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Male fertility and its association with occupational and mobile phone towers hazards: An analytic study

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KEYWORDS

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Abstract *Objective:* The aim of the study is to determine the association of male fertility with the occupational and mobile phone towers hazards. *Background:* Male reproductive ability is likely to have multiple genetic and environmental determinants. A seminal fluid analysis is clinical marker of male reproductive potential. *Aim:* To find out whether environmental hazard such as mobile phone tower has an effect on male reproductive ability. *Methods:* Two hundred couples were enrolled, one hundred subfertile couples as a study group (n = 100), and one hundred fertile couples as a control group (n = 100). Environmental exposure to electromagnetic radiation from mobile phone towers and occupational state was assessed by standard questionnaire. Semen analysis was done for the subfertile males, because the fertile males (control group) refused to give semen samples. *Results:* The occupational hazard expressed significant difference between the subfertile and the control groups (38% versus 12%) ($p < 0.05$), with odds ratio (OR) = 4.5 and 95% Confidence Interval (CI): 2.175–9.288, and also the environmental factor (mobile tower within fifty meters from their house) showed significant difference (29% versus 12%) ($p < 0.05$), with OR = 3; 95% CI: 1.426–6.290. SFA of the subfertile males was 40% abnormal versus 60% normal semen analysis. These abnormalities were classified into 35% oligozoospermia, 55% asthenospermia, and 10% teratozoospermia. Oligozoospermia was associated with more occupational hazard (OR = 1.8, 95% CI: 0.569–5.527). Teratozoospermia was associated with more occupational hazard (OR = 5.23, 95% CI: 0.524–52.204), and with exposure to environmental hazard (OR = 2.6, 95% CI: 0.342–19.070), and associated with smoking hazard (OR = 1.7, 95% CI: 0.225–12.353). *Conclusions:* Male fertility represented by quality of semen might be affected by occupational and environmental exposures, so it seems that prevention of occupational and environmental risk factors, may lead to improvement of semen quality in subfertile men.
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1. Introduction

Subfertility is a failure to achieve pregnancy after one year of unprotected intercourse. It can be primary or secondary (1). The period in definition may be extended to two years in young female partner and shortened to six months in older one (2).

Based on statistics released by the World Health Organization (WHO), the prevalence of infertility is 10–15%. Male factors (as main cause or with female factor) are involving in 35% of all causes of infertility (3). Sperm analysis is an essential important diagnostic study in male subfertility diagnostic approach and usually is abnormal in subfertile men. Because medical history cannot explain all male infertility cases, these observations may be linked to a growing impact of potential occupational and environmental factors (4).

Environmental factors such as heat, smoking, radiation and others can effect on spermatogenesis. Based on some theories heat generator environmental sources such as jobs which need long time sitting (like driving) can cause subfertility (5).

The increasing use of devices for wireless communication has given rise to fears that the radiofrequency electromagnetic fields (RFEMFs) emitted by such devices (e.g., mobile and wireless phones) and by their respective base stations cause various adverse health effects (6). The discussion about possible health effects by exposure to RF-EMF recently has shifted toward subfertility, mainly focusing on males (7). Electromagnetic radiation (EMR) emitted by mobile cellular phones (8), and more recently, wi-fi network signals (9) can affect semen analysis characteristics (10–12).

2. Aim of the study

1. To analyze SFA in a group of subfertile couples.
2. Those with abnormal parameters were studied for possible exposure to environmental hazard as a cause for their subfertility by comparing them with a control group who were fertile.

3. Subjects and methods

This study was designed as a case-control study. Two hundred couples were enrolled, one hundred subfertile couples as a study group ($n = 100$), and one hundred fertile couples as a control group ($n = 100$). Among 220 subfertile couples attended the infertility clinic of Babylon Teaching Hospital for Maternity and Pediatric in Al-Hilla city in Iraq, from September 2014–March 2015, one hundred convenience couples were selected (random selection, odd no method). Demographic data of subfertile group are shown in Table 1.

A standard questionnaire was used for collecting demographic characteristics, education, type and duration of subfertility, occupational state, and if they live near to mobile phone base station (within fifty meters) and with power intensity of 71.226 mW/m^2 (these numbers are gained from the local environmental office) and the duration of exposure to the electromagnetic radiation which were obtained.

All the subfertile couples were surveyed for their etiology of subfertility by medical and surgical examination by surgeon and Doppler examination for possibility of varicocele; semen analysis was done for the males.

Table 1 Demographic data regarding the subfertile and the control males.

The parameter	Subfertile group	Fertile group
Age (years)	34.61 ± 10.65	37.48 ± 7.24
Education		
Unenlightened (no)	(18) 18%	–
School (no)	(62) 62%	(50) 50%
Higher degree (no)	(20) 20%	(50) 50%
Work		
Work hazard (no)	(38) 38%	(12) 12%
Non hazard (no)	(62) 62%	(88) 88%
Environmental factor		
Mobile towers (no)	(29) 29%	(12) 12%
Non hazard (no)	(71) 71%	(88) 88%
Smoking		
Smokers (no)	(38) 38%	(32) 32%
Nonsmokers (no)	(62) 62%	(68) 68%
Seminal fluid analysis (SFA)		
Normal (no)	(60) 60%	–
Abnormal (no)	(40) 40%	

Values are mean ± standard deviation or percentages ($n = 100$).

The control group was volunteers either relatives or staff of the Babylon Teaching Hospital for Maternity and Pediatric in Al-Hilla city in Iraq. Demographic data of fertile group are shown in Table 1. They had a child within the last year, and depending on their fertility, the control seminal fluid analysis was considered normal and we neglected the effects of environmental hazards on these control groups as we are focusing on their fertility per se.

3.1. Semen analysis

Seminal fluid analysis (SFA) was done for all the subfertile males ($n = 100$). Semen samples were collected by masturbation (after 3–5 days of sexual abstinence) in a clearly labeled standard container (which is a clean plastic plate with wide and dry mouth without any detergent compounds or other toxic substances). The samples were allowed to liquefy for at least 30 min at 37 °C incubator (Binder–Germany).

The sample specimen was mixed thoroughly; notes were recorded regarding the volume, color, PH and whether the sample runs freely on pipetting. Viscous samples are difficult to pipette, leaving sticky strands. High viscosity will interfere with accurate assessment of density and motility, and repeated aspiration by a needle or pipette can reduce the viscosity.

One drop of semen sample is laid on the slide and covered by a cover slide and examined by the microscope (Olympus S*31 Tokyo, Japan); sperm count is made in 4–5 fields in high power field (HPF), as well as motility %, sperm morphology, whether aggregation and white blood cells are found or not. The semen samples were evaluated according to WHO (13).

3.2. Statistical analysis

Statistical analysis of the data was performed with Statistical Package for Social Science (SPSS, Inc., Chicago, IL) SPSS version 20 for Windows. Continuous variables were expressed as

mean ± standard deviation and range, categorical variables as percentages. Between-group differences were tested with Compare means – independent samples *t*-test for continuous parameters and nonparametric tests – Chi-square with Risk Estimate for categorical parameters obtain an odd ratio and a Confidence Interval. A p value of <0.05 was considered significant for all analyses.

4. Results

4.1. Demographic characters of the study subfertile group

4.1.1. Demographic characters of the subfertility (type and cause)

4.1.1.1. Type of subfertility. The total number of the subfertile group was 100 couples. In this study, we found that 64% were suffering from primary subfertility, while 36% have got secondary subfertility.

4.1.1.2. Subfertility cause. Male contribution for subfertility was found to be 40% (13% isolated male factor and 27% combined), while female contribution was 73% (46% isolated female factor and 27% were of combined cause), and 14% unexplained cause.

4.1.2. Demographic characters of the study subfertile males

Demographic characteristics of the subfertile males are outlined in Table 1.

4.1.2.1. Age. The male partners mean age ± SD is 34.61 ± 10.65 years and the range is 21–53 years.

4.1.2.2. Education. Eighteen percentage of the male were unenlightened (never went to school), 62% school education (primary and secondary school), and 20% higher degree.

4.1.2.3. Work hazard. Thirty-eight percentage of subfertile male had exposure to work hazard as "driver" sitting for long period, "worker" painters and construction workers and "militaries", and 62% non-hazard.

4.1.2.4. Environmental hazard. Twenty-nine percentage of subfertile couples had exposure to environmental hazards (communication's tower beside their house-within fifty meters), and 71% non-hazard. The duration of the exposure to the environmental factor ranged from 2 to 7 years, with power intensity of 71.226 mW/m^2.

This amount of power intensity is more than ten times greater than the recommended safety power intensity that is equal to or less than 6.3 mW/m^2 (14). Frequency is about 1000 MHz of the electromagnetic radiation (6).

4.1.2.5. Smoking. Thirty-eight percentage of our male study group was found to be smoker and most of them were heavy smoker (more than 40 cigarettes per day), while the nonsmoker was 62%.

4.1.2.6. Seminal fluid analysis (SFA). SFA was performed for all males of the subfertile group; according to WHO (13) major semen parameters, 60% have normal SFA and 40% have abnormal SFA (either oligozoospermia 35%, asthenospermia 55%, or teratozoospermia 10%) with or without infection.

4.2. Demographic characters of the control (fertile) males

Demographic data of the fertile males are outlined in Table 1.

4.2.1. Age

The total number of the fertile (control) group was 100 couples. The male partners mean age ± SD is 37.48 ± 7.24 years, the range is 21–53 years, and age of control group matches well with the age of subfertile group.

4.2.2. Education

None of male in the control group unenlightened, 50% school education, and 50% higher degree.

4.2.3. Work hazard

Twelve percentage had exposure to work hazard, while 88% non-hazard.

4.2.4. Environmental hazard

Twelve percentage from the fertile couples was found to have exposure to environmental hazards (communication's tower beside their house-within fifty meters), and 88% non-hazard. The duration of the exposure to the environmental factor ranged from 2 to 5 years, with power intensity of 71.226 mW/m^2.

This amount of power intensity is more than ten times greater than the recommended safety power intensity that is equal to or less than 6.3 mW/m^2 (14). Frequency is about 1000 MHz of the electromagnetic radiation (6).

4.2.5. Smoking

Thirty-two percentage of our male control group was found to be smoker and most of them were heavy smoker, while the nonsmoker is 68%.

4.3. Comparison of demographic data of the subfertile and the control males

The male work hazard expressed significant difference between the subfertile and the control groups ($p < 0.05$), with odds ratio (OR) = 4.5 and 95% Confidence Interval (CI): 2.175–9.288 and the environmental factor showed significant difference ($p < 0.05$), with OR = 3; 95% CI: 1.426–6.290, while the smoking had non-significant difference between the two groups ($p > 0.05$), with OR = 1.3, 95% CI: 0.727–2.333 as shown in Table 2.

4.4. Seminal fluid analysis of the study (subfertile) males and its association with the environmental, occupational and smoking hazards

SFA of the subfertile males was 40% abnormal versus 60% normal semen analysis. These abnormalities were classified into 35% oligozoospermia, 55% asthenospermia, and 10% teratozoospermia.

There is significant association between oligozoospermia semen abnormality with the occupational hazards, and there is significant association between the teratozoospermia semen abnormality with the occupational, environmental and smoking hazards as shown in Table 3.

Table 2 A Comparison of demographic data of the subfertile and the control males. Values are percentages (n = 100).

Parameter	Study group	Control group	*P*-value	Odds ratio	95% CI***
Occupational			0.000*	4.5	2.175–9.288
Work hazard	(38) 38%	(12) 12%			
Non hazard	(62) 62%	(88) 88%			
Environment			0.003*	3	1.426–6.290
Mobile towers	(29) 29%	(12) 12%			
Non hazard	(71) 71%	(88) 88%			
Smoking			NS**	1.3	0.727–2.333
Smokers	(38) 38%	(32) 32%			
Non smokers	(62) 62%	(68) 68%			

* Significantly different from the corresponding group.
** NS: non-significant difference.
*** 95% CI: 95% Confidence Interval.

Table 3 Seminal fluid analysis abnormalities of the subfertile males and its association with hazards (environmental, occupational and smoking). Values are odds ratio (OR) and 95% Confidence Interval (95% CI). (n = 100).

Hazards	Oligozoospermia		Asthenospermia		Teratozoospermia	
	OR	95% CI	OR	95% CI	OR	95% CI
Occupational	1.8*	0.569–5.527	1.07	0.875–1.323	5.23*	0.524–52.204
Environmental	1.03	0.844–1.193	1.19	0.427–3.307	2.6*	0.342–19.070
Smoking	1.02	0.865–1.193	1.2	0.983–1.457	1.7*	0.225–12.353

* Significant association of the hazard with the semen abnormalities.

5. Discussion

This study examined the association of environmental hazards with male fertility reflected by SFA. It showed that environmental hazards such as those present in the workplace or area of residence could lead to reduced semen parameters. Table 2 compares the demographic characteristic of the subfertile and the control males, and shows the following significant differences.

In the present study, the work hazard expressed significant difference between the subfertile and the control groups, more occupational hazards were reported in the subfertile group (38% versus 12%), odds ratio (OR) = 4.5 and Confidence Interval (CI), 2.175–9.288; p-value = 0.000, and most of them were drivers, militaries and workers. Workers (painters and construction workers) can be exposed to a number of harmful physical, chemical and psychological factors in their working environment. The driving hazards may include being sedentary for long periods of time, exposure to vibration and heat (3). Our results were similar to those reported in studies on taxi drivers by (15), and it is in agreement with results reported by (16).

The exposure to environmental hazards shows significant difference between the subfertile and the fertile men; as higher percentage of exposure to mobile phone tower among subfertile group, 29% versus 12% for the fertile group, OR = 3; CI, 1.426–6.290; p-value = 0.003 (Table 2). This result goes with those of Foster and coworkers (17), who reported that environmental pollutants have been shown to have a negative effect on fertility potential in men (18).

Smoking hazard shows non-significant difference between the subfertile and the fertile men, 38% versus 32%, OR = 1.3; CI, 0.727–2.333; $p > 0.05$.

Seminal fluid analysis abnormalities of the subfertile males associate with environmental, occupational and smoking hazards, and Table 3 shows the following significant associations.

Occupational hazard is associated with more SFA abnormalities; with oligozoospermia by OR = 1.8, 95% CI: 0.569–5.527, and with teratozoospermia by OR = 5.23, 95% CI: 0.524–52.204. Jobs that require working in hot environments or mechanical trauma and physical load on the pelvic contents can reduce semen quality. With respect to effects of exercise and vigorous physical activity, it has been demonstrated that workers are at risk for decreasing sperm count possibly due to increasing mechanical trauma of testis and pelvic. Therefore, it seems that militaries and workers are more at risk for subfertility disorders, reduced semen quality due to specific working condition, and probably repeated physical trauma. These results are concomitant with those reported by (19,20).

Exposure to environmental hazard (mobile tower within fifty meters from their house) was associated with more SFA abnormalities (Teratozoospermia), OR = 2.6; 95% CI: 0.342–19.070. These findings go with those reported by (10,11) as they reported electromagnetic radiation (EMR) emitted by mobile cellular phones and their base station can affect semen analysis characteristics. The pathophysiological basis for the adverse effects on spermatozoa has been elucidated as being EMR-induced increased mitochondrial reactive oxygen species generation causing decreases in sperm vitality, while stimulating DNA base adduct formation leading, ultimately, to DNA fragmentation, so more sperm shape abnormalities (12).

Smoking hazard was associated with more SFA abnormalities (Teratozoospermia), OR = 1.7, 95% CI: 0.225–12.353. Cigarette smoking can be a somatic cell mutagen and a

carcinogen. Toxic substances such as nicotine, carbon monoxide, mutagenic pyrolysis-derived compounds, and cadmium can be absorbed during the inhalation of cigarette smoking. Toxic metabolites of cigarette smoking may impair spermatogenesis, resulting in the production of abnormal shaped spermatozoa. This finding agreed with those reported by Dai Lee and colleagues (21). In addition, cigarette-smoking can be correlated with increased levels of seminal oxidative stress (22,23).

6. Conclusions

Quality of semen might be affected by occupational and environmental exposures, so it seems that prevention of occupational and environmental risk factors, may lead to improvement of semen quality in subfertile men.

Recommendations

Further case-control studies and clinical trials are recommended to recognize subfertility causes in men in our population.

1. Additional analyses examining the environmental effects on reproductive health in our society, to assess the effect of other types of environmental hazards (such as living near a factory or exposure to pesticides in rural areas) on SFA are also important.
2. Change in lifestyle such as smoking cessation may lead to improvement of semen quality in subfertile men.

Conflict of interest

The authors declare that there are no conflict of interests.

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