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Exposure to Magnetic Fields and Childhood Leukemia: An Overview of Meta-Analysis

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Abstract

Background: Leukemia is the most common cancer in children. We aimed to evaluate the association between exposure to magnetic fields and childhood leukemia.

Materials and Methods: In this overview, the relevant articles evaluating the association between exposure to magnetic fields and childhood leukemia are screened on the electronic databases of Scopus, EMBASE, Cochrane, Web of Science, and Medline until February 10, 2019.

Results: The first meta-analysis showed a statistical association between the magnetic field intensity of ≥0.4 μT and ≥0.2 μT and childhood leukemia. The second meta-analysis based on wiring configuration codes resulted in a pooled relative risk estimate of 1.46 (95% CI=1.05-2.04 μT, P=0.024) and 1.59 (95% CI=1.14-2.22 μT, P=0.006) for exposure to 24-h measurements of magnetic fields, indicating a potential effect of residential magnetic field exposure on childhood leukemia. In the third meta-analysis, the odds ratios of exposure categories of 0.1-0.2 μT, 0.2-0.3 μT, and ≥0.3 μT over <0.1 μT were 1.07 (95% CI=0.81-1.41 μT), 1.16 (95% CI=0.69-1.93 μT), and 1.44 (95% CI=0.88-2.36 μT), respectively. In contrast to the three meta-analyses, there was no statistically significant association between exposure to ≥ 0.1μT and childhood leukemia. In addition, no significant difference was observed between two groups of children living at a distance of <100 m from the source point of magnetic fields and those living at a distance of ≥ 100 m (OR=1.34; 95% CI=0.98-1.83).

Conclusion: Three meta-analyses showed a statistical association between magnetic field intensity and childhood leukemia (ranged 0.1-2.36 μT). The results of one study also showed that there was no relationship between exposure to ≥ 0.1 μT and childhood leukemia.

Key Words: Children, Exposure, Magnetic, Leukemia.

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1- INTRODUCTION

Leukemia is one of the most common childhood and adulthood cancers. It has been estimated that 30% of leukemia occurs before the age of 15 years and is often acute in children. Compared with other childhood cancers, the impact of exposure to environmental factors on leukemia has been reported frequently (1). The industrialization of societies in the 20th century has been accompanied by the increasing use of radiation sources such as cell phones, microwaves, some pieces of industrial and medical equipment, radio stations, broadcast towers, and even personal computers. Overall, these devices have exposed children to environmental hazards more than adults. According to the World Health Organization (WHO), 1-4% of children are exposed to radiofrequency and electromagnetic waves.

The development of childhood leukemia is one of the major research interests of researchers (2). Most of the leukemia-inducing damage is due to high voltage power transmission lines and electrical appliances, whose impact diminishes with increasing distance from the power source (3). Following occupational and residential exposure, especially in industrial areas, despite the sources of electromagnetic waves, broadcast towers with a distance of shorter than 200 m have the greatest adverse effect on health (4).

In the review studies, parental and prenatal exposures to environmental radiation have also been identified as effective agents in childhood leukemia (5). Studies have examined the pathology of exposure to cell phone and microwave radiation. Despite the contradictory results and the influence of other factors, these radiations have been associated with an increased risk of damage to the genetic content of cells (i.e., DNA) and the risk of leukemia, lymphoma, and brain tumors in sensitive groups including children. Various studies have examined the association of exposure to ionizing (gamma and X-rays) and non-ionizing (cell phone, broadcast, and industrial radiation) radiations with childhood leukemia. However, the reported results are contradictory (6). The effects of confounding factors such as alcohol consumption during pregnancy on childhood leukemia should be considered in addition to radiation (7). The purpose of this study is to review studies evaluating the effects of exposure to radiations and waves emitted from environmental sources on childhood leukemia.

2- MATERIALS AND METHODS

The search process includes screening the relevant articles evaluating the association between exposure to magnetic fields and childhood leukemia on the electronic databases of Scopus, EMBASE, Cochrane, Web of Science, and Medline.

2-1. Search strategy

In this review, all (Persian and English) meta-analyses that evaluate the association between exposure to magnetic fields and childhood leukemia were searched on the electronic databases of Scopus, EMBASE, Cochrane, Web of Science and Medline (via PubMed) until February 10, 2019. Two independent researchers performed the search process and a supervisor judged any disagreement in this regard.

2-2. Selection process

Two reviewers reviewed initially the abstracts of searched articles and then downloaded their full text to review carefully. Subsequently, they chose relevant studies independently. Finally, the articles that met the inclusion criteria were included in the review and their used relevant references were reviewed to find further studies. The third reviewer judged any disagreement between the reviewers.

3- RESULTS

Finally, four meta-analyses were included in this study. The first meta-

analysis, which was on 11,699 cases and 13,194 controls, reported a statistical association (OR=1.57; 95% CI =1.03-2.40) between the magnetic field intensity of ≥0.4 μT and childhood leukemia when the reference level was <0.1 μT. A statistical association (OR=1.31, 95% CI=1.06-1.61) was seen between the magnetic field intensity of ≥0.2μT and childhood leukemia when the reference level was <0.1 μT (8). The second meta-analysis on 19 studies found no statistically significant association between exposure to ≥ 0.1μT and childhood leukemia (OR=1.17; 95% CI=0.087-1.57; I^2=40.6%; P=0.11).

No statistically significant difference was observed between two groups of children living at a distance of <100 m from the source point of magnetic fields and those living at a distance of ≥ 100 m (OR=1.34; 95% CI=0.98-1.83) (4). The meta-analysis on four case-control studies and one cohort study based on wiring configuration codes resulted in a pooled relative risk estimate of 1.46 (95% CI=1.05-2.04, P=0.024), and 1.59 (95% CI=1.14-2.22, P=0.006) for exposure to 24-h measurements of magnetic fields, indicating a potential effect of residential magnetic field exposure on childhood leukemia (9). In the entire published results (seven studies with a total of 10,865 cases and 12,853 controls) after year 2000, the odds ratios of exposure categories of 0.1-0.2 μT, 0.2-0.3 μT, and ≥0.3 μT over <0.1 μT were 1.07 (95% CI=0.81-1.41), 1.16 (95% CI=0.69-1.93), and 1.44 (95% CI=0.88-2.36), respectively (10).

4- DISCUSSION

The purpose of this study was to review studies evaluating the effects of exposure to radiations and waves emitted from environmental sources on childhood leukemia. According to the obtained results, three meta-analyses showed a statistical association between magnetic field intensity and childhood leukemia. The results of one study also showed that there was no relationship between exposure to ≥ 0.1μT and childhood leukemia. Electromagnetic waves establish the basic functions of the communication infrastructures in human societies. Satellites, telecommunications towers, cell phones, data networks, broadcast towers, microwaves, medical equipment, and many other foundations of the technology world as much as increased living facilities are associated with an increase in the odds ratio of uncontrolled exposure and the incidence of adverse effects on human health (11). The results of a review article evaluating case-control studies by Zhao et al. (2014) showed a positive and significant association between residential exposure to electromagnetic radiation sources and the occurrence of childhood leukemia (8). Angelillo et al. (1999) also found a strong association between leukemia and exposure to electromagnetic fields (12).

However, these positive findings found a significant association of the magnetic field calculations with the two directions and intensity parameters of the emitted waves (9, 13). These results revealed an association between leukemia incidence and magnetic field intensity of ≥0.3μT. In comparison, negative results have been reported about exposure to magnetic field intensity of less than 0.01 to 0.03 μT (14). Ahlbom et al. (2000) and Kheifets et al. (2000) also reported a significant association between exposure to magnetic field intensity of ≤0.3 and ≤0.4 μT and childhood leukemia (10, 14). In contrast to the above studies, a meta-analysis by Callahan (2018) showed no significant association between electromagnetic radiation and the incidence of childhood leukemia. The results in children living at a distance of <100 m from the source point of magnetic fields and those living at a distance of ≥ 100 m showed no difference in increasing odds ratio (3). In addition,

the study of socioeconomic factors as confounding factors in the incidence of childhood leukemia reported no statistically significant effect. Further, in a meta-analysis by Atzmon et al. (2016), it was reported that risk of morbidity and mortality from exposure to microwave radiation and radiofrequency waves increases through various cancers including childhood and adulthood leukemia; however, these exposures showed no statistically significant association with the incidence of pediatric brain tumors. In this meta-analysis, there were differences in the susceptibility of children and the duration of exposure in the cancer risk assessment (15).

In a cohort study by Ha et al. (2016), the risk of leukemia in children exposed to radiofrequency radiation emitted from tower mounted amplifier was greater than the children exposed to lower levels of radiation; but brain tumors and other childhood cancers showed no association in this regard (16). According to Feychting (2011), the results of epidemiological studies on the association of exposure to radiofrequency radiation and the risk of cancer are positive in several studies.

However, the impacts of low-level radiation and the poor association between the distance from the magnetic fields and the risk of cancer have left many questions (17). The consequence of cancers (leukemia, nervous system, and brain tumors) because of maternal exposure to radiation in pregnancy and the use of cell phones in childhood, despite the simultaneous effect of confounding factors, remains controversial. Only one study examined the effect of cell phone radiation along with recording confounding factors on the cancers in samples aged 7-19 years in Denmark, Norway, Sweden, and Switzerland. Nevertheless, the results showed no significant association with the incidence of brain tumors with the exposure to cell phone radiation in this age group (18).

5- CONCLUSION

Three meta-analyses showed a statistical association between magnetic field intensity and childhood leukemia (ranged 0.1-2.36 μT). The results of one study also showed that there was no relationship between exposure to ≥ 0.1μT and childhood leukemia. The distance from the source point of magnetic fields did not show a significant effect on childhood leukemia. Reviewing the relevant studies show that some of these works have considered all exposure to electromagnetic radiation including radiofrequency to be effective in cancer incidence and others have regarded the effect of distance from the source point to be effective in outcomes. Hence, it is necessary to conduct a retrospective cohort and subsequent prospective studies with a larger sample size than previous studies and concurrent study of confounding factors involved in childhood leukemia.

6- CONFLICT OF INTEREST: None.

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