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Impact of Cellphone Radiation on Human Male Fertility

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ABSTRACT

Background: Concerns regarding the possible impact of mobile phones on health have grown recently as the number of individuals using mobile phone devices has increased. Recently, experts have investigated the effects of cell phone use on male fertility. Other research indicates that Electromagnetic fields (EMFs) stimulate follicle growth and macrophages in the corpus luteum. This study aimed to assess whether prolonged exposure to Radio Frequency Electromagnetic Radiation (RF-EMR) emitted by cell phones negatively affects male reproductive health by reducing semen quality parameters, including motility, morphology, and viability.

Methods: A cross-sectional study was conducted from February 2024 to February 2025 in Erbil City, the Kurdistan region of Iraq. The study included 113 men with normozoospermia, aged between 25 and 40 years, who were divided into four groups based on their daily mobile phone usage: no exposure (none), low exposure (less than 2 hours), medium exposure (2 to 4 hours), and high exposure (more than 4 hours). Semen analyses were performed following the criteria established by the World Health Organization (WHO).

Results: There were notable differences ($P < 0.001$) in sperm motility, morphology, and count among the exposure groups. Specifically, sperm motility decreased from 62.5% in non-users to 45.3% among those with high exposure, and sperm concentration fell from 58.2 million/ml to 42.5 million/ml. Morphological normal forms slightly declined from 5.6% to 5.0%.

Conclusion: There is a negative correlation between semen quality and the duration of mobile phone usage.

Key words: Male Fertility; Semen Quality; Wireless Devices; Radio Frequency; Electromagnetic Radiation.



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INTRODUCTION

Mobile phone usage is rising globally, and these devices emit considerable electromagnetic radiation (EMR), raising concerns about their biological impact. One growing area of concern is the effect of EMR on male fertility, particularly on sperm quality. EMR may affect male reproductive function through thermal and non-thermal mechanisms, including increased scrotal temperature and oxidative stress. Oxidative stress plays an important role in male infertility by disturbing the delicate equilibrium between reactive oxygen species (ROS) production and antioxidant capability [1, 2].

Animal studies have shown that EMR exposure may impair testicular function and reduce testosterone levels. Numerous studies have shown that animals' testosterone levels and testicular function can be adversely affected by radiofrequency electromagnetic radiation (RF-EMR) from wireless devices. Significant drops in blood testosterone levels and compromised testicular function were seen in male rats exposed to RF-EMR from cell phones [3].

Human studies similarly suggest negative effects, reporting associations between prolonged mobile phone use and decreased sperm motility, viability, and concentration [4, 5].

A recent study by Sienkiewicz et al. (2025) suggested that prolonged exposure to non-ionizing electromagnetic radiation (NIR) from mobile devices may have a detrimental effect on male fertility [6].

Based on human studies, NIR can reduce sperm count, motility, and viability, as well as induce morphological modifications in sperm and reproductive tissues, as well as induce oxidative stress, DNA damage, and genomic instability [7].

Although several studies exhibit methodological limitations, the data suggest a possible association between cell phone usage and infertility. For instance, a study involving 361 infertile men found that longer durations of mobile phone usage were significantly correlated with reduced sperm quality parameters. These effects were observed regardless of baseline sperm count (≥ 20 million spermatozoa/ml) or low sperm counts (< 20 million spermatozoa/ml) [8].

A further study by Kim S et al. (2021) revealed that prolonged mobile phone usage is associated with reduced sperm motility in 153 males undergoing infertility assessments [9]. The discovery indicates that extended use of mobile devices may hinder sperm motility. A prospective research study conducted by Panagopoulos (2023) investigated 13 males with normal sperm patterns. The study showed that utilizing GSM phones for six hours each day over five days diminished the rapidly

increasing motility of sperm [10].

Natheer Jameel Yaseen (2022) reported that the majority of adult populations throughout the world currently use and are exposed to radiofrequency electromagnetic radiation emitted from mobile phones, and male infertility accounts for around half of all cases worldwide [11].

The two main public health issues facing the world today are obesity and infertility. The World Health Organization (WHO) reported in 2016 that around 13% of individuals were obese and 39% of people aged 18 and over were overweight. Interestingly, 39% and 11% of men were involved in these two situations, respectively [12].

Recent data reveal that the proximity of cell phones to the waist is associated with reduced sperm concentrations compared to individuals who refrain from using them or store them in different locations. Numerous illnesses, such as diabetes, cancer, heart disease, brain deterioration, sperm quality, and erectile dysfunction [13].

Recent studies have investigated the association between mobile phone use and various health conditions, including cognitive deterioration and negative psychophysical impacts [14]. On the other hand, Higher body mass index (BMI) is linked to subfertility in both men and women [15].

Additionally, there is a lack of population-based data from specific geographic contexts like the Kurdistan region in Iraq. This study aims to fill that gap by conducting study on evaluating the impact of different durations of mobile phone use on semen quality, as well as exploring the role of body mass index (BMI) as a potential modifier of EMR effects on fertility. This investigation provides region-specific evidence that contributes to a global understanding, particularly by examining the impact of radiofrequency EMR exposure on sperm motility, viability, and morphology—key parameters of male fertility.

MATERIALS AND METHODS

A cross-sectional study was conducted from February 2024 to February 2025 in Erbil City, located in the Kurdistan region of Iraq. The study included 113 healthy male participants, aged 25 to 40, who were in regular sexual relationships with partners diagnosed with female factor infertility and had sought advice from clinics. Participants were selected based on normal semen parameters, as specified by the WHO 2023 guidelines [16], which include normozoospermia defined by sperm concentration of at least 15million/ml, total motility of 40% or more, and morphology consisting of at least 4% normal forms. In order to examine the potential impact of cell phone radia-

tion on sperm health, participants were grouped according to their daily mobile phone usage into 4 groups: those without exposure, low exposure (under 2 hours), medium exposure (2 to 4 hours), and high exposure (above 4 hours). All participants gave their written informed consent. Participants were not included in the study if they were diagnosed with any form of male infertility, such as azoospermia, oligozoospermia, or identified testicular conditions, or if they had a history of varicocele, cryptorchidism, or previous surgeries on the genitals. Other exclusion criteria encompassed smoking, alcohol use, recent febrile illness (within the last 3 months), exposure to recognized occupational hazards like heat, radiation, or harmful chemicals, as well as consumption of drugs or supplements known to influence sperm production. The body mass index (BMI) for all participants was determined based on self-reported measurements of height and weight (kg/m^2). According to WHO standards, participants were classified as underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), or obese (BMI \geq 30.0). While obesity was not the main focus of the study, it was included in subgroup analyses because of its recognized impact on semen quality.

Statistical analyses were performed using SPSS software version 21. The data were tabulated and analyzed using an independent two-tailed *t*-test to compare continuous variables such as sperm concentration and motility between groups and to assess potential correlation between obesity and motility/morphology parameters. Qualitative variables are represented by frequencies and percentages. A *P*-value of less than

0.05 indicated that the difference between the groups was statistically significant.

RESULTS

Mobile phone usage was classified into four distinct categories: non-users ($n=53$), a low usage group ($n=30$) with less than 2 hours of daily phone use, a medium usage group ($n=15$) engaging with their phones for 2 to 4 hours each day, and a high usage group ($n=15$) using their phones for more than 4 hours per day.

Table 1 provides a summary of a study examining semen characteristics and BMI among 113 individuals based on their self-reported exposure to mobile phone radiation. As exposure duration increases from non-existent in Group A to low, medium, and high in subsequent groups, there is a corresponding gradual decrease in sperm concentration, total sperm count, and motility. Statistically meaningful differences are only observed in the high-exposure group compared to non-users. Specifically, sperm concentration decreases significantly (42.5 ± 9.8 vs. 58.2 ± 12.1 million/ml, $p < 0.001$), and motility is notably lower ($45.3 \pm 7.2\%$ vs. $62.5 \pm 5.6\%$, $p < 0.001$). The sperm count for individuals in the low/medium exposure categories appears implausibly low (41.06, 32.42) in comparison to non-users (63.3).

In terms of other parameters, there were no remarkable differences between the groups regarding BMI, sperm volume, or normal morphology. Although the high-exposure group had a lower average morphology, it was not significantly different from that of the non-users.

Table 1. Semen quality parameters (Mean \pm SD) according to mobile phone usage and body mass index

Studied Groups	Count No. (%)	BMI	Sperm Volume (ml)	Sperm Conc. (mil/ml)	Sperm Count (mil)	Motility (%)	Normal Morphology (%)	P Value*
Non users	53 (46.9)	27.82 \pm 4.83	2.8 \pm 0.6	58.2 \pm 12.1	63.33 \pm 0.60	62.5 \pm 5.6	5.6 \pm 1.1	Reference
Low exposure (<2 hours)	30 (26.5)	26.23 \pm 3.30	2.7 \pm 0.5	54.6 \pm 10.9	41.06 \pm 7.77	57.8 \pm 6.2	5.3 \pm 1.2	0.999
Medium exposure (2–4 hours)	15 (13.3)	27.89 \pm 3.05	2.6 \pm 0.4	48.5 \pm 10.3	32.42 \pm 7.04	53.3 \pm 5.6	5.23 \pm 1.3	0.312
High exposure (>4 hours)	15 (13.3)	28.17 \pm 6.39	2.6 \pm 0.5	42.5 \pm 9.8 [†]	22.55 \pm 4.81	45.3 \pm 7.2 [†]	5.0 \pm 1.3	<0.001

*Independent *t*-test: *P*-values compare each group to the non-user group (Reference).

[†] Statistically significant difference from non-users ($p < 0.001$).

DISCUSSION

Male infertility refers to the failure to achieve pregnancy in a fertile female after 12 months or more of regular, unprotected sexual intercourse. It accounts for 40–50% of global infertility cases and is commonly attributed to abnormal sperm parameters, hormonal imbalances, genetic disorders, or environmental exposures [17].

In the present study involving 113 normozoospermic males, we identified a significant inverse correlation between the duration of mobile phone use and key semen quality parameters. Men with higher daily mobile phone exposure exhibited significantly lower sperm concentration, reduced motility, and abnormal morphology compared to non-users or those with limited exposure. These observations provide additional evidence in favor of the hypothesis that extended exposure to radiofrequency electromagnetic fields (RF-EMFs) may negatively impact male reproductive health [18].

One possible explanation for these findings relates to EMF-induced elevation in scrotal temperature is that the process of spermatogenesis requires a temperature lower than the core body temperature, and various physiological mechanisms work to maintain an optimal scrotal environment. When EMFs elevate tissue temperature, this delicate balance may be disrupted, potentially hindering sperm maturation [19].

In addition, recent studies indicate that EMF exposure enhances the production of reactive oxygen species (ROS), leading to oxidative stress. The accumulation of ROS can disrupt the equilibrium between free radicals and antioxidants, leading to cellular damage. Specifically, EMFs, particularly those from wireless devices have been shown to affect voltage-gated ion channels through forced oscillation, producing abnormal gating and ionic imbalances [20]. The resulting oxidative stress can trigger inflammatory pathways, which may worsen cellular damage. Mitochondrial dysfunction and DNA fragmentation are some of the resulting outcomes of this stress, affecting fertility and having wider health implications like cancer and sensitivity to electromagnetic fields [21].

This study's histopathological examinations revealed consistent alterations in the germinal epithelium, including increased nuclear staining and atypical spermatid structures, like double-headed sperm, which align with previous findings [22, 23]. Differing from the findings of Kozopas et al. (2020), which reported a link between increased BMI and decreased sperm quality, our research did not detect any significant association [12]. The variation might arise due to differences in participant characteristics, sample size, or BMI distribution. Unlike the broader and more heterogeneous

population studied by Kozopas, our sample was limited to normozoospermic males, potentially reducing the ability to detect such associations.

The acute symptoms like fatigue, headaches, and sleep disturbances can be further elucidated by the thermal effects of RF-EMF exposure. These biological responses have underpinned the development of safety thresholds for mobile and wireless devices [24]. Moreover, Heran Cao *et al.* (2024) have highlighted the role of extracellular adenosine 5'-triphosphate (ATP) in modulating spermatogenesis and fertilization processes, indicating a complex network of signaling mechanisms that might be affected by environmental EMF exposure [25].

Further evidence from Hatch *et al.* (2021) and Darvish *et al.* (2021) demonstrated increased apoptosis and decreased germ cell counts in seminiferous tubules following EMF exposure, reinforcing the biological plausibility of our findings [26, 27]. These observations are of growing significance given the rising prevalence of infertility and its consequences on individual well-being and healthcare systems.

Even though these findings align with existing literature, several limitations must be acknowledged. Many studies, including ours, are constrained by small sample sizes, limiting the generalizability of the results. Additionally, short-term or acute exposure models may not adequately reflect the effects of chronic EMF exposure, which are more relevant to real-life scenarios. Another challenge lies in the heterogeneity of EMF parameters, including differences in frequency, intensity, and modulation make direct comparison across studies difficult. Furthermore, methodological variability and the lack of standardized exposure protocols hinder reproducibility and limit the potential for meta-analyses. Measurement of EMF exposure levels, both *in vivo* and *in vitro*, remains a technical challenge, often complicated by inadequate control of environmental and lifestyle confounders. Importantly, many studies, including ours, focus on either thermal or non-thermal effects, with limited research exploring their combined and potentially synergistic mechanisms. Future research on EMF exposure should focus on large, long-term studies with diverse populations, using standardized protocols and precise measurements. Deeper investigation into both oxidative and thermal effects at the molecular level is needed, along with translational studies on human tissues. Understanding dose-response relationships and identifying safe exposure thresholds will guide regulations. Collaboration across scientific fields and better control of confounding factors are essential. Exploring protective strategies, like antioxidants, may help reduce EMF-related damage.

CONCLUSION

The use of mobile devices negatively impacts semen quality, leading to declines in motility, viability, and morphological characteristics. Various potential outcomes, ranging from major to minor effects and varying degrees of testicular damage, provide evidence that mobile phones harm men's fertility.

ETHICAL DECLARATIONS

• Ethics Approval and Consent to Participate

Ethical approval was granted by the Ethics Committee of the College of Medicine, Hawler Medical University (Document No. C/4/86, dated 06 June 2024).

• Consent for Publication

Non.

• Availability of Data and Material

The datasets are available from the corresponding author upon reasonable request.

• Competing Interests

The authors declare that there is no conflict of interest.

• Funding

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• Use of Generative Artificial Intelligence

The authors declare that no generative AI tools were used in the preparation, writing, or editing of this manuscript.

• Authors' Contributions

All authors contributed significantly, directly, and intellectually to the work and consented to its publication.

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