

Effect of Electromagnetic-Radiofrequency Devices on Male Infertility at Urban Private Infertility Clinics in East Java

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KEYWORDS

Sperm, mobile phone, electromagnetic, electromagnetic radiation, radiofrequency, WiFi.

ABSTRACT

Background: As technology becomes increasingly integrated into urban lifestyles, the use of mobile phones, laptops/computers, and WiFi has surged, reshaping habits and routines. However, this reliance on devices raises concerns about potential health impacts, including male infertility rates. This study explores how lifestyle factors, particularly mobile phone usage and exposure to electromagnetic radiation (EMR) and radio frequencies (RF), influence male infertility. Methods: Conducted in Surabaya, Indonesia, this study analyzed sperm analysis data from 260 husbands attending private infertility clinics. Data spanning 2018 to 2023 were collected, with interviews conducted to assess EMR-RF exposure. Statistical analysis using the Mann-Whitney test evaluated differences in sperm analysis results between groups exposed to EMR-RF and controls. Results: A notable prevalence of EMR-RF exposure was observed among men aged 31-40, particularly those working indoors. Significant associations were found between EMR-RF exposure and sperm analysis results, with key factors such as mobile phone usage duration, storage practices, and WiFi exposure showing statistically significant correlations ($p < 0.05$). Conclusion: This study highlights the impact of EMR-RF exposure on male fertility, particularly concerning mobile phone use and WiFi exposure. These findings underscore the importance of further research and potential interventions to mitigate the health risks associated with EMR-RF exposure in urban populations.

1. Introduction

Infertility is a significant global challenge, that affects the health, financial, psychological, and social aspects of couples of childbearing age. According to the World Health Organization (WHO), in 2010, it was estimated that around 48 million couples experienced infertility, with the current prevalence likely being higher [1][2]. In about half of infertility cases, male infertility factors are identified, with abnormal semen parameters being a common cause, such as nonstandard sperm count, motility, and morphology. Epidemiological data indicates an increasing prevalence of male infertility globally, which may exacerbate its impact on the well-being of couples and society at large. Although routine semen analysis is performed as part of infertility diagnosis, the cause often remains unexplained, even after careful hormonal and genetic testing. Many environmental factors have also been identified as potentially influencing sperm quality and contributing to male infertility. For example, exposure to radiofrequency electromagnetic radiation (RF-EMR) from devices such as mobile phones have attracted attention in research regarding decreased sperm quality. According to La Vignera et al, scientific and public attention to RF-EMR has concentrated on the potential increased risk of brain tumors, but there are also concerns about its impact on male reproductive health [3]. In this context, further research is needed to understand in more depth the relationship between environmental factors, such as EMR-RF, and male infertility.

Male infertility is one of the significant reproductive health problems worldwide, which can have far-reaching impacts on the physical, emotional, and social well-being of affected couples. One of the factors that contribute to male infertility is sperm disorders, such as a decrease in sperm quality which can affect reproductive ability. Various environmental factors have been identified as potential causes of impaired sperm quality, including exposure to electromagnetic (EM) and radio frequency (RF) effects originating from everyday electronic devices such as cell phones, laptops, and Wi-Fi [4]–[11].

Previous research has indicated the potential negative influence of EM and RF exposure on sperm quality and male fertility. EM and RF exposure is believed to increase oxidative stress in the body, which can result in DNA damage in sperm and impact reproductive ability [6], [8], [10], [12] However, most of this research was conducted in laboratory contexts or outside the clinical environment, and not many studies have investigated this relationship in real populations, especially in clinical settings in hospitals or other health institutions.

Considering the importance of this issue, as well as the lack of research conducted in a clinical setting, we aimed to conduct a more in-depth field study on the influence of EM and RF exposure on sperm analysis regarding male fertility or infertility. The exposure used as a variable is the length of daily use of a cellphone, WiFi use, length of exposure to a monitor screen, and storing the cellphone in a trouser pocket. This study was conducted at an infertility clinic in Surabaya, a private health institution that serves patients with various reproductive health problems.

By collecting data from patients who have consulted these health institutions for fertility problems or male infertility, we hope to provide a better understanding of how EM and RF exposure may affect sperm quality in real populations. We will also consider other potential factors that may affect sperm quality, such as lifestyle, medical history and work environment.

By obtaining more comprehensive information about the relationship between EM and RF exposure and sperm quality in patients experiencing male fertility or infertility, it is hoped that this study can provide a valuable contribution to efforts to prevent and treat male infertility problems. In addition, the results of this study can also provide a basis for the development of better health policies and guidelines related to the use of electronic devices that have the potential to affect men's reproductive health.

This study aimed to investigate the potential influence of environmental factors, including electromagnetic and radio frequency exposure, on sperm parameters in male patients, in the hope of providing deeper insight into the relationship between the environment and male infertility.

2. METHODS

This research was conducted in accordance with ethical and safety guidelines after obtaining approval from the review board of the Research Ethics Commission of the Faculty of Medicine, Brawijaya University with number: 230/ EC/ KEPK – S3/ 10/ 2022. The study population for this research used an observational analytical approach with test methods Mann-Whitney to analyze data from 130 male patients undergoing treatment at an infertility clinic in Surabaya with abnormal sperm analysis results. These samples were compared with 130 husbands with normal sperm analysis results as a control group. Sampling was carried out from 2018 to 2023.

Investigation of exposure to electromagnetic wave radiation (EMR) and radio frequency (RF) in this study used self-report questionnaires and interviews with patients in both groups. Then analyzed using by IBM SPSS ver. 25.0 with t test was used to examine differences in EMR and RF exposure on sperm analysis (SA) results between the study group and the control group. The t-test analysis chosen was the Mann-Whitney test. This test was chosen because the data obtained is categorical with an ordinal scale and not normally distributed, and this method is suitable for analyzing differences between two independent groups. The P-value is considered statistically significant if the P-value is less than 0.05.

This study tries to see the influence of EMR-RF on the life habits of utilized mobile phones/ mobile phones (Electro_HP), storing mobile phones in trouser pockets (Electro_HP_Pocket), utilization laptops or utilization monitors (Electro_Monitor) and utilization Wifi (Electro_WiFi). Closed interviews were conducted utilizing a Likert scale.

Utilization of a cellphone for more than 18 hours per day can affect the results of sperm analysis. The effect of radiation within 30 days can reduce the number of spermatogonia cells, cellsgerm and Leydig cells in mouse experiments. At least the use of HP 900 MHz RF for 3 hours a day for a year can reduce sperm parameters and can cause cancer in experimental mice [13]–[16].

The frequency with which men keep their mobile phones in their trouser pockets can affect the quality of their sperm and thus disrupt their fertility levels. The daily habit of keeping a mobile phone in the front trouser pocket while it is active can reduce sperm quality during fecundation [17]–[19].

Utilization of a TV/Laptop/Computer monitor for more than 7 hours a day can decrease [11], [15], [20]. Thermal and non-thermal effects of utilization of this device can result in a decrease in sperm quality.

The effect of WiFi on sperm quality will be visible if you use it for more than 4 hours a day. Computer or laptop devices connected to 4G or 5G WiFi can result in a decrease in the quality of sperm analysis [21]–[23][24].

3. RESULTS AND DISCUSSIONS

Result

Subject Characteristics

The total number of research subjects was 260 husbands. The results of the demographic analysis of the selected samples based on occupation include cook workers/ chefs/ bakers, athletes/ training instructors, employees/ office workers (indoors), and employees/ field workers (outdoors).

Table 1. Sperm Analysis Results by Occupation

Work	Abnormal	Normal	Total
Cook Workers/ Chef/ Baker	6	0	6
Athlete/ Training instructor	3	0	3
Employees/ office workers (indoor)	73	92	165
Employees/ field workers (outdoors)	48	38	86
Total	130	130	260

The sperm analysis results are then divided into two categories: Abnormal and Normal. From this table, you can see the number of patients who had abnormal and normal sperm analysis results for each job category. There were 6 Cook patients with abnormal sperm analysis results and none with normal results. Meanwhile, in the employee/office worker (indoor) category, there were 73 patients with abnormal sperm analysis results and 92 patients with normal sperm analysis results.

The total of all job categories is followed by 260 patients, and each job category has a different number of patients. The total number of patients with abnormal and normal sperm analysis results is also recorded in the table.

Table 2. Age distribution based on sperm analysis results

Age group	SA Results		Total
	Abnormal	Normal	
<=20	3	0	3
21-30	46	45	91
31-40	53	53	106
41-50	22	26	48
>=51	6	6	12
Total	130	130	260

Age ranged from 19 – 59 years, with the most aged 34 years being 14 people. There was no age group difference between the study group and the control group.

Table 3. Sperm analysis results by location

Region of origin	Abnormal	Normal	Total
East Java	102	129	231
Central Java	7	0	7
West Java	9	0	9
Outside Java	12	1	13
Total	130	130	260

Then the region of origin is not only from within East Java Province but also from other regions such as Central Java, West Java, and Outside Java. From this table, you can see the number of patients who had abnormal and normal sperm analysis results for each category of origin. For example, there were 102 patients from East Java with abnormal sperm analysis results and 129 patients with normal sperm analysis results. Meanwhile, in the Central Java category, there were only 7 patients with abnormal sperm analysis results and none were normal.

Differences between EM and RF exposure in each group

In statistical analytical testing of electromagnetic (EM) and radiofrequency (RF) exposure to sperm analysis, each exposure can be seen in Table 4.

The Electro_HP group is men with the habit of utilizing mobile phones for more than 18 hours per day in a month. Meanwhile, those grouped under Electro_HP_Pocket are cellphone users who often keep their active

mobile phones in their trouser pockets. The Electro_WiFi group is a user of WiFi facilities at least 4 hours a day. And the Electro_Monitor group is a laptop/computer user for at least 7 hours per day a week.

Table 4. Differences between electromagnetic and radiofrequency exposure on sperm analysis results

	Mann-Whitney U Test	Wilcoxon W	WITH	Asymp. Sig. (2-tailed)
Electro_HP	3.190.000	11.705.000	-9.705	0,000
Electro_WiFi	4.437.000	12.952.000	-7.780	0,000
Electro_Monitor	3.804.000	12.319.000	-8.943	0,000
Electro_HP_Pocket	3.509.000	12.024.000	-9.120	0,000

TestMann-Whitney This is used to answer the proposed hypothesis, namely that there are differences in variables between the utilized mobile phones/ mobile phones (Electro_HP)/ storing mobile phones in trouser pockets (Electro_HP_Pocket)/ utilization laptops or utilization monitors (Electro_Monitor)/ utilization Wifi (Electro_WiFi) on the results of sperm analysis (SA). The procedure is as follows:

1. If the significance value is <0.05 then H_a is accepted, and H_o is rejected.
2. If the significance value is > 0.05 then H_o is accepted, and H_a is rejected.

Statistical analysis uses testsMann-Whitney showed that there were significant differences between the study group (patients with sperm analysis abnormalities) and the control group in all observed variables, namely Electro_HP, Electro_WiFi, Electro_Monitor, and Electro_HP_Pocket. Test resultsMann-Whitney shows that all these variables have negative Z values, with Z values ranging from -7.780 to -9.705, and the significance value is asymp. sig. (2-tailed) of 0.000 for each variable. A very small significance value indicates that the difference between the two groups is very statistically significant. Thus, it can be concluded that there is a significant difference in electromagnetic exposure between patients with sperm abnormalities and the control group. It has been proven that there is a potential relationship between electromagnetic and radio frequency exposure and impaired spermatogenesis in patients based on abnormal sperm analysis results.

Discussion

Since the electrical era until now, in the robotic and digitized era, humans have been inseparable from the electrical environment and electric fields. Non-ionizing radiation can be generated by various types of electric devices. Various kinds of radio-frequency sources can cause radiation, such as televisions, computer or laptop monitors, mobile phones, radios, WiFi, even electricity lines in the house can also cause it. Electrical voltage at home with a frequency of 50-60 Hz can produce 0.4 mT [8][25].

Utilization a laptop, in this case can produce 1.15mT, for 7 hours per day a week can reduce the number and movement of sperm. Exposure to radiation resulting from computer monitors can cause oxidative stress [8].

The use of mobile phones (HP) or smartphones has become common among urban residents. Not only do office people use mobile phones, but it has spread widely to various groups. The cheaper price of mobile phones and recent advances in telecommunications have made mobile phones an everyday necessity.

On the positive side, mobile phones help us in many ways, from communication to searching for information and even as personal assistants at work. But what about the negative effects? HP can produce electromagnetic effects and radio frequency radiation which can affect the quality of male infertility, especially the sperm it produces [8], [20], [24], [26], [27].

In the medical field, especially in this case the field of infertility, it turns out that utilization mobile phones for an average of more than 14 hours a day have resulted in abnormal sperm analysis results. In previous research, utilization a cell phone for 18 hours per day as far as 3 cm for 28 days resulted in a decrease in sperm cells, spermatogonia and Leydig cells. HP at 900MHz for one hour with a SAR value of 2.0 W/Kg affects morphometry and reduces sperm fertilization ability [7]–[9], [12], [22]. The radiation generated by HP affects the concentration and other parameters of sperm analysis which have an impact on male infertility problems [8], [14], [24], [26]–[29]

Laboratory research on Winstar included exposure of the animals to cell phone radiation4G (2350 MHz treatment for 2 hours every day for 56 days). There was a decrease in sperm analysis parameters [12]. Frequencies often used on mobile phones include 800 to 2200 MHz. Other studies also used mice as subjects and obtained abnormal sperm numbers and shapes [30] besides that it also affected the blood-brain barrier and cell membranes through ROS (reactive oxygen species) which can damage cells [9], [17], [27]. Likewise, the

damage caused by ROS to spermatogenesis results in damage to sperm DNA [18], [27] .

Utilization of WiFi can also cause radiation which affects sperm production. When exposed to a laptop connected to WiFi (2.4 GHz) for 4 hours at a temperature of 25°C will reduce sperm movement and cause damage to their DNA. Likewise, in other studies, mice exposed to 2,437 GHz for 24 hours per day for 20 weeks also experienced DNA damage [8], [18], [27].

WiFi networks also produce electromagnetic radiation. This EMR can also affect sperm quality. Although some question this risk, more and more journals state the dangers of this radiation on the quality of existing sperm [5]. The effect of electromagnetic radiation caused by WiFi can affect sperm quality.

Electromagnetic radiation, both the thermal and non-thermal effects it produces, as well as Radio Frequency, can harm the quality of sperm to achieve fecundation [8], [12], [18], [22], [24].

Pregnancy planning needs to be prepared wisely. It is not only enough to consume adequate nutrition or a sufficient economy, but also living habits and lifestyle are taken into consideration and require healthy improvement [21], [25].

4. CONCLUSION

The conclusion of this study indicates that exposure to electromagnetic radiation (EMR) and radio frequency (RF) from devices such as mobile phones, computers/laptops, and WiFi significantly impacts male infertility at infertility clinics in Surabaya, East Java. Data shows that men aged 31-40, especially those working indoors, are more susceptible to EMR-RF exposure. Prolonged mobile phone usage, storage practices, and WiFi exposure are significantly correlated with reduced sperm quality, including sperm analysis parameters such as concentration, morphology, and motility. EMR-RF exposure has also been shown to cause oxidative stress, which can damage sperm DNA and spermatogenesis, contributing to infertility issues. Therefore, this study emphasizes the need for greater awareness of the health risks associated with electromagnetic radiation exposure and the importance of interventions to mitigate the negative effects of technology use on male fertility.

Conflict Of Interest

There is no conflict of interest in this study. This article is independent and only for academic and public research purposes.

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Reference

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