to electromagnetic fields (EMF). In this overview, inspired by the lectures and the discussions among participants, the authors summarize current knowledge on exposure to EMF and disease risk, with emphasis on studies of use of mobile phones and brain tumours and exposure to power lines and childhood leukaemia. Sources of bias and error hamper straightforward conclusions in some areas and, in order to move forward, improvements in study design and exposure assessment are necessary. The scientific evidence available to date on possible long-term effects from exposure to ELF and RF fields is not strong enough to revise current protection limits based on the known acute effects of such exposures. Precautionary measures may be considered to reduce ELF exposure of children or exposure to RF during mobile phone use, keeping in mind that it is unclear whether they involve any preventive benefit. Possible health effects from mobile phone use in adults and in children should be investigated further by prospective epidemiological studies with improved exposure assessment and brain tumour incidence rates should be monitored. Further studies on the relation between childhood leukaemia and ELF magnetic fields would be worthwhile if they focus on heavily exposed groups and attempt to minimize possible selection bias. In conclusion, epidemiological studies conducted with appropriate diligence can play a key role in finding the answers.

2. Occupational exposure

A BIOMONITORING STUDY OF GENOTOXIC RISK TO WORKERS OF TRANSFORMERS AND DISTRIBUTION LINE STATIONS.

Celikler S, Aydemir N, Vatan O, Kurtuldu S, Bilaloglu B.

International Journal of Environmental Health Research 2009; 19(6): 42-43.

A cytogenetic monitoring study was carried out on a group of workers from transformer and distribution line stations in the Bursa province of Turkey, to investigate the genotoxic risk of occupational exposure to extremely low frequency electric (ELF) and magnetic fields (EMF). Cytogenetic analysis, namely chromosomal aberrations (CAs) and micronucleus (MN) tests were performed on a strictly selected group of 55 workers and compared to 17 controls. CA and MN frequencies in electrical workers appeared significantly higher than in controls ($p < 0.001$, 0.05 , respectively). The frequency of CA in exposed groups were significantly enhanced with the years of exposure ($p < 0.01$). The effect of smoking on the level of CA and MN was not significant in the control and exposure groups.

Conclusions: The results of this study demonstrated that a significant induction of cytogenetic damage in peripheral lymphocytes of workers engaged to occupational exposure to ELMF in electric transformer and distribution stations.

3. Exposure assessment

CURRENT DENSITY IN A MODEL OF A HUMAN BODY WITH A CONDUCTIVE IMPLANT EXPOSED TO ELF ELECTRIC AND MAGNETIC FIELDS.

Valic B, Gajsek P, Miklavcic D.

Bioelectromagnetics. 2009; 30(7): 591-599.

A numerical model of a human body with an intramedullary nail in the femur was built to evaluate the effects of the implant on the current density distribution in extremely low frequency electric and magnetic fields. The intramedullary nail was chosen because it is one of the longest high conductive implants used in the human body. As such it is expected to alter the electric and magnetic fields significantly. The exposure was a simultaneous combination of inferior to superior electric field and posterior to anterior magnetic field both alternating at 50 Hz with the values corresponding to the ICNIRP reference levels: 5000 V m⁽⁻¹⁾ for electric field and 100 microT for magnetic flux density. The calculated current density distribution inside the model was compared to the ICNIRP basic restrictions for general public (2 mA m⁽⁻²⁾). The results show that the implant significantly increases the current density up to 9.5 mA m⁽⁻²⁾ in the region where it is in contact with soft tissue in the model with the implant in comparison to 0.9 mA m⁽⁻²⁾ in the model without the implant.

Conclusions: As demonstrated the ICNIRP basic restrictions are exceeded in a limited volume of the tissue in spite of the compliance with the ICNIRP reference levels for general public, meaning that the existing safety limits do not necessarily protect implanted persons to the same extent as they protect people without implants.

URBAN EXPOSURE TO ELF MAGNETIC FIELD DUE TO HIGH-, MEDIUM- AND LOW-VOLTAGE ELECTRICITY SUPPLY NETWORKS.

Bottura V, Cappio Borlino M, Carta N, Cerise L, Imperial E.

Radiat Prot Dosimetry. 2009; 137(3-4): 214-217.

The regional environment protection agency (ARPA) of the Aosta Valley region in north Italy performed a survey of magnetic field triggered by the power supply network in high, medium and low voltages on the entire area of Aosta town. The electrical distribution system for houses was not however taken into account. The aim of the survey was to evaluate the global population exposure and not simply the assessment of the legal exposure limit compliance.

The results obtained during this measurement campaign performed on the entire area of Aosta town confirmed what had emerged during a previous survey for the evaluation of ELF magnetic field exposure in schools: the field generated by medium- or low-voltage lines and transformers in an urban area must not be neglected nor under evaluated.

4. Leukaemia studies

FACTORS ASSOCIATED WITH RESIDENTIAL MOBILITY IN CHILDREN WITH LEUKEMIA: IMPLICATIONS FOR ASSIGNING EXPOSURES.

Urayama KY, Von Behren J, Reynolds P, Hertz A, Does M, Buffler PA.

Ann Epidemiol. 2009; 19(11): 834-840.

In epidemiologic studies, neighborhood characteristics are often assigned to individuals based on a single residence despite the fact that people frequently move and, for most cancer outcomes, the relevant time-window of exposure is not known. The authors evaluated residential mobility patterns for a population-based series of childhood leukemia cases enrolled in the Northern California Childhood Leukemia Study. Complete residential history from 1 year before birth to date of diagnosis was obtained for 380 cases diagnosed between 1995 and 2002. All residences were assigned U.S. Census block group designations using a geographic information system. Overall, two-thirds (65.8%) of children had moved between birth and diagnosis, and one-third (34.5%) moved during the first year of life. Approximately 25% of the mothers had moved during the year before the child's birth. Multivariable analysis indicated greater residential mobility to be associated with older age of the child at diagnosis, younger age of the mother at child's birth, and lower household income. Among those who had moved, residential urban/rural status for birth and diagnosis residences changed for about 20% of subjects, and neighborhood socioeconomic status for 35%.

Conclusions: These results suggest that neighborhood attribute estimates in health studies should account for patterns of residential mobility. Estimates based on a single residential location at a single point in time may lead to different inferences.

A SYSTEMATIC REVIEW AND META-ANALYSIS OF CHILDHOOD LEUKEMIA AND PARENTAL OCCUPATIONAL PESTICIDE EXPOSURE.

Wigle DT, Turner MC, Krewski D.

Environ Health Perspect. 2009; 117(10): 1505-1513.

The authors conducted a systematic review and meta-analysis of childhood leukemia and parental occupational pesticide exposure. Searches of MEDLINE (1950-2009) and other electronic databases yielded 31 included studies. Two authors independently abstracted data and assessed the quality of each study. Random effects models were used to obtain summary odds ratios (ORs) and 95% confidence intervals (CIs). There was no overall association between childhood leukemia and any paternal occupational pesticide exposure (OR = 1.09; 95% CI, 0.88-1.34); there were slightly elevated risks in subgroups of studies with low total-quality scores (OR = 1.39; 95% CI, 0.99-1.95), ill-defined exposure time windows (OR = 1.36; 95% CI, 1.00-1.85), and exposure information collected after offspring leukemia diagnosis (OR = 1.34; 95% CI, 1.05-1.70). Childhood leukemia was associated with prenatal maternal occupational pesticide exposure (OR = 2.09; 95% CI, 1.51-2.88); this association was slightly stronger for studies with high exposure-measurement-quality scores (OR = 2.45; 95% CI, 1.68-3.58), higher confounder control scores (OR = 2.38; 95% CI, 1.56-3.62), and farm-related exposures (OR = 2.44; 95% CI, 1.53-3.89). Childhood leukemia risk was also elevated for prenatal maternal occupational exposure to insecticides (OR = 2.72; 95% CI, 1.47-5.04) and herbicides (OR = 3.62; 95% CI, 1.28-10.3).

Conclusions: Childhood leukemia was associated with prenatal maternal occupational pesticide exposure in analyses of all studies combined and in several subgroups. Associations with paternal occupational pesticide exposure were weaker and less

consistent. Research needs include improved pesticide exposure indices, continued follow-up of existing cohorts, genetic susceptibility assessment, and basic research on childhood leukemia initiation and progression.

UPDATED ESTIMATES OF THE PROPORTION OF CHILDHOOD LEUKAEMIA INCIDENCE IN GREAT BRITAIN THAT MAY BE CAUSED BY NATURAL BACKGROUND IONISING RADIATION.

Little MP, Wakeford R, Kendall GM.

J Radiol Prot. 2009; 29(4): 467-482.

The aetiology of childhood leukaemia remains generally unknown, although exposure to moderate and high levels of ionising radiation, such as was experienced during the atomic bombings of Japan or from radiotherapy, is an established cause. Risk models based primarily upon studies of the Japanese A-bomb survivors imply that low-level exposure to ionising radiation, including to ubiquitous natural background radiation, also raises the risk of childhood leukaemia. In a recent paper (Wakeford et al 2009 in *Leukaemia* 23 770-6) the authors estimated the proportion of childhood leukaemia incidence in Great Britain attributable to natural background radiation to be about 20%. In this paper they employ the two sets of published leukaemia risk models used previously, but use recently published revised estimates of natural background radiation doses received by the red bone marrow of British children to update the previous results. Using the newer dosimetry they calculate that the best estimate of the proportion of cases of childhood leukaemia in Great Britain predicted to be attributable to this source of exposure is 15-20%, although the uncertainty associated with certain stages in the calculation (e.g. the nature of the transfer of risk between populations and the pertinent dose received from naturally occurring alpha-particle-emitting radionuclides) is significant. The slightly lower attributable proportions compared with those previously derived by Wakeford et al (*Leukaemia* 2009 23 770-6) are largely due to the lower doses (and in particular lower high LET doses) for the first year of life.

BIRTH WEIGHT, SEX AND CHILDHOOD CANCER: A REPORT FROM THE UNITED KINGDOM CHILDHOOD CANCER STUDY.

Smith A, Lightfoot T, Simpson J, Roman E; UKCCS investigators.

Cancer Epidemiol. 2009; 33(5): 363-367.

Birth weight has been linked to the risk of developing childhood cancer, in particular childhood leukaemia. However, despite many childhood cancers having a male predominance and boys generally weighing more than girls at birth few studies have reported sex-specific associations. The relationship between birth weight and childhood cancer risk was examined using information from a national case-control study. Children (0-14 years) newly diagnosed with cancer in GB were ascertained between 1991 and 1996 (n=3651) and for comparison, controls matched on sex, month and year of birth were identified from primary care population registers (n=6337). Birth weights were obtained from the Office of National Statistics for all targeted subjects born in England and Wales. Overall, cases were, on average, 30 g heavier at birth than controls (p=0.003) with differences seen by cancer type; those diagnosed with hepatic tumours weighing around 500 g less than controls at birth (p<0.0001) and those with leukaemia being, on average, 50 g heavier than those without (p=0.001). An interaction between birth weight and sex was found for acute leukaemia (chi(2)=11.2, p=0.04) and when data were stratified by sex, an association between high birth weight and risk of ALL was seen with girls (>4000 g, OR 1.86, 95% CI 1.38-2.50, chi(2) for trend 20.2, p<0.0001).

Conclusions: These results support the hypothesis that birth weight is an important determinant for childhood cancer. In addition, the data are consistent with the notion that childhood leukaemia has a prenatal origin.