

A review on residential exposure to electromagnetic fields from overhead power lines: electrification as a health burden in rural communities

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Abstract—*Electrification has improved millions of lives over the years. With the benefit of electricity comes the emission of electromagnetic fields (EMFs) from power lines, substations, electrical home appliances and railways. There have been studies done to associate exposure to EMFs with the development of health effects such as cancer and transient biological effects. The aim of this paper is to provide discourse on the association between EMFs and cancer, not excluding other severe health effects such as cognitive impairment and preterm labor in pregnant women. In this paper, google scholar, science direct and PubMed were used to search for literature. Out of thirty articles, fifteen were selected and used to compile this paper. These articles revealed that studies in the past have found conflicting results from research conducted globally. Eight articles out of the fifteen found a link between exposure to EMFs and leukemia as well as impaired neurobehavioral function in children. Six articles found a statistically insignificant association, with one article being inconclusive. World Health Organization (WHO) found a link between childhood Leukemia and EMFs, bringing it into the attention for more research to be done to confirm this association. Based on the evidence, epidemiological studies need to be done and address the data scarcity relating to EMFs from power lines; especially in the South African context.*

Keywords—*electromagnetic fields; health effects; power lines; electrification; cancer.*

I. INTRODUCTION

Energy generation has changed over the years as there has been growth and diversification in relation to technology. There has been a decline in the combustion of sources like wood to generate heat and allow for cooking to be carried out in households. Individuals now utilize appliances, devices and engage in processes that are powered by electric currents – using an elevator, microwave, television or machinery in an occupational setting. Despite this beneficial act, electrification and operation of appliances emits extremely low frequencies of electromagnetic Fields (ELF-EMFs). This type of radiation cannot alter chemical bonds as opposed to ionizing radiation. However, it can interact with matter in other ways such as exhibiting energy in the form of heat [1] [2]. A common example of this interaction would be the occurrence of an individual being electrocuted when they come into contact with an electric powerline – causing severe burns on the body.

In 1998, National Institute of Environmental Health Sciences (NIEHS) classified ELF-EMFs as a Class 2B possible carcinogens, however no specific cancer that occurred upon exposure have been confirmed [3] [4]. The development of cities and the need to provide electricity results in an increase in the emissions of EMFs. Creating a public health concern to individuals and the need for investigation to be conducted in order to determine the transient and long-term health effects [5].

Research done over the years has mainly focused on the association between cancer and EMFs while indicating that other associated health effects are yet to be determined. Conflicting results have been established, thus delaying the innovation and implementation of the necessary control measures to protect the health of individuals

II. METHODOLOGY

Search engines such as Google Scholar, PubMed, NCBI, Science Direct and Research Gate were used to obtain data for this review. Keywords such as EMFs, power lines, health effects and cancer were used to search for relevant articles. A total of 30 articles were found and only 15 articles were used in this review.

III. OVERVIEW OF HEALTH EFFECTS FROM EMFS

According to WHO, exposure to EMFs from electrical powerlines has been associated with transient exposure related effects such as headaches, fatigue, anxiety, insomnia and muscle pains. The probability of childhood leukaemia has been associated with exposure to EMFs, especially in communities residing in close proximity to powerlines, substations and also from household electrical appliances (WHO). The development of health effects has been associated with exposure to magnetic fields as electric fields can easily be screened practically by any screening material. In many studies, exposure has been quantified with distances from the source, At 50 m from powerline, there was an increased risk of cancer and stunted growth in children, and also at 200 m stunted growth was also observed [6]. Rathebe et al. investigated the levels of extremely low frequency (ELF) magnetic fields emitted by 132 kV substations in Mangaung metropolitan region, and it was found that at a distance of 1 m from the substation, exposure levels exceeding 3 μ T were recorded [7]. The levels above 3 μ T

has been associated with leukaemia in children under the age of 10 [8]. Many studies have been published globally in trying to associate exposure to EMFs with long-term health effects, but there is still none conclusive evidence.

IV. RESULTS AND DISCUSSION

Out of the 15 articles selected, 8 found a link between EMF and development of leukaemia, 6 found a statistically insignificant and one was inconclusive. The studies focused on the distance from the powerlines, cases of cancer and other health effects arising from exposure.

A. Health effects in relation to distance from powerline

A strong link between leukaemia and proximity to high voltage power lines was found. All the studies found that there was an increased risk among children living less than 600 m away from a high voltage powerline. [9] [10]. There was also an increased risk of neurobehavioral function changes among children living in close proximity to power lines compared to those living at a greater distance away from powerlines. This indicated that children living near high voltage powerlines are at a greater risk of developing leukaemia [11] [12] [13]. There is limited literature focusing on the South African context, especially with millions of people living in informal settlements located near high voltage powerlines. There is a need for more research to be done in South Africa to assess if the health of people living near power lines is being compromised.

In 2007, WHO found the evidence linking childhood leukaemia and EMFs as not strong enough but still regarded the event as that of great concern. Women living less than 600 m away from high voltage power lines had increased incidences of preterm birth and birth defects [20]. There is limited research on the topic to provide concrete evidence on the effects of EMFs to unborn babies. It is recommended that schools as well as homes should be located away from high voltage power lines to reduce the incidence of transient and long-term health consequences [14].

B. Exposure to EMFs and long-term health effects

Studies on the link between adult cancers and proximity to power lines found no statistically significant to support the link. The studies found there is no increased risk for developing cancer due to close proximity with powerlines, though they cannot be ruled out as a possible contributor to cancer. In this instance, there is a need for more research to be done in order to explore the topic further [15] [16].

Evidence acquired through research in order to associate the occurrence of other chronic diseases like breast cancer, brain tumours and cardiovascular diseases to EMFs has been found to be substantially weak. Mainly due to the fact that the quality of the evidence obtained did not complement the weight of the data captured by investigators [17] [18]. There is still uncertainty regarding the association between brain tumours and neurodegenerative diseases in relation to EMFs.

Recent cases of research have indicated that it is unlikely for the occurrence of breast cancer and cardiovascular diseases to be associated with exposure to EMFs [19].

C. Exposure from railway lines

Magnetic fields generated by transportation systems like trains are usually static; exhibiting exposure to train drivers in their occupational fields. Despite limited literature focusing on static magnetic fields in the abovementioned occupational setting, average exposure levels in a year range between tens and hundreds of microtesla. In Swedish railway drivers, there was evidence indicating a relationship between exposure and response for myeloid leukaemia and Hodgkin's disease upon exposure to extremely low frequencies (ELF). [20]. In addition to exposure levels, non-biological effects relating to static magnetic fields have also been given attention as negative health effects can occur among individuals with implanted electronic medical devices. For safety reasons, it is suggested that areas with a magnetic flux density that is greater than 0.5 mT be demarcated. [21].

Railways emit static magnetic fields of which the people working at the railways and those living near railways are exposed to. The International Commission on Non-Ionizing Radiation Protection sets the guidelines on the exposure limits. ICNIRP recommends that occupational exposure of the head and trunk should not exceed a spatial peak magnetic flux density of 2 T. However, exposure up to 8 T can be permitted if the environment is controlled and exposure is restricted to the limbs. Acute exposure of the general public should not exceed 400 mT (any part of the body). Fields greater than 0.1 T induce flow potentials particularly in and around the heart and other major blood vessels, but their significance for the health is unclear and no clinically significant neurological effect or effects on cardiovascular functioning, foetal development, carcinogenesis or other endpoints have been found from exposure up to 8T. There are few epidemiological data on long-term health effects in persons exposed to static fields either in an occupational setting or on a community level [22].

D. Exposure of test animals to EMFs

An experiment was conducted with a sample population in order to indicate whether there would be adverse health effects. The population was exposed to 5 μ T, at a frequency of 50 Hz for a duration of 4 hours. No physiological changes were observed in terms of blood cell count, calcium concentrations and pulse rate. At 60 Hz, there were slight changes in heart rate that were observed, however, these changes could be reversed by eliminating exposure. Thus, illustrating no cause – effect relationship between EMFs and cancer. Evaluating the health effects associated with EMFs is a timeous process that does not provide a clear link as quickly as desired despite the continuous changes that are accompanied by new technologies. Individuals exposed to a genotoxin today, will most likely not have any recognizable changes in their DNA the next day [23] [24].

E. Exposure to low-frequency EMFs

Exposure to EMFs in their low frequencies do not result in any chronic health effects, except the probability of leukaemia at an average exposure of 3 μ T. The only resultant effects that were identified were changes in the production of hormones and calcium transportation across the body. There was no direct link that was found between EMFs and occurring diseases or disorders like Alzheimer's disease and depression [25] [26] [27].

CONCLUSION AND RECOMMENDATION

Only one out of the 15 articles used, the results were inconclusive regarding the link between cancer and exposure to EMFs. In the South African context where electricity is generated and mainly relied upon as an energy source, there is bound to be an increase in the number of EMFs health related issues. Some households are located in close proximity to railways stations where powerlines are not placed underground like in other countries. Commuters spend vast durations of time either embarking on a journey or waiting for the train to arrive. The continuous changes associated with technology as well as the absence of quality clinical evidence to substantiate the obtained information deems results as being inconsistent.

Further research focusing on alternative, safer energy sources could also be done to determine whether or not the occurrence of cancer associated with EMFs can be halted. This can also provide concrete evidence about the existence of a link between childhood leukaemia and EMF exposures. The link between cancer and the exposure to EMFs from high voltage power lines still need to be studied to provide evidence of a definite association. There is little to no research done in the South African context despite thousands of people living near high voltage power lines.

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