Journal of Midwifery & Reproductive Health

JMRH.mums.ac.ir

The Role of Using Cell Phones and Internet on women's risk of Miscarriage: a Case-control Study

Masoumeh Mosayebi Molasaraie (MSc)[1], Shamim Pilevari (PhD)[2], Amin Doosti Irani (PhD)[3], Zahra Cheraghi (PhD)[4*]

[1] MSc Student of Epidemiology, Department of Epidemiology, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran
[2] Associate Professor, Endometrium and Endometriosis Research Center, Hamadan University of Medical Sciences, Hamadan, Iran
[3] Assistant Professor, Research Center for Health Sciences, Hamadan University of Medical Sciences, Hamadan, Iran
[4] Assistant Professor, Modeling of Noncommunicable Diseases Research Center, Hamadan University of Medical Sciences, Hamadan, Iran

ARTICLE INFO

Article type:
Original article

Article History:
Received: 22-May-2022
Accepted: 06-Dec-2022

Key words:
Cell Phone
Internet
Miscarriage
Case-control Study

ABSTRACT

Background & aim: Despite the concerns about using cell phones and internet on women's reproductive health, few studies have considered this issue, with most focusing on animal models. The present study was conducted to examine the effect of using cell phones and internet on miscarriage.

Methods: In this case-control study, a sample of 211 cases and 394 controls were selected through stratified random sampling from women referred to urban health centers in Zanjan in 2019. Data on telephone and internet use was collected using a self-administered questionnaire, while health records were collected using a checklist. Women with miscarriage history were chosen randomly as the case and women with a successful pregnancy history as the control.

Results: Considering the average internet use per hour, and with the effect of other variables remaining constant, the odds of miscarriage increased, and this association was borderline significant (OR=1.07, 95% CI: 0.99, 1.15, P=0.050). Meanwhile, for every hour of cell phone conversations during pregnancy, although the odds of miscarriage increased, but this association was not statistically significant (OR=1.12, 95% CI: 0.86, 1.45, P=0.380). Similarly, turning off cell phones at night decreased the odds of miscarriage, but this association was also not statistically significant (OR=0.97, 95% CI: 0.58, 1.61, P=0.380).

Conclusion: Although the effect of internet use on miscarriage was small and had borderline statistical significance, it appears reasonable to take preventive measures to reduce exposure to low-frequency electromagnetic waves by pregnant women.

Please cite this paper as:
Mosayebi Molasaraie M, Pilevari Sh, Doosti Irani A, Cheraghi Z. The Role of Using Cell Phones and Internet on Pregnant women's risk of Miscarriage: a Case-control Study. Journal of Midwifery and Reproductive Health. 2023; 11(3): 3794-3800. DOI: 10.22038/JMRH.2022.65656.1917

Introduction

Miscarriage means the spontaneous loss of the fetus, and refers to the premature withdrawal of the gestational product (during the first 20 weeks of pregnancy) and before its development (1). The global risk of miscarriage rate has been reported to be 10% to 20% of pregnancies (2). Based on previous studies, miscarriage increases the risk of mental disorders in pregnant women by 2.5 times. According to the information of this organization, the most common complications following a miscarriage are infections, bleeding, embolism, and physical problems (3).

According to the previous studies, the risk of miscarriage depends on factors such as lifestyle including diet, maternal smoking, alcohol consumption, and other factors such as obesity,

* *Corresponding author*: Zahra Cheraghi, Assistant Professor, Modeling of Noncommunicable Diseases Research Center, Hamadan University of Medical Sciences, Hamadan, Iran. Tel: 0098918 317 7990, Email: cheraghiz@ymail.com

maternal age of 35 years or more, history of miscarriage, history of extrauterine pregnancy, and paternal age (4-7).

Nowadays, new risks such as the use of cell phones and internet Wi-Fi threaten women's reproductive health. Rare but significant evidence has convinced the International Agency for Research on Cancer (IARC) to classify Wi-Fi waves as potentially carcinogenic to humans in 2011(8).

Another worrying point about cell phones is the radio waves emitted from the cell phone, which have a very low-frequency electromagnetic field (2). Although human exposure to electromagnetic waves with shallow frequency has increased in daily life, few studies have been conducted at the human level regarding its health effects, and most of the studies have been at the animal and laboratory levels (9-10).

Previous studies have reported the adverse effects of long-term exposure to Wi-Fi waves: decreased sleep and irregular sleep patterns, headaches, fatigue, impaired brain and memory function, stress, increased skin temperature, and even depression. Moreover, Wi-Fi waves can increase oxidative stress, cell DNA damage, endocrine changes, preterm labor, low birth weight, miscarriage in pregnant women, and even detrimental effects on sperm health parameters (e.g., sperm count, morphology, and mobility) (11-12).

Additionally, Wi-Fi waves can result in rapid aging and significantly affect metabolic systems like increased blood glucose levels, increased fat levels, increased neuroregulatory disorders, and decreased testosterone levels in men. Despite the concerns about using cell phones on women's reproductive health, few studies have considered this issue. Hence, this study was conducted to examine the effect of using cell phones and internet and on miscarriage.

Materials and Methods

The participants of this case-control study, which was approved under ethics code of IR.UMSHA.REC.1399.672, were selected from women with or without a miscarriage history referred to urban health centers in Zanjan (a city located in western Iran) in 2019. Sampling was done by random stratified method from health centers. The final sample was randomly drawn, or the random table technique was done, proportionally. After selecting the women and making them phone calls, they were asked to refer to the health centers. The women with a miscarriage history were chosen randomly as the case and women with a successful pregnancy history as the control in 2019. All subjects had a pregnancy record in comprehensive urban health service centers. The exclusion criteria was having a history of intentional or legal abortion in the last pregnancy.

Data were collected by a checklist of health records available in comprehensive urban health service centers in Zanjan. The checklist had 25 items with demographic characteristics and risk factors for miscarriage. Moreover, a researcher-made questionnaire was used to extract information about the internet and cell phone exposure. The questionnaire was administered as a pilot study. The validation process was carried out using the opinions of seven experts. The content validity index (CVI) was assessed in three dimensions: clarity, relevance, and importance. The mean CVI was acceptable above 75%. The problematic questions were edited and removed in case needed. The reliability index (Cronbach's alpha) was studied as well, for which a mean of 75% was obtained.

The relationship between each of the independent variables and miscarriage was statistically analyzed using a multiple logistic regression at a 95% confidence level. In entering the data in the final model using the backward technique, we kept only those variables whose p-value was ≤ 0.20 in the univariate model. Analyses were carried out with Stata 14 software. Informed consent was obtained from participants.

Results

This case-control study comprised 211 cases and 394 controls. The mean age of women in the case group was higher than the control group (32.2±6.5 vs. 31.2±5.7 years) (P= 0.020).

The educational level significantly differed between case and control women i. e women in the control group had a higher university education (36.5 vs. 23.7%) ($p<0.001$). Also, a higher percentage of women in the case group had less than three year's pregnancy interval

(45.9 vs. 24.6%) (p = 0.010). Women in the case group had a higher history of miscarriage in previous deliveries (29.3 vs. 18.1%) (P< 0.001).

There was no significant difference between women in the case and control group in terms of stillbirth (2.28% vs. 4.27%) (p= 0.172). Women in the control group had less history of blood coagulation problems than those in the case group (0.51% vs. 2.37%) (p= 0.042). There was no significant difference between two groups in terms of anemia (2.8% vs. 3.1%) (p= 0.226).

Table 1. Demographic, obstetric and characteristics and other clinical information of the case and control groups

Variables	Case (N=211)	Control (N=394)	P-value
Education (%)			
Primary	20.3 (43)	9.1 (36)	
Middle school	24.2 (51)	17.8 (70)	<0.010
High school/diploma	31.8 (67)	36.6 (144)	
Academic	23.7 (50)	36.6 (144)	
Total number of pregnancies	2.6 ± 1.2	2.8 ± 1.03	<0.010
Pregnancy interval less than 3 years (%)	46.0 (97)	13.2 (52)	<0.001
Stillbirth history (%)	4.3 (9)	1.3 (5)	0.172
History of anemia (%)	10.4 (22)	3.0 (12)	0.040
History of miscarriage (%)	29.4 (63)	9.6 (38)	<0.001
History of urinary tract infection (%)	12.8 (27)	5.1 (20)	0.233
History of Coagulation disorders (%)	2.4 (5)	0.25 (1)	0.042
Age (years)	32.2 ± 6.5	31.2 ± 5.7	0.020
Cell phone use per day (hours)	3.4 ± 2.8	2.9 ± 2.3	0.309
Total Internet usage time (hours)	3.1 ± 3.6	2.8 ± 2.9	0.226
Modem/data off at night (%)	49.2 (104)	50.7 (107)	0.730
Turning off cell phone at night (%)	64.5 (136)	73.1 (154)	0.080

The mean difference was analyzed by independent t-test and the difference in ratios by Chi-square test.*

Table 2. Role of some risk factors of miscarriage using multiple logistic regression model

Variables	Crude OR** (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age (per year)	1.02 (1.01, 1.05)	0.042	0.99 (0.94, 1.04)	0.805
Education (for any higher level of degree)	0.66 (0.56, 0.78)	< 0.010	0.53 (0.40, 0.71)	< 0.001
Gravidity (per one)	1.56 (1.31, 1.84)	< 0.010	1.10 (0.80, 1.50)	0.545
Pregnancy interval* (yes/no)	2.60 (1.82, 3.71)	< 0.010	2.87 (1.68, 4.90)	< 0.001
Stillbirth history (yes/no)	1.90 (0.74, 4.87)	0.178	1.02 (0.20, 5.02)	0.978
History of miscarriage (yes/no)	1.89 (1.27, 2.80)	0.001	1.03 (0.54, 1.95)	0.923
History of coagulation disease (yes/no)	4.74 (0.91, 24.67)	0.064	4.46 (0.63, 31.57)	0.134
History of anemia (yes/no)	1.87 (1.02, 3.45)	0.043	1.75 (0.76, 4.02)	0.186
History of urinary tract infection (yes/no)	1.37(0.81, 2.32)	0.234	1.20 (0.62, 2.466)	0.545
Internet usage (per one hour)	1.02 (0.96, 1.08)	0.453	1.07 (0.99, 1.15)	0.050
Using cell phones (per one hour)	1.01 (0.94, 1.09)	0.618	1.12 (0.86, 1.45)	0.380
Phone off at night (yes/no)	1.33 (0.94, 1.89)	0.098	0.97 (0.58, 1.61)	0.909

* Less than three years
** Odds Ratio

The case and control groups reported no history of smoking or alcohol consumption. Thus, the analysis of this variable was impossible. Duration of internet use per day was longer among the case women (3.1 ± 3.6 vs. 2.8

± 2.9) (p= 0.226). In addition, the length of cell phone use per day was longer in the case compared to the control group(3.4 ± 2.8 vs. 2.9 ± 2.3) (p= 0.309); although in both cases there was no significant difference between two case and control groups (Table 1).

Considering the average internet use per hour, and with the effect of other variables remaining constant, the odds of miscarriage increased, and this association was borderline statistically significant (OR=1.07, 95% CI: 0.99, 1.15, P=0.050). Meanwhile, for every hour of cell phone conversations during pregnancy, the odds of miscarriage increased, though this association was not statistically significant (OR=1.12, 95% CI: 0.86, 1.45, P=0.380). Additionally, turning off cell phones at night decreased the odds of miscarriage, but this association was not statistically significant (OR=0.97, 95% CI: 0.58, 1.61, P=0.380). According to the multiple logistic regression, pregnancy intervals less than three years increase the odds of miscarriage, this association was statistically significant (OR=2.87, 95%CI :(1.68, 4.90), P<0.001).

Also, by increasing the level of education, the rate of unintentional miscarriage increased, this association was not statistically significant (OR=0.53, 95%CI :(0.40, 0.71), P<0.001) (See Table 2).

Discussion

The study aimed to determine the relationship between the cell phone and internet use with the risk of miscarriage. The findings showed that for every hour of cell phone conversations during pregnancy, although the odds of miscarriage increased, but this association was not statistically significant. Similarly, turning off cell phones at night decreased the odds of miscarriage, but this association was also not statistically significant.

In a systematic review by Jaffer et al. (2019), in which 23 articles, ten on laboratory animals and five on the human population was reviewed the findings indicated that cellular Wi-Fi waves caused physiological changes in the testes, degenerative changes, decreased testosterone levels, increased apoptotic cells, and DNA damage. These effects were mainly due to the increased testicular temperature and oxidative stress activity. The significant outcome of the study was that exposure to Wi-Fi at 2.45 GHz is dangerous for the male reproductive system (18).

Mahmoudabadi et al. (2015) conducted a case-control study to examine using cell phones during pregnancy and the risk of premature miscarriage (less than 10 weeks). The results showed that women in the case group had more conversations via cell phone than the control group (19). In their study, the risk of miscarriage was 1.11 times associated with an increase in the specific absorption of electromagnetic waves of the cell phone, with a statistically significant difference. There are some differences between the study of Mahmoudabadi and our study. In our study, in addition to the role of the duration of mobile phone usage, the duration of internet usage has been identified. Secondly, different confounding variables have been investigated compared to the mentioned study. Mahmoudabadi et al. measured four confounding factors including mother's age, father's age, history of abortion, and spouse's relatives, while in our study, 11 variables were examined.

In addition, in a population-based cohort study, Li et al. (2002) examined the direct effects of magnetic fields on reproductive health, including miscarriage among 969 pregnant women (10). Although they could not find a direct association between exposure to the magnetic field surface and the risk of miscarriage, but it was observed that the risk of miscarriage increases with an increase in the level of maximum magnetic field exposure with a threshold of about 16 mg (magnetic field measurement unit).

In another study, Sun et al. (2010) (20) investigated the effects of 50 Hz magnetic field exposure on hormone secretion in the first trimester of pregnancy in vitro. The results showed that exposure to MF for a more extended period (72 hours) could inhibit HCG secretion and progesterone by the human first trimester.

All miscarriage cases in 2019 registered in the comprehensive urban health service centers were included in the present study. Thus, the selection bias in the survey was minimized. Moreover, the appropriate number of controls was selected twice, which enhances the study's statistical power.

Despite the limited evidence for the role of cell phone emissions on fertility health, several studies do not confirm this finding (19, 21-22), probably due to the lack of information and epidemiological data. Among these studies, Mahram et al. (2013) (23) found no statistically significant effects of very low-frequency electromagnetic waves on pregnancy and fetal development, pregnancy length, preterm delivery, birth weight, head circumference, and human congenital anomalies.

In this case-control study, education and non-adherence to three-year intervals between pregnancies were statistically significant in the multiple logistic regression model. Therefore, by not observing the three-year interval between pregnancies and increasing the level of education, the rate of miscarriage increased by 2.87 times and decreased by 47%, respectively.

Concerning the role of the interval between pregnancies, it is noteworthy that consecutive pregnancies with a gap of shorter than three years increase the risk of anemia in women and thus disrupt maternal anemia, oxygen delivery, nutrition, and fetal health (13). Nonyane et al. (2019) and Baqui et al. (2018) showed that short intervals between pregnancies increased the risk of miscarriage and fetal death (14-15). Additionally, WHO experts suggest that women wait at least six months after a miscarriage before being pregnant again (16).

The effect of education was significant in the multivariate logistic regression model. As the level of education increased, the miscarriage rate decreased by 47%. Higher education was generally associated with higher economic and social status. In this regard, women with higher socioeconomic status were more likely to have fewer risk factors. They have better lifestyle, awareness of the need for prenatal care, and proper placement between pregnancies. Poorolajal et al. (2014) confirmed this finding (17).

The present study had several critical limitations. First, only the self-reported method was used to measure exposure, and using no accurate measurement tool might be a source of information bias. Second, the duration of using the Internet and cell phone months after the miscarriage has been asked and measured. Thus, women's behaviors during pregnancy and exposure could differ from exposure measurement during this study. As a result, such a difference may cause measurement bias or recall bias to some extent that reduces exposure. Third, because of the nature of case-control studies, the observed effect may not necessarily be causal. Thus, a central longitudinal survey with good power and more accurate exposure measurement is strongly suggested. Additionally, the risk of Wi-Fi waves on male fertility has been attributed to the effect of the internet on sperm quality stated in different studies (24). However, since its effect was not examined in this study simultaneous Internet and cell phone usage by the couple is recommended in the future studies.

In general, the review studies (25-26) conducted in the field of smartphone radiation on pregnancy show insufficient evidence for the relationship between mobile phone radiation and reproductive health. It is necessary to conduct analytical studies with a larger sample size and consider more confounding factors. The present study was done in the most reliable analytical studies format, although longitudinal studies are recommended to reduce recall bias.

Conclusion

Despite the exact non-recognition of the bio mechanisms of the internet and mobile phone on miscarriage, the results of this study indicated that the risk of miscarriage increases with increased internet use. Although the effect was small and a borderline statistical significance was seen, it appears reasonable to take preventive measures to reduce exposure to low-frequency electromagnetic waves by pregnant women.

Acknowledgments

We appreciate the cooperation of experts from comprehensive urban health service centers in data collection. Moreover, all the participants of the study are appreciated for their responsiveness. The funders had no role in study design, data collection, and analysis, decision to publish, or manuscript preparation.

Conflicts of interest

The authors declared no conflicts of interest.

References

1. Zhou H, Liu Y, Liu L, Zhang M, Chen X, Qi Y. Maternal pre-pregnancy risk factors for miscarriage from a prevention perspective: a cohort study in China. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2016; 206(2016): 57-63.
2. Cohain JS, Buxbaum RE, Mankuta D. Spontaneous first trimester miscarriage rates per woman among parous women with 1 or more pregnancies of 24 weeks or more. BMC Pregnancy and Childbirth. 2017; 17(1): 1-7.
3. Quenby S, Gallos ID, Dhillon-Smith RK, Podesek M, Stephenson MD, Fisher J, et al. Miscarriage matters: the epidemiological, physical, psychological, and economic costs of early pregnancy loss. The Lancet. 2021; 397(10285): 1658-1667.
4. Wang JX, Davies MJ, Norman RJ. Obesity increases the risk of spontaneous abortion during infertility treatment. Obesity Research. 2002; 10(6): 551-554.
5. Metwally M, Ong KJ, Ledger WL, Li TC. Does high body mass index increase the risk of miscarriage after spontaneous and assisted conception? A meta-analysis of the evidence. Fertility and Sterility. 2008; 90(3): 714-726.
6. Turner MJ, Fattah C, O'Connor N, Farah N, Kennelly M, Stuart B. Body mass index and spontaneous miscarriage. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2010; 151(2): 168-170.
7. de La Rochebrochard E, Thonneau P. Paternal age and maternal age are risk factors for miscarriage; results of a multicentre European study. Human Reproduction. 2002; 17(6): 1649-1656.
8. IAfRoC. IARC classifies radiofrequency electromagnetic fields as possibly carcinogenic to humans 2011 [21.02.2022]. Available at: https://www.iarc.who.int/wp-content/ uploads /2018/07/pr208_E.pdf.
9. Mansouri E, Keshtkar A, Khaki A, Keshtkar E, Khaki A. Effects of Extremely Low Frequency Electromagnetic Fields and Simultaneous Treatment with Allium Cepa on Biochemical Parameters and Ultrastructure of Ovarian Tissues of Rats. Iranian Journal of Medical Physics. 2019; 16(2): 158-165.
10. 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; 13(1): 9-20.
11. Nazıroğlu M, Yüksel M, Köse SA, Özkaya MO. Recent reports of Wi-Fi and mobile phone-induced radiation on oxidative stress and reproductive signaling pathways in females and males. The Journal of Membrane Biology. 2013; 246(12): 869-875.
12. Kesari KK, Agarwal A, Henkel R. Radiations and male fertility. Reproductive Biology and Endocrinology. 2018; 16(1): 118.
13. Sun D, McLeod A, Gandhi S, Malinowski AK, Shehata N. Anemia in pregnancy: a pragmatic approach. Obstetrical & Gynecological Survey. 2017; 72(12): 730-737.
14. Nonyane BAS, Norton M, Begum N, Shah RM, Mitra DK, Darmstadt GL, et al. Pregnancy intervals after stillbirth, neonatal death and spontaneous abortion and the risk of an adverse outcome in the next pregnancy in rural Bangladesh. BMC Pregnancy and Childbirth. 2019; 19(1): 62.
15. Baqui AH, Ahmed S, Begum N, Khanam R, Mohan D, Harrison M, et al. Impact of integrating a postpartum family planning program into a community-based maternal and newborn health program on birth spacing and preterm birth in rural Bangladesh. Journal of Global Health. 2018; 8(2): 020406.
16. Word Health Organization. Report of a WHO technical consultation on birth spacing 2007 [Available from: https:// www.who.int/ reproductivehealth/publications/family_planning/WHO_RHR_07_1/en/.
17. Poorolajal J, Cheraghi P, Cheraghi Z, Ghahramani M, Doosti Irani A. Predictors of miscarriage: a matched case-control study. Epidemiol Health. 2014; 36: e2014031-e.
18. Jaffar FHF, Osman K, Ismail NH, Chin K-Y, Ibrahim SF. Adverse effects of Wi-Fi radiation on male reproductive system: a systematic review. The Tohoku Journal of Experimental Medicine. 2019; 248(3): 169-179.
19. 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.
20. Sun W, Tan Q, Pan Y, Fu Y, Sun H, Chiang H. Effects of 50-Hz magnetic field exposure on hormone secretion and apoptosis-related gene expression in human first trimester villous trophoblasts in vitro. Bioelectromagnetics. 2010; 31(7): 566-572.
21. Khaki AA, Khaki A, Gharachour LS, Khourshidi F, Taj AN, Madinei N. Pre and post natal exposure of 50 Hz electromagnetic fields on prostate glands of rats: an electron microscopy study. Iranian Journal of Reproductive Medicine. 2008;

9(2): 77-82. [Persian]
22. Huuskonen H, Saastamoinen V, Komulainen H, Laitinen J, Juutilainen J. Effects of low-frequency magnetic fields on implantation in rats. Reproductive Toxicology. 2000; 15(1): 49-59.
23. Mahram M, Ghazavi M. The effect of extremely low frequency electromagnetic fields on pregnancy and fetal growth and development. Archives of Iranian Medicine. 2013; 16(4): 221-224.
24. Adams JA, Galloway TS, Mondal D, Esteves SC, Mathews F. Effect of mobile telephones on sperm quality: a systematic review and meta-analysis. Environment International. 2014; 70: 106-112.
25. El Jarrah I, Rababa M. Impacts of smartphone radiation on pregnancy: A systematic review. Heliyon. 2022; 8(2): e08915.
26. Ghazanfarpour M, Kashani ZA, Pakzad R, Abdi F, Rahnemaei FA, Akbari PA, et al. Effect of electromagnetic field on abortion: A systematic review and meta-analysis. Open Medicine. 2021; 16(1): 1628-1641.