

Relationship between the Exposure to Magnetic Fields during Pregnancy and Risk of Abortion: A Review Article

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Abstract

Background

Exposure to electro-magnetic fields is a risk factor for abortion. We aimed to review the relationship between exposure to magnetic fields during pregnancy and the risk of abortion.

Materials and Methods: Two independent researchers screened the articles with related keywords including: "Radiofrequency", "RF", "RF-EMFs", "Phone", "Mobile phone", "Cell phone", "Electromagnetic field", "Electromagnetic waves", "EMF", "EMW", "Magnetic Field", "Abortion", and "Miscarriage". Following electronic databases: Scopus, EMBASE, Cochrane, Web of Science and Medline were searched without time and language restrictions from inception up to March, 2020.

Results: In the first study, there was a significant difference in the magnitude of Extremely Low-Frequency Electro-Magnetic Fields (ELF-EMF) between the two groups in the participants' houses. In the second study, the relationship between the miscarriage risks with high Magnetic Field exposure was evaluated among pregnant women by eliminating various confounding factors. In the third study, there was a relationship between miscarriage risk and prenatal exposure to the highest magnetic field, about 16 mG (95% CI: 1.2-2.7). In the fourth study, the research units exposed to higher MF levels were 2.72 times more at risk of miscarriage compared to the women exposed to lower MF levels. In the fifth study, a significant difference was observed between the two groups regarding the magnitude of ELF-EMF in the participants' houses. A significant likelihood of miscarriage in women who exposed to a significant level of the electromagnetic wave was observed; however, this relationship was not confirmed by the Wald test.

Conclusion

The effect of exposure on the risk of abortion depends on the distance from the source of radiation and the intensity of the frequency of the waves.

Key Words: Abortion, Exposure Magnetic Fields, Women.

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1- INTRODUCTION

Exposure to the electromagnetic field waves is a risk factor that has been studied with concern about the risk of the incidence of spontaneous abortion. In most studies, the effect of exposure has not been directly evaluated, and with this hypothesis, women who lived in the vicinity of high-voltage power lines or sources with high levels of radiations were high-risk cases for the fetal loss before 20 weeks of gestation (1). It seems logical that vulnerable groups, including pregnant women, are at higher risk of exposure to ambient radiofrequency radiations (2). Radiations generative sources such as mobile phones, computers, and television monitors, some medical and industrial equipment, and even some home appliances have also increased the chances of exposure with the advancement of new technology (3).

Hence, health status and the possible relationship between the effect of exposure to magnetic fields radiations and incidence of cancers, cardiovascular diseases, immune system, and even reproductive system, including the incidence of spontaneous abortions are discussed in scientific communities as a retrospective and prospective studies (4, 5). Abortion means the termination of a pregnancy, either spontaneously or intentionally, before the embryo reaches sufficient development to survive. Abortion is usually defined as the termination of pregnancy before the 20th week of gestation or birth weight less than 50 grams (6). According to the World Health Organization, 210 million women worldwide become pregnant each year, and 22% of them resort to abortion. It is estimated that 46 million abortions occur each year, which is equivalent to 35 abortions in 1000 women aged 15-45 years. It is estimated that the effective rate of exposure depends on the distance of the mother from generative radiation sources.

Moreover, since the embryo is more sensitive in early pregnancy, the exposure might increase the risk of abortion and fetal defects (7). Therefore, the World Health Organization has recommended the need for more extensive and detailed studies to investigate the relationship between exposure to the electromagnetic field waves and the increased risk of spontaneous abortions (8). Although several studies have examined the harmful effects of non-ionizing radiation on critical stages of embryonic growth and increase the likelihood of cell death, the need for prospective cohort studies among pregnant women to examine the relationship between the exposure and increase the risk of abortion is raised (9).

2- MATERIALS AND METHODS

In this review, two independent researchers searched several databases, including Scopus, Web of Science, EMBASE and Medline via PubMed, in the period from inception up to March 21, 2020. Moreover, the Google and Google Scholar search engines were also checked for more assurance. The keywords were a combination of "Radiofrequency", "RF", "RF-EMFs", "Phone", "Mobile phone", "Cell phone", "Electromagnetic field", "Electromagnetic waves", "EMF", "EMW", "Magnetic Field", "Abortion, and "Miscarriage".

The search was carried out for possible studies, abstracts of the studies were screened for identification of eligible studies, full-text articles were obtained and assessed, and a final list of included studies was made. This process was carried out independently and in duplication by two reviewers so that the third reviewer resolved any disagreement. In this study, all case-control and cohort studies that examined the relationship between exposure to electromagnetic field waves and the risk of abortion were included in the study. Pilot, preliminary

and case report studies were not included due to limited sample size and a higher risk of bias. There were no language restrictions for articles.

3- RESULTS

The review studies resulted in five eligible articles. In a nested case-control study in 2002, Lee et al. evaluated the relationship between spontaneous abortions with residential and personal magnetic fields. The highest personal MF exposure and the exposure with substantial average differences between consecutive levels showed a relationship with the clinical miscarriage risk (1). In a study, there were valuable prospective documents on the relationship between miscarriage risk and prenatal exposure to the highest magnetic field about 16 mG [95% Confidence Interval (CI) = 1.2-2.7], which is unlikely to be the result of unmeasured confounding factors or uncontrolled biases (2). In a case-control study by Shamsi Mahmoudabadi et al. (2012), participants included the women with unexplained spontaneous abortion at < 14 weeks of gestation (n=58), and matched pregnant women at >14 weeks gestation (n=58). There was a significant difference (P<0.001) in the magnitude of Extremely Low-Frequency Electro-Magnetic Fields (ELF-EMF) between the two groups in the participants' houses (3). In the prospective cohort study, the relationship between the miscarriage risk with high Magnetic Field (MF) exposure was evaluated among pregnant women (n= 913) by eliminating various confounding factors. The results revealed that the research units exposed to higher MF levels were 2.72 times more at risk of miscarriage (hazard ratio: 2.72, 95% CI: 1.425.19) compared to the women exposed to lower MF levels (9). A significant likelihood of miscarriage in women who exposed to a significant level of the electromagnetic wave was observed. However, this relationship was not confirmed by Wald's test (10). A case-

control study was conducted on women with unexplained spontaneous abortion at < 14 weeks gestation (n=292), and pregnant women at >14 weeks gestation (n=308), who were homogenous for maternal age, paternal age, history of abortions, and family relationships, to evaluate the relationship between mobile phone use during pregnancy and the risk of spontaneous abortion. A significant difference was observed between the two groups (P<0.001) regarding the magnitude of ELF-EMF in the participants' houses (11).

4- DISCUSSION

During the past thirty years, the use of devices that emit radiofrequency and electromagnetic radiations have been increased, and consequently, human exposure has also been expanded (12). Mobile phone phones have been mostly used and exposed in connection with the latest technology worldwide. In the last decade, there have been 5 billion mobile phone subscribers worldwide, and so far, with the rapid growth of technology, the complications of mobile phone abuse have become a controversial issue in the scientific community and even the general public (13). In this study, a review of studies has been carried out on the increased risk of abortion among pregnant women exposed to electromagnetic waves. According to the results of the study by Li et al. (2017), the effective rate of exposure on the risk incidence of abortion depends on the distance from the radiations generative source and the high level of waves (9). The importance of this study was to design a prospective cohort and its accuracy in measuring the rate of exposure and estimating the risk of abortion among the mothers compared to previous studies (1, 2, 9). Although in this study, the generative radiation sources and the rate of exposure were based on mothers' diaries, however, the highest risk of abortion incidence was reported with the highest

level of exposure (9). According to the longitudinal study conducted by Abad et al. (2016), there was a significant relationship between the incidence of spontaneous abortion and exposure to electromagnetic waves. High-frequency waves are related to the highest chance of losing a pregnancy. In this study, the most critical possible theories of cell damage, its genetic content, and tissue destruction of the embryo were raised following the loss of interstitial water and increased radiation penetration rate (10). The case-control study by Shamsi Mahmoudabadi et al. (2013) revealed that the effect of low-frequency waves in the range of 3-3000 Hz from home generative sources and the incidence of unjustified abortion in women at gestational age less than 14 weeks had the significant relationship.

In the mentioned study, the possible mechanism of undesirable complications of radiations emitted from home appliances such as TV monitors, mobile phones, microwave ovens, and living in the vicinity of high voltage power lines was raised in the damage of fetal cell development process, which emphasizes on the distance to the generative source as an active factor in the exposure rate of the mother's uterus on the strength and weakness of the risk incidence (3).

Another case-control study by Shamsi Mahmoudabadi et al. (2015) pointed out the possible relationship in examining the effect of using a mobile phone in pregnancy and the incidence of abortion. Consequently, the results of this study described the possible relationship and raised the need for further studies. Also, the duration of mobile phone use per day and its distance as a generative source of radiation from the mother at the time of non-use was considered as the active factors on the undesirable consequences of the pregnancy (11). A population-based cohort study was conducted by Li et al. (2002), reported an increased risk of

abortion among pregnant women associated with the increased intensity of electromagnetic waves higher than 16 mG waves' length. The capability of this study, despite the results based on prospective design and more accurate measurement of exposure rate by participants during 24 hours, the adverse effects of waves on the incidence of premature abortions before the tenth week of gestational and susceptible populations such as women with a history of previous abortion showed a more definite relationship. In this study, despite other risk factors, the amount of magnetic charge emitted from generative sources was suggested as a potential risk factor (2). Lee et al.'s cohort study (2002) investigated the relationship between past exposure to electromagnetic waves with the incidence of abortion and the effect of waves on the incidence of abortion. Both control and exposure groups were at risk of an abortion if they lived in high-risk areas and were exposed to waves-generating house appliances.

In this study, the results of prospective and retrospective studies were consistent, and the active factors in the incidence of abortion depended on the distance to the generative source and high levels of waves' frequency (1). Despite several studies that have been carried out so far, there is still a need to design broader prospective studies with the control of interfering factors affecting the incidence of abortion and more accurate measurement of radiation exposure (9). Mobile phones are also one of the devices that emit low levels of RF1 in the microwave range (14). There are currently more than 700 million mobile phone users in the world. These phones emit various frequencies in different countries and continents. Exposure to radiofrequency energy depends on the frequency of mobile phones. Analog phones, digital phones, and third-generation phones produce emit nearly 450-900 MHz, 850-1900 MHz, and

2000MHz of frequency (15). The value of SAR2 always decreases when the skin is exposed to or passes through a mobile phone radio antenna. Tissues near mobile phone devices are more vulnerable to damage compared to the tissues far from mobile phone antennas (16). Some studies have shown that keeping cell phones in pants pockets may lead to male sperm infertility since they are located near the reproductive organs, especially the testicles, where sperm are produced and stored. Moreover, the long-term use of mobile phones may have adverse effects on sperm motility (16).

According to our knowledge, the present study is the first review conducted on radiofrequency exposure during pregnancy and abortion. Several possible mechanisms have been proposed on the effects of radiofrequency waves on the embryo. Radiofrequency waves at a high-frequency level with heating affect the neural development of the embryo. In this regard, some studies have shown that the rate of wave absorption emitted from the mobile phone by the mother's uterus is low and does not increase the mother's body temperature (13).

Another hypothesis is that although the RFR energy emitting from the mobile phones or holding the mobile phone close to the body when reaching the embryo is very low, the blood-brain barrier of the premature embryo may affect neurodevelopment of the embryo. The results of previous studies have shown that the metabolism of glucose in the brain is increased near the site of the mobile phone antenna (17). Exposure to radiofrequency waves leads to disrupt the release of melatonin from the pituitary gland, which may affect the pregnant mother's metabolic and sex hormones and may also affect fetal brain development (18).

4-1. Study Limitations

Despite several studies that were conducted so far, there is still a need to design broader prospective studies with the control of interfering factors affecting the incidence of abortion and more accurate measurement of radiation exposure (9). Another limitation was the design of studies through a retrospective method in which there is a possibility of bias in the response of participants and accurate measurement of the amount and discussed the intensity of exposure to generative sources of electromagnetic waves (19). One of the main constraints of this study was the heterogeneity rate of the study results, and therefore, there was not the possibility of meta-analysis. In all of these studies, extensive limitations were observed in sample size. Therefore, statistical power may not be sufficient to calculate the relationship between exposure to electromagnetic fields during pregnancy and the risk of abortion. It is suggested that future studies would have a sufficient sample size.

5- CONCLUSION

The effective rate of exposure to electromagnetic waves on the risk of abortion in pregnant mothers depends on the distance from the generative source of radiations and the intensity of the waves' frequency. On the other hand, the effect of low-frequency waves in the range of 3-3000 Hz from home generative sources and the incidence of spontaneous abortion in women at gestational age less than 14 weeks, indicated a significant relationship. Also, the duration of using the mobile phone per day and its distance as a generative source were related to at risk of abortion.

6- CONFLICT OF INTEREST: None.

7- REFERENCES

1. Lee GM, Neutra RR, Hristova L, Yost M, Hiatt RA. A nested case-control study of residential and personal magnetic field measures and miscarriages. *Epidemiology*. 2002;21-31.
2. Li D-K, Odouli R, Wi S, Janevic T, Golditch I, Bracken TD, et al. A population-based prospective cohort study of personal exposure to magnetic fields during pregnancy and the risk of miscarriage. *Epidemiology*. 2002;9-20.
3. Shamsi MF, Ziaei S, Firoozabadi M, KAZEMNEJAD A. Exposure to extremely low frequency electromagnetic fields during pregnancy and the risk of spontaneous abortion: a case-control study. 2013.
4. Jauchem JR. Effects of low-level radio-frequency (3 kHz to 300 GHz) energy on human cardiovascular, reproductive, immune, and other systems: a review of the recent literature. *International journal of hygiene and environmental health*. 2008;211(1-2):1-29.
5. Divan HA, Kheifets L, Obel C, Olsen J. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology*. 2008;523-9.
6. Tafazoli M, Kermani T, Saadatjoo A. Effects of saffron on abortion and its side effect on mice balb/c. *The Horizon of Medical Sciences*. 2004;10(3):53-5.
7. Koren G. Exposure to electromagnetic fields during pregnancy. *Canadian Family Physician*. 2003;49(2):151.-
8. Organization. WH. WHO Research Agenda for Extremely Low Frequency Fields. (World Health Organization, Geneva, Switzerland, 2007). 2007.
9. Li D-K, Chen H, Ferber JR, Odouli R, Quesenberry C. Exposure to magnetic field non-ionizing radiation and the risk of miscarriage: A prospective cohort study. *Scientific reports*. 2017;7(1):1-7.
10. Abad M, Malekafzali H, Simbar M, Mosaavi HS, Khoei EM. Association between electromagnetic field exposure and abortion in pregnant women living in Tehran. *International Journal of Reproductive BioMedicine*. 2016;14(5):347.
11. Mahmoudabadi FS, Ziaei S, Firoozabadi M, Kazemnejad A. Use of mobile phone during pregnancy and the risk of spontaneous abortion. *Journal of Environmental Health Science and Engineering*. 2015;13(1):34.
12. Papadopoulou E, Haugen M, Schjolberg S, Magnus P, Brunborg G, Vrijheid M, et al. Maternal cell phone use in early pregnancy and child's language, communication and motor skills at 3 and 5 years: the Norwegian mother and child cohort study (MoBa). *BMC public health*. 2017;17(1):685.
13. Divan HA, Kheifets L, Olsen J. Prenatal cell phone use and developmental milestone delays among infants. *Scandinavian journal of work, environment & health*. 2011;37(4):341-8.
14. Galaktionova G, Mastriukova V, Strzhizhovskii A. Sensitivity of mammalian tissues to prolonged exposure to high-tension permanent magnetic fields. *Kosmicheskaiia biologiiia i aviakosmicheskaiia meditsina*. 1985;19(2):78-81.
15. Agarwal A, Deepinder F, Sharma RK, Ranga G, Li J. Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study. *Fertility and sterility*. 2008;89(1):124-8.
16. Kibona L, Swagarya G, Kisangiri M. Analysis of the Impact of Electromagnetic Radiations from Cell Phones on Male Sperm Infertility. *International Journal of Scientific and Research Publications (IJSRP)*. 2013;3:6.
17. Choi KH, Ha M, Ha EH, et al. Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure. *Environ Res*. 2017;156:810-817. doi:10.1016/j.envres.2017.04.029
18. Hocking B. Maternal cell phone use and behavioral problems in children. *Epidemiology*. 2009;20(2):312.
19. Baste V, Oftedal G, Møllerlørkken OJ, Mild KH, Moen BE. Prospective study of pregnancy outcomes after parental cell phone exposure: the Norwegian Mother and Child Cohort Study. *Epidemiology*. 2015;26(4):613-21.