Impact Of Lifestyle And Environment On Semen Quality: A Pilot Study Conducted In Infertile Men

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Abstract

Introduction: Lifestyle habits and exposure to environmental and occupational pollution have been linked to adverse reproductive outcomes, but their effects on male semen quality are still uncertain. Our aim was to assess the impact of these modifiable lifestyle factors on routine semen parameters according to the current World Health Organization guidelines.

Methods : A cross sectional study was conducted in our Laboratory including data of 180 men consulting for couple's infertility. All participants were interviewed and they provided semen samples. The interview included questions about demographics, socio-economic status as well as medical and surgical history. After that, a multi-item questionnaire was given to patients to outline their occupational exposure to harmful environmental and lifestyle factors (consumption of alcohol, smoking, cell phone use, sleep quality, prolonged sitting, shift Work, dietary habits, exposure to endocrine disruptors, physical activity). Then, we analyzed different semen parameters for each patient.

Results: The average age of our population is 36.1± 6, 7 years. A negative association was found between smoking and sperm vitality and mobility (p=0.005 and p=0.049 respectively).

We also identified evident association between poor quality of sleep because of non-standard shift work and sperm concentration (P=0.02). In fact, a strongly positive correlation was found between the number of hours of sleep and the increase of sperm volume (p=0.022). We also detected a negative association between sperm motility and long hours of sitting (P=0.006). Cell phone use and its placement in the pocket was negatively related to the sperm vitality.

Conclusions: Health programs focusing on smoking cessation are expected to have a positive impact on semen quality and consequently male fertility. Furthermore, poor sleep quality and sitting for long hours are associated with increased semen perturbations. Thus, patients should also be recommended to control their sleep hygiene and physical activity.

INTRODUCTION:

Infertility is a worldwide problem. It affects up to 15% of all couples trying to conceive, with male infertility as the sole cause in 20%–30% of cases (1).

A decline in semen quality has been observed over the recent decades, including a reduction in semen count, volume, motility, and morphology (2). Consequently, the World Health Organization (WHO) has lowered the accepted values for classic normal sperm parameters (3). Some authors have suggested that this decline in sperm quality is associated with the observed decrease in fertility; regarding this, it is essential to understand the causes of the decrease in sperm quality (4).

Several reports have prompted interest in the potential impact of environment and lifestyle on male fertility potential. It has been suggested that the decline in semen quality in addition to several specific chronic diseases (5, 6), is most probably caused by environmental rather than genetic factors (2, 7). Considerably, there is a concerning link between a decreased semen quality and various lifestyles and environmental factors including diet, exercise, obesity, non-standard shift work, smoking, exposure to electromagnetic radiation, polycyclic aromatic hydrocarbons or heavy metals, and air pollution, and a decreased semen quality (8, 9). Furthermore, the exposure to toxic pollutants present in the environment, as well as other job-related factors, may negatively affect male fertility in humans (10,

7).

Sokol et al (11) reported that men exposed to high levels of pollution have a higher percentage of teratospermia, decreased motility and increased sperm DNA damage. In addition, patients who are in contact with pesticides, which mimic human hormones, leading to a decrease in spermatogenesis and, in some cases, to oligozoospermia. Also, contact with heat sources may result in an increase in the scrotal temperature and therefore, a decrease in sperm production and an increase in the number of spermatozoa with abnormalities (1, 12). In order to provide further information on these controversial lifestyle habits and environmental factors, we analyzed the possible association of smoking habits, harmful occupational exposure, sleep quality, long hours sitting, electromagnetic radiation, physical exercise, and body mass index (BMI) with several semen parameters among men supervised in our Andrology exploration Laboratory.

Therefore, the aim of the present study was to determine the relationship between the previously cited factors on human semen characteristics in view of the new 2010 WHO criteria (13) for the laboratory examination of human semen among infertile men referred to our center.

MATERIALS AND METHODS:

Study group:

The present study is a cross sectional one conducted between July 2019 and January 2020 in our Laboratory of Reproductive Biology. The population included in this study was all infertile men aged between 20 and 55 years who referred to our center and agreed to participate in this study. Data collection tools included demographic interrogatory with medical history, lifestyle habits and environmental factors questionnaire which was filled by the participants and spermogram indices data sheet.

The protocol of our study was approved by the local ethics committee of the hospital. Indeed, patients were assured of the confidentiality of all information as a written informed consent was signed by all subjects.

Information about environmental, lifestyle factors

Men who give their consent were asked to complete a questionnaire on the day of semen collection for routine semen analysis. The questionnaire aimed to report their age, sociodemographic characteristics, the length of sexual abstinence, height, weight and to provide information on their profession as the shift work or exposure to any other factor, medical and surgical history, and lifestyle factors as smoking, alcohol, cell phone use and his placement in the pocket, sleep quality, prolonged sitting and its duration in hours per day, dietary habits, practice of physical exercise and occupational exposure to pesticides, heavy metals, atmospheric pollutants as polycyclic aromatic hydrocarbons, heat sources, ionizing radiation, endocrine disruptors.

Regarding the exposure to endocrine disruptors (ED), were identified shampoo brands, shower gel, deodorant, perfume, hair gel, lotions used by patients and their frequency of use. An in-depth study of their composition was made and were identified the various components in each product and for each patient, after that, we have retained for each patient the list of reprotoxic substances regulated at european level by the European Agency for Safety and Health at Work; 2016 (14); The list of substances that may have reprotoxic potential, as endocrine disruptors offered by various institutions around the world (15).

This allowed us to identify patients exposed to ED as well as those with high exposure. The high exposure was defined by a high degree of harmfulness, a high content of ED or a combination of several ED.

The non inclusion criteria were as follows: using infertility-related medication during the past 3 months, incidence of psychological illness according to the patient's statement or record of the patient, having urinary tract infection or genital infection, and history of varicocele or varicocelectomy, severe diseases, mumps or undescendent testis and no ability to read and write. All leukocytospermia (concentration ≥ 1x106/ml) were excluded from this study. Azoospermic and severe oligospermic men were not excluded from the study but we excluded the history of genetic abnormalities explaining male infertility such as karyotype abnormalities (micro deletions of the Y chromosome, gonosomal aneuploidies, balanced genetic abnormalities), hypogonadotropic or hypergonadotropic hypogonadism, hormonal disorders and syndromic sperm abnormalities, in particular monomorphic teratospermia,

Sperm collection and semen analysis:

Semen analysis was performed according to WHO 2010 criteria (13), and it is supervised by internal and external quality controls. Samples were obtained by masturbation after 2–5 days abstinence. After liquefaction at 37C, semen samples were analyzed, no longer than 1 hour after

ejaculation. Semen volume (ml) and pH were measured. Sperm motility (%) was classified into total motility(TM) and progressive motility (PR). Vitality (%) was analyzed by Eosin Nigrosin method. Samples were diluted in order to analyze the sperm concentration (×106 /ml) and round cell count (×106 /ml) after incubation in the Malassez chamber. Then, air-dried seminal smears were fixed and stained with Shörr staining procedure and sperm morphology was evaluated according to the criteria proposed by David and adapted by Auger using a ×100 oil-immersion bright field objective (13).

Leukocyte concentration was determined when round cell concentration was > 1 x 106 by mixing 20 µl of semen sample with 20 µl of working solution of leucocyte stain (LeucoScreen; Ferti Pro), according to the manufacturer's instructions. The number of peroxidase-positive cells which stain yellow or brown is counted under 400× magnification.

Semen parameter cut-off values (lower reference limits) established by the WHO manual (fifth edition)(13) were as follows: semen volume (1.5 ml), sperm concentration (15 million/ml), motility (32%PM, 40%TM), vitality (58%), morphology (15 % normal forms according to David modified classification), round cells (<1 x106/ml).

Statistical analysis

Statistical analysis was performed using SPSS 20.0 .Descriptive statistics including frequency distribution as well as central and dispersion indices such as mean and standard deviations were used to describe lifestyle habits, environmental factors and demographic characteristics. Pearson's correlations coefficients were used to determine the relationship between lifestyle characteristics, environmental factors and several spermogram parameters. Significance level for statistical tests was considered less than 0.05.

RESULTS:

Study population

A total of 180 patients met the inclusion criteria and were included in this study. Their demographic characteristics are presented in table 1. The average age of the patients was 36, 1 ± 6, 7 years .Most of our patients (69%) work as active military ranging from soldier to senior officer, 77% of patients had primary infertility and 23 % secondary infertility. Their duration of infertility was 3, 71 ± 3, 39 years. The abstinence before the semen analysis was 3 to 5 days in all patients.

Environmental and lifestyle factors among study participants

The average of the overall lifestyle modifiable factors and occupational exposures of 180 participants in this analysis are shown in table 1.

Most of the study participants (64%) were overweight (BMI 25–29.9 kg/m2) and 10% were obese (BMI >30kg/ m2), whereas 26% had normal weight (BMI 18–24.9 kg/m2); 53%of participants were smokers with an average number of cigarette packs per year of 15.96±11.86. Regular alcohol consumption was noted in 14% of cases.

As for sleep quality and non-standard shift work, 34%of patients had irregular sleep and 74% of patients were on night shifts with an average number of 6.58±3.74 night shift per month.

The leisure time physical activity was reported by 58 % of the study population and only 20% had regular physical activity more than twice a week. Prolonged sitting of more than 4 hours per day was noted in 66% of patients.

The use of the cell phone and the average duration of its being in the pocket was 11.09±4.79 hours for all men. Of the study population, 67% had an equilibrated dietary and sufficient fluid intake. In addition, the patients had been particularly exposed to occupational factors such as atmospheric polluants in 77% (fume) and heat in 60% of cases. For other factors, exposure to solvents was documented in 24% , pesticids in 11%, while exposure to heavy metals, hydrocarbons and ionizing radiation were noted in 37%,31% and 13% respectively.

The exposure to endocrine disruptors was documented in 77% of patients of which 38% had high exposure as defined above.

Standard semen parameters analysis

Table 2 represents the means and standard deviations of the main sperm parameters among infertile patients. According to WHO 2010 guidelines [14], 9 % of the participants had normal sperm characteristics, while 83% had teratozoospermia and 7% had severe oligoasthenoteratospermia.

Association between modifiable lifestyle factors and semen quality

Based on Pearson correlation, there was no significant statistical relationship between the male age and BMI with all spermogram indices ($p > 0.05$).

Regarding smoking, a significant negative relationship was observed with both sperm vitality ($r=-0.421$; $p = 0.005$) and sperm motility ($r=-0.302$; $p=0.049$) (Table 3), whereas, a positive and statistically significant association was observed between alcoholism and sperm vitality ($r=0.23$; $p=0.038$). Poor sleep quality because of non-standard shift work was associated with lower semen concentration($r=-0.24$; $p=0.023$). Adding to that, a positive correlation was found between the number of hours of sleep and the increase of sperm volume ($p=0.022$).

No significant correlation was found between leisure time physical activity and any semen parameters but long hours of sitting are associated with an increase of asthenospermia ($r=-0.301$; $p=0.006$). Cell phone use and its placement in the pocket was negatively related to the sperm vitality.

Furthermore, no significant relationship was noted between other occupational exposure to harmful factors as atmospheric polluants, heavy metals, hydrocarbons, solvants, ionizing radiation, heat, endocrine disruptors, and dietary habits, and spermogram indices.

Table 1

Characteristics of the study population

Characteristics	N (%)
Age ans	
24- 30	(38)21.1%
30-40	(94)52.2%
40- 54	(48)6.4%
Mean (SD)	36.1±6.7
BMI [kg/m2]	
18–24.9	66(26%)
25–29.9	96(64%)
30–35	18(10%)
Mean (SD)	26.5±2.8
Median (min–max)	18.9-34.9
Smoking	
No	84(47%)
Smoker	96(53%)
mean number cigarette packs/ year	15,96±11.86
Alcohol	
1/month	40(22)
1/week	30(16)
4–7/week	26(14%)
Leisure time activity	
No	76 (42%)
>2/month	68(38%)
>2/week	36(20%)
Long hours sitting/ day	
<4 hours	62(34%)
>4 hours	118(66%)
Sleep quality	
Irregular sleep	62(34%)
Night shifts	134(74%)
mean number night shifts /month	6.58±3.74
Cell phone use	180(100%)
mean duration in the pocket	11.09±4.79
Dietary habits	
balanced diet(intake of vegetables and fluid)	120(67%)
Occupational factors	
atmospheric polluants(fume)	138(77%)
heat	108(60%)
solvents	44(24%)
pesticids	20(11%)
heavy metals	66(37%)
Endocrine disruptors	138(77%)
High exposure to ED	68(38%)

BMI: body mass index; ED : endocrine disruptors

Table 2

Means of conventional semen parameters of patients

	Patients Mean ± SD	Min-max
Volume(ml)	3.11±1.56	0.8-8
Progressive motility (a+b) %	29,02±12.68	0-50
Total motility(a+b+c) %	34.37 ± 13.09	5-55
Concentration (million/ml)	48.64±55.58	0-400
Vitality %	76.6±16.28	16-97
Typical forms%	7.76±5.85	0-24
TZI	1.86±0.4	1.18-3.17

Table 3

The association between modifiable lifestyle factors and semen parameters

Main semen parameters	Coef (*p* value)
Volume (ml)	
Smoking	-0.38 (0.72)
Number of hours of sleep	0.245(0.022)*
Night shifts	0.191(0.07)
Motility (%)	
Smoking	-0.302(0.049)*
Llong hours sitting	-0.301(0.006)*
Vitality (%)	
Smoking	-0.421(0.005)*
Alcholism	0.23(0.038)*
Cell phone use/pocket	-0.257(0.02)*
Concentration (Million/ml)	
Smoking	-0.035(0.74)
Irregular sleep	-0.24(0.023)*
Long hours sitting	-0.019(0.86)
Typical forms	
Smoking	-0.072(0.52)
Heat	-0.112(0.32)
Atmospheric polluants (fume)	-0.173(0.12)
Long hours sitting	-0.077(0.49)
Night shifts	-0.049(0.71)

*(*P-value < 0.05, significant association)*

DISCUSSION:

Several lifestyle factors may have a notable influence on semen quality and male fertility potential, since many independent studies have showed an association with poor semen quality and impaired fertility.

This study seems to be the first on Tunisian infertile men and was designed to determine the relationship between infertile men's lifestyles and sperm parameters.

These results presented here are in agreement with previous studies which suggested that lifestyle factors may affect semen quality, In fact, Both alcohol consumption and cigarette smoking have been proposed to negatively impact male fertility and subsequent reproductive outcome (16). However, their effect on routine semen parameters remains controversial; our results suggest that cigarette smoking was associated with reduced sperm vitality and motility.

Previous studies done on men of all ages have revealed contradictory results, reporting a deleterious effect of smoking on sperm quality including motility, sperm concentration (17) and morphology, which are the parameters most frequently used in clinical settings to assess fertility (18). However, the evidence has not been unequivocal, and some studies have not come up with any relation to semen quality (19, 20).

A recent metaanalysis (21) concluded that smoking may have an overall negative effect on semen parameters and these effects were overall more pronounced in infertile men than in the general population. In addition, the deterioration of semen quality was particularly associated with moderate and heavy smoking. The pathophysiological mechanisms, thus, involved in the smoking-subfertility link, as described in the literature are: hematotesticular barrier crossing of cigarette metabolites, oxidative stress production responsible for cytoplasmic membrane alteration and DNA damage in sperm (22).

Studies linking alcohol intake with semen quality have shown contradictory results. Some suggested no association (23; 24), whereas, others suggested a negative association between alcohol intake and semen quality (25). In the present study, we identified a relationship between alcohol drinking and an increased percentage of sperm vitality which is in line with results of other studies that outlined an apparent protective effect of moderate alcohol drinking on sperm parameters (26, 20) . In fact, it is known that beer and wine contain polyphenols such as resveratrol or xanthohuminol, which therapeutic and cellular protection potentials have been, demonstrated (23).

Our findings suggest that irregular sleep quality caused by non-standard shift work may lead to a decreased sperm concentration. Accordingly, a positive link was found between the number of hours of sleep and sperm volume. These results are in agreement with previous studies which suggested that male infertility was associated with shift work (27) and which clains that shift work was not directly associated with semen quality but workplace exertion was. In a study including 255 infertile and 267 fertile men, male infertility was more likely to be observed among shift workers (28). Limited littérature have been provided

regarding the mechanism of decreased fertility among individuals who work in shifts. Recent studies have suggested the role of circadian rhythm disturbances as a function of shift work schedules is related to disruption of the brain-gonadal axis that can ultimately lead to infertility. Ortiz et al (29) suggested the detrimental role of serotonin on male reproductive health as higher levels of urinary 5-hydroxyindoleacetic acid (HIIA), were registred among infertile male shift workers compared to shift workers who recently fathered children. Indeed, higher 5-HIIA levels were negatively associated with sperm concentration and motility. Serum markers such as serotonin, as indirectly measured by urinary 5-HIIA, may reflect the neuroendocrine imbalances associated with male infertility among shift workers (30). Adding to that, when assessing the relationship between sleep quality and hypogonadal symptoms, Pastuszak et al (31) highlighted a significant linear association between self-reported sleep quality and androgen deficiency in the aging male scores (P ¼ .008). In fact, respondents who were “very satisfied” with their sleep quality had higher scores than those who were “somewhat dissatisfied” with their sleep quality (P ¼ .02). While there is no consensus regarding the effects of non-standard shift work on serum testosterone levels, a clear evidence supporting more severe symptoms of hypogonadism in non-standard shift workers with poor sleep quality and shift work sleep disorder exists(30).

Long hours of sitting were also identified as a risk factor to decreased sperm motility. Our results are in line with a study conducted by Hjollund et al (32) on 60 volunteers, who measured scrotal temperature profiles for 3-days and showed variation of scrotal temperatures during periods of sedentary work were 0.7 ° C higher compared to other times of the day. This link between prolonged sitting position and motility could be explained by thermal stress induced by this position which would negatively impact spermatic parameters (33).

In the present study, a negative relationship between cell phone use and daily duration of its placement in the pocket and sperm vitality was observed. This is in line with some studies (34;35) showing that cell phones used for longer durations adversely affected the quality of semen by decreasing the sperm counts, motility, viability, and morphology (34). Also, men who carried their mobile phone in their hip pocket or on their belt had lower sperm motility (35). Cell phone radiation has been shown to induce oxidative stress and consequently alteration of cytoplasmic membrane and sperm DNA damage, and these abnormalities appear to be directly related to the duration of the cell phone use(34).

Air pollution is widely known to have adverse effects on human health. Sokol et al. (11) reported that men exposed to high levels of pollution have a higher percentage of teratospermia, decreased motility and increased sperm DNA damage.

In the recent meta-analysis of Pizzol et al [36], 22 studies are included showing that environmental and occupational pollutants may affect sperm count, volume, concentration, motility, vitality and sperm DNA, and chromatin integrity. All included articles reported significant alterations in at least one of the outcomes studied in association with at least one of the pollutants studied.

Notwithstanding the fact that a large body of evidence on the negative role of pollutants on semen parameters, we could not depict any significant correlation with atmospheric polluants as fume, heavy metals, hydrocarbons, solvents, or pesticides and main sperm characteristics

However, there was no relationship between the male age or increased BMI and all spermogram indices ($p > 0.05$), Regarding male aging impact on sperm quality, some studies have shown an association between male aging and semen quality, others are in agreement with our results and have reported no relationship (37, 38).

Our findings align with a metaanalysis of 31 studies that found no evidence of any association between increased BMI and semen parameters (39).

Our results showed no significant correlation between dietary habits or exposure to endocrine disruptors, and semen parameters.

Semen quality has been studied as an important variable in determining the negative effects caused by PE [40]. A meta-analysis published by Carlsen et al demonstrated a significant decrease in average sperm concentrations from 113 to 66 million / ml, but, during this period, other confounding factors, such as period of abstinence, sperm morphological analysis, age and fertility were taken into consideration with regard to the decrease in sperm quality, although that they have not been proven sufficient for a definitive conclusion [41].

Our study had several strengths. The cross-sectional and

analytical nature of the study with well-specified and complete data for all patients. It is the first study in Tunisia which was interested in studying the impact of environmental and lifestyle factors on sperm parameters.

Our patient sample can be considered representative as it identified all patients referred to our laboratory for spermiological exploration during the study period and its size studied is sufficient to have statistically reliable results.

Nevertheless, this study has some limitations: the majority of our patients are soldiers who have a very particular standardized habits and lifestyle. Thus, a sample bias might have been generated and it may be therefore necessary to conduct a multicenter study on the population.

Data from the present study outlined a significant effect of modifiable lifestyle factors (smoking, alcohol drinking, cell phone use, long hours sitting, and irregular sleep quality caused by non-standard shift work) on semen quality. These findings stress the need for some lifestyle modifications in order to improve semen quality and fertility potential.

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