

# Overview of the epidemiologic studies on the health effects of ELF electric and magnetic fields (ELF-EMF) published in the second quarter of 2024.

Leander De Mol  
Research Unit Occupational and Insurance Medicine  
Department of Public Health and Primary Care  
Ghent University

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# 1. Reviews and meta-analyses

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## 2. Residential exposure

### 2.1. Do somatic symptom distress and attribution predict symptoms associated with environmental factors?

Köteles, F., & Nordin, S. (2024). Do somatic symptom distress and attribution predict symptoms associated with environmental factors? *Journal of Psychosomatic Research*, 179.

Background: Several individuals experience symptoms associated with environmental factors (SAEF), also known as (idiopathic) environmental intolerances. Findings from qualitative studies suggest that appearance of symptoms might be the first step, followed by the acquisition of a specific attribution. Furthermore, the belief in the risk of certain environmental factors can lead to the presence of symptoms due to this factor, even though the factor is absent. This may indicate a substantial role for psychological factors in the development of SAEFs.

The current study investigated cross-sectional and longitudinal (three years) associations between attribution and symptoms with respect to symptoms associated with chemical substances, certain indoor environments (buildings), sounds, and electromagnetic fields (EMFs).

Methods: The authors used data from the first two waves of the population-based Västerbotten Environmental Health Study (n = 2336). Participants completed the Patient Health Questionnaire Somatic Symptom Scale (PHQ-15), the Environmental Symptom-Attribution Scale, and answered single questions on the four aforementioned SAEFs.

Results: Using binary logistic regression analyses, all four SAEFs showed significant cross-sectional associations with somatic symptom distress and the respective attribution, meaning that individuals who experienced symptoms reported higher discomfort due to their symptoms, and attributed these to the respective factor. In the longitudinal analysis, development of SAEF-Chemicals and SAEF-Sound were predicted by both somatic symptom distress and attribution. SAEF-EMFs was predicted only by attribution, whereas neither somatic symptom distress nor attribution forecasted SAEF-Buildings. This indicates that for EMFs, the belief that EMFs can cause symptoms is a crucial prerequisite for the development of SAEF-EMFs.

Conclusions: Overall, these findings suggest that attribution (i.e., a specific expectation) plays a substantial role in the development and maintenance of many SAEFs. Although changing patients' ideas about the causes of their somatic symptoms appears to be particularly challenging, the option that their knowledge about the harmful effects of various environmental factors may have preceded the SAEF might contribute to recovery. The results in this study suggest that this strategy may also be successful regarding prevention of development of future SAEFs related to chemical substances, sound, and EMFs, but less so regarding SAEF related to buildings.

Comment: The authors presented participants with the question ‘Are you getting symptoms from certain switched-on electrical devices that you believe most other people are not getting symptoms from?’, which does not offer the opportunity to distinguish between different types of EMFs. This is noted by the authors, who write that ‘it is possible that there are different temporal pathways and/or SAEF-EMFs is a heterogeneous category with respect to its development and the magnitude of somatic symptom distress.’

## 2.2. Electric and magnetic field pollution in near substations and investigation of anxiety and depressive effects on adult individuals living in this area.

Sert, C., Başak, N., & Koruk, İ. (2024). Electric and magnetic field pollution in near substations and investigation of anxiety and depressive effects on adult individuals living in this area. *Electromagnetic Biology and Medicine*, 43(3), 145–155.

Background: The possibility exists that exposure to electromagnetic fields causes a variety of health problems in living systems. The goal of this study was to measure the electric and magnetic field levels around the transformers and distribution centers located in the city center, determine their compliance with international standards, and investigate the effects on anxiety and depression in adult individuals living close to them.

Methods: The authors investigated EMF pollution in Şanlıurfa (Turkey) city center and also investigated anxiety-depression symptoms in individuals (18–40 years old) exposed to this pollution. Electric field and magnetic field measurements were taken at Electricity Distribution Center and 44 substations (for each transformer), at 0 points, 1 meter away, 2 meters away and the house/office closest to the transformer. The experimental group was individuals living in electricity distribution center residences and individuals living near transformers (n = 55). The control group was selected from individuals who lived outside the city center of Şanlıurfa, did not have transformers or high transmission lines near their homes, and did not have any chronic diseases that could cause stress (n = 50). Anxiety and depression symptoms of the groups were measured using the Beck Anxiety Inventory Scale (BAI) and Beck Depression Inventory Scale (BDI). The relationship between EMF pollution and anxiety-depression was evaluated statistically.

Results: Maximum magnetic and electric field values were recorded as 0.22 mT and 65.9 kV/m, respectively. All measured MF values were below standards, but EF values were above standards at some points. No significant relationship between the EMF

Conclusions: There is no statistically convincing evidence of a relationship between EMF exposure and anxiety-depression ( $p > 0.05$ ). The authors interpreted this as an indication that exposure to electromagnetic fields does not cause anxiety and depression in individuals.

## 3. Occupational exposure

### 3.1. A Bibliometric and Scientometric Network Analysis of Occupational Safety and Health in the Electric Power Industry: Future Implication of Digital Pathways.

Wong, K. P., & Meng, X. (2024). A Bibliometric and Scientometric Network Analysis of Occupational Safety and Health in the Electric Power Industry: Future Implication of Digital Pathways. *Sustainability (Switzerland)*, 16(13).

Background: The increased demand for electricity has given rise to numerous related industries, resulting in perilous working conditions and a significant number of safety accidents for workers. In recent years, there has been an increasing focus on improving occupational safety and health in the electric power industry. However, the lack of a systematic review or the integration of disaggregated studies has hindered the understanding of the state of the development of this research field. This study aimed to perform a literature search of relevant publications and subsequently performed a scientometric analysis. This results in a visual image reflecting the relationships between influential publications and research teams, and the evolution of research topics over time.

Methods: A bibliometric analysis focused on the research cooperation, author keywords, and journal co-citation patterns of studies was carried out, while a temporal trend analysis was employed to identify topical focuses and trends for further research on the occupational safety and health of electrical workers. Papers were searched for across three databases, namely Web of Science, Scopus, and Google Scholar. Using “occupational safety and health” and “electric power industry” as keywords, the articles published from 1991 to 2022 were retrieved.

Results: A total of 608 articles published from 1991 to 2022 were collected for the bibliometric analysis. Four clusters were successfully recognized in the search results after adopting the process of cluster analysis based on a total of 608 articles. As for the countries, most of the publications and citations came from the United States. The most frequent keywords were safety, exposure assessment, electrocution, and electrical injury.

Regarding occupational health of workers in the electric power industry, the authors identified two studies that link ELF-EMF exposure to increased risks of breast cancer and brain cancer. Additional potential adverse impacts on the nervous and cardiovascular systems have also been reported. These risks prompted the industry to adopting assessment techniques and exposure guidelines to evaluate potential health risks.

Conclusions: This study highlights occupational safety and health in the electric power industry and provides insights into the knowledge structure, emerging trends, and future directions of research in this field.

## 4. Exposure Assessment

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## 5. Leukaemia Studies

### 5.1. Trends in childhood leukemia incidence in urban countries and their relation to environmental factors, including space weather.

Khabarova O, Pinaev SK, Chakov VV, Chizhov AY, Pinaeva OG. Trends in childhood leukemia incidence in urban countries and their relation to environmental factors, including space weather. *Front Public Health*. 2024;12:1295643.

**Background:** Leukemia is the most common cancer in children. Its incidence has been increasing worldwide since the early 20<sup>th</sup> century, suggesting the presence of common sources of the disease, most likely related to people's lifestyle and environment. Understanding the relationship between childhood leukemia and environmental conditions is critical to preventing the disease.

**Methods:** This discussion article examines established potentially-carcinogenic environmental factors, such as vehicle emissions and fires, alongside space weather-related parameters like cosmic rays and the geomagnetic field. To discern the primary contributor, the authors analyze trends and annual variations in leukemia incidence among 0-14-year-olds in the United States, Canada, Australia, and Russia from 1990 to 2018. Comparisons are drawn with the number of vehicles (representing gasoline emissions) and fire-affected land areas (indicative of fire-related pollutants), with novel data for Russia introduced for the first time.

**Results:** While childhood leukemia incidence is rising in all countries under study, the rate of increase in Russia is twice that of other nations, possibly due to a delayed surge in the country's vehicle fleet compared to others. This trend in Russia may offer insights into past leukemia levels in the USA, Canada, and Australia. The findings highlight vehicular emissions as the most substantial environmental hazard for children among the factors examined. The authors also advocate for the consideration of potential modulation of carcinogenic effects arising from variations in cosmic ray intensity, as well as the protective role of the geomagnetic field. To support the idea, they provide examples of potential space weather effects at both local and global scales. The additional analysis includes statistical data from 49 countries and underscores the significance of the magnetic field dip in the South Atlantic Anomaly in contributing to a peak in childhood leukemia incidence in Peru, Ecuador and Chile.

**Conclusion:** The authors emphasize the importance of collectively assessing all potentially carcinogenic factors for the successful future predictions of childhood leukemia risk in each country.

## 5.2. Examining the relationship between land use and childhood leukemia and lymphoma in Tehran.

Norzaee, S., Yunesian, M., Ghorbanian, A., Farzadkia, M., Rezaei Kalantary, R., Kermani, M., Nourbakhsh, S. M., & Eghbali, A. (2024). Examining the relationship between land use and childhood leukemia and lymphoma in Tehran. *Scientific reports*, 14(1), 12417.

**Background:** The authors conducted a hospital-based case–control study to explore the association between proximity to various land use types and childhood leukemia (Acute Lymphoblastic Leukemia (ALL) and Acute Myeloid Leukemia (AML) and lymphoma (Hodgkin’s (HL) and non-Hodgkin’s lymphoma (NHL).

**Methods:** This research involved 428 cases of childhood leukemia and lymphoma (2016–2021), along with a control group of 428 children aged 1–15 in Tehran. The authors analyzed the risk of childhood cancer associated with land use by employing logistic regression adjusted for confounding factors such as parental smoking and family history.

**Results:** The odds ratio (OR) for children with leukemia and lymphoma residing within 100 m of the nearest highway was 1.87 (95% CI = 1.00–3.49) and 1.71 (95% CI = 1.00–2.93), respectively, in comparison to those living at a distance of 1000 m or more from a highway. The OR for leukemia with exposure to petrol stations within 100 m was 2.15 (95% CI = 1.00–4.63), and for lymphoma it was 1.09 (95% CI = 0.47–2.50). A significant association was observed near power lines (OR = 3.05; 95% CI = 0.97–9.55) within < 100 m for leukemia. However, no significant association was observed between power lines and the incidence of childhood lymphoma. There was no association between bus stations, major road class 2, and the incidence of childhood leukemia and lymphoma.

**Conclusions:** The results suggest a possible association between the incidence of childhood leukemia and proximity to different urban land uses (i.e., highways and petrol stations). This study is the first step in understanding how urban land use affects childhood leukemia and lymphoma in Tehran. However, comprehensive studies considering individual-level data and specific pollutants are essential for a more nuanced understanding of these associations.

### 5.3. Cancer risk in individuals with polydactyly: a Swedish population-based cohort study.

Wachtmeister, A., Tettamanti, G., Nordgren, I., Norrby, C., Laurell, T., Lu, Y., Skarin Nordenvall, A., & Nordgren, A. (2024). Cancer risk in individuals with polydactyly: a Swedish population-based cohort study. *British Journal of Cancer*, 131(4), 755–762.

**Background:** Polydactyly is a feature of several cancer predisposition syndromes (CPS). However, cancer risk in individuals with polydactyly is largely unknown.

**Methods:** The authors performed a matched cohort study using data from Swedish national registers. The study included 6694 individuals with polydactyly, born in Sweden between 1970–2017. Polydactyly was categorized as thumb polydactyly, finger polydactyly, polydactyly+ (additional birth defects and/or intellectual disability) or isolated polydactyly. Each exposed individual was matched to 50 comparisons by sex, birth year and birth county. Associations were estimated through Cox proportional hazard models.

**Results:** An increased childhood cancer risk was found in males (HR 4.24, 95% CI 2.03–8.84) and females (HR 3.32, 95% CI 1.44–7.63) with polydactyly+. Isolated polydactyly was associated with cancer in childhood (HR 1.87, 95% CI 1.05–3.33) and young adulthood (HR 2.30, 95% CI 1.17–4.50) in males but not in females. The increased cancer risk remained after exclusion of two known CPS: Down syndrome and neurofibromatosis. The highest site-specific cancer risk was observed for kidney cancer and leukaemia.

**Conclusions:** An increased cancer risk was found in individuals with polydactyly, especially in males and in individuals with polydactyly+. These findings encourage future research about polydactyly and cancer associations and emphasize the importance of clinical phenotyping.

### 5.4. Leukemia Types and Subtypes Analysis: Epidemiological Age-Standardized Exploration in the Mexican Bajío Region.

Romero-Morelos, P., González-Yebra, A. L., Bueno-Rosario, L. J., & González-Yebra, B. (2024). Leukemia Types and Subtypes Analysis: Epidemiological Age-Standardized Exploration in the Mexican Bajío Region. *Medicina (Lithuania)*, 60(5).

**Background:** Leukemia, characterized by abnormal leukocyte production, exhibits clonal origin from somatic mutations. Globally, it ranked 15th in cancer incidence in 2020, with higher prevalence in developing countries. In Mexico, it was the ninth most frequent cancer. Regional registries are vital for understanding its epidemiology. This study aims to analyze the prevalence and age-standardized incidence rates of leukemias in a tertiary care hospital in the Mexican Bajío region.

**Methods:** Leukemia cases from 2008–2018 were analyzed, and 535 medical records were included in this study. The prevalence, distribution, and age-specific incidence rate of different types and subtypes of leukemia were determined according to sex and age groups.



**Results:** Overall, 65.79% consisted of lymphocytic leukemia, 33.64% of myeloid leukemia, and 0.56% of monocytic leukemia. No significant sex-based differences were found, but age-specific patterns were observed. Leukemia distribution by age revealed significant associations. Lymphocytic leukemia dominated in the pediatric population, particularly acute lymphocytic leukemia, while myeloid leukemia shifted towards adulthood. Age-specific incidence patterns showed, first, that lymphocytic leukemia is the most common leukemia in pediatric ages, and second, there is a shift from acute lymphocytic leukemia dominance in pediatric ages to myeloid leukemia incidence in late adulthood, emphasizing nuanced epidemiological dynamics.

**Conclusions:** Acute leukemia cases occurred with high prevalence in the included study population, with a high incidence in pediatric and adulthood populations, especially for acute lymphocytic leukemia, showing a (<18 years) 153.8 age-standardized incidence rate in the pediatric group, while in the adult population, the age-standardized rate was 59.84. In the age-specific analysis, it was found that the childhood group (5-9 years) were the most affected by acute lymphocytic leukemia in the pediatric population, while in the adult population, the early-adulthood group (15-29 years) were the most affected age group. In contrast, chronic myeloid leukemia affected both adults and the pediatric populations, while chronic lymphocytic leukemia and monocytic leukemia were exclusive to adults. The study underscores the need for tailored diagnostic, treatment, and preventive strategies based on age, contributing valuable insights into the leukemia epidemiology of the Bajío region.

## 5.5. Residential proximity to oil and gas developments and childhood cancer survival.

Hoang, T. T., Rathod, R. A., Rosales, O., Castellanos, M. I., Schraw, J. M., Burgess, E., Peckham-Gregory, E. C., Oluyomi, A. O., Scheurer, M. E., Hughes, A. E., & Lupo, P. J. (2024). Residential proximity to oil and gas developments and childhood cancer survival. *Cancer*.

**Background:** Environmental toxicants may impact survival in children with cancer, but the literature investigating these associations remains limited. Because oil and gas developments emit several hazardous air pollutants, the authors evaluated the relationship between residential proximity to oil or gas development and survival across 21 different pediatric cancers.

**Methods:** The Texas Cancer Registry had 29,730 children ( $\leq 19$  years old) diagnosed with a primary cancer between 1995 to 2017. Geocoded data were available for 285,266 active oil or gas wells and 109,965 horizontal wells. The authors calculated whether each case lived within 1000 m (yes/no) from each type of oil or gas development. Survival analyses were conducted using Cox regression, adjusting for potential confounders.

**Results:** A total of 14.2% of cases lived within 1000 m of an oil or gas well or horizontal well. Living within 1000 m of an oil or gas well was associated with risk of mortality in cases with acute myeloid leukemia (AML) (adjusted hazard ratio [aHR], 1.36; 95% confidence interval [CI], 1.01-1.84) and hepatoblastoma (aHR, 2.13; 95% CI, 1.03-4.39). An inverse association was observed with Ewing sarcoma (aHR, 0.35; 95% CI, 0.13-0.95). No associations were observed with horizontal well. There was evidence of a dose-response effect in children with AML or hepatoblastoma and residential proximity

to oil or gas wells. In general, the magnitude of association increased with decreasing distance and with higher number of wells across the three distances.

Conclusions: Residential proximity to oil or gas wells at diagnosis is associated with the risk of mortality in children with AML or hepatoblastoma.

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