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Body mass index and impact on semen quality of men attending an infertility clinic

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ABSTRACT

Background: The reproductive consequences of lifestyle factors in men are still controversial. In this prospective study, we verified the impact of body mass index alterations on semen parameters of patients who attended an infertility clinic.

Materials and Methods: Semen samples from 156 subjects aged 22 to 53 years were analyzed. Smokers were categorized as mild (≤ 10 cigarettes/day), moderate (10-20 cigarettes/day") and heavy smokers (> 20 cigarettes/day"). Men were grouped based upon calculated body mass index values (underweight, <18.5 Kg/m2; normal, 18.5-24.9 Kg/m2; overweight, 25-29.9 Kg/m2 ; obese, ≥ 30 Kg/m2). The data collected included patient height and weight, semen volume, sperm concentration, percent sperm motility, percent sperm morphology (normal forms).

Results: Body mass index did not significantly affect ejaculate volume and sperm concentration. Overweight and obese men showed a percentage of progressive motility (medians 20% and 10%, respectively) significantly lower than that reported in normal-weight men (median 30%; p=0.0043).

Conclusion: Our results suggest that lifestyle factors as obesity could play a major role in male infertility.

Keywords: lifestyle factors; BMI alterations; male infertility; IVF.

SOMMARIO

Background: Le conseguenze riproduttive dei fattori legati allo stile di vita negli uomini sono ancora controverse. In questo studio prospettico noi abbiamo investigato l'impatto delle alterazioni del Body Mass Index sui parametri seminali in pazienti afferenti ad un servizio per la cura della sterilità.

Materiali e Metodi: Sono stati analizzati i campioni seminali di 156 soggetti di età compresa tra 22 e 53 anni. I fumatori sono stati classificati in lievi (<10 sigarette/die), moderati (10-20 sigarette/die) e forti fumatori (>20 sigarette/die). Gli uomini studiati sono stati suddivisi in gruppi in base ai valori di Body Mass Index (sottopeso <18.5 kg/m2; normopeso 18.5-24.9 kg/m2; sovrappeso 25-29.9 kg/m2; obesi >30 kg/m2). I dati raccolti comprendevano altezza e peso, volume seminale, concentrazione nemaspermica, percentuale di motilità nemaspermica, percentuale di morfologia nemaspermica (forme normali).

Risultati: I valori di body mass index non alteravano significativamente il volume di eiaculato e la concentrazione nemaspermica. I pazienti in sovrappeso ed obesi mostravano percentuali di motilità progressiva (mediana 10% e 20% rispettivamente) significativamente inferiori a quelle ritrovate negli uomini normopeso (mediana 30%; p = 0.0043).

Conclusioni: I risultati del nostro studio suggeriscono che i fattori legati allo stile di vita, come l'obesità, possono giocare un ruolo primario nella sterilità maschile.

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INTRODUCTION

It has been estimated that approximately 15% of the population in industrially developed countries are affected by infertility[1]. The most common causes of infertility are different and include ovulatory disorders, tubal disease, endometriosis, male factor and unexplained infertility. In 2010, a report of the "European Society of Human Reproduction (ESHRE) Task Force on Ethics Law" focused on the impact of lifestyle on reproductive potential, ART results , outcome of pregnancies and health of the conceptus[2]. There is an increasing body of evidence that lifestyle factors can contribute to subfertility. These factors include delayed child bearing, obesity, not exercising or exercising excessively, inappropriate diet, smoking, psychological stress, alcohol and/or caffeine consumption, and exposure to environmental pollutants and chemicals[3,4]. In recent years, the impact of smoking and obesity on reproductive performance has been evaluated[5]. The adverse effects of a high body mass index (BMI) on female fertility, are well known. Excess body weight has been associated with an increased rate of polycystic ovary syndrome, menstrual cycle disturbances, infertility, miscarriage, infertility treatment failure and multiple complications of pregnancy including gestational diabetes, pre-eclampsia, macrosomic fetus and cesarean delivery[6-7]. The reproductive consequences of lifestyle factors in men, however, have been studied to a lesser extent and literature data are controversial. Obesity in men leads to an altered reproductive hormonal profile characterized by decreased testosterone and sex hormone-binding globulin (SHGB) levels, increased estradiol levels and, in morbidly obese men, alterations in gonadotropin secretion[8]. The association of body weight with standard semen analysis parameters or male fertility has been examined in multiple studies with inconsistent results[9-12].

In order to verify the impact of BMI alterations on male reproductive potential, we evaluated semen quality in male partners of infertile couples undergoing in vitro fertilization techniques.

MATERIALS AND METHODS

Patients

A cohort of (300) male partners of couples undergoing conventional in vitro fertilization (IVF) or intracytoplasmic sperm injection (ICSI), after signing an informed consent, were initially recruited in a prospective observational study at the Reproductive Medicine Unit, University of Palermo, Italy, from the beginning of 2015 to the end of 2016. For each subject, medical history was assessed using a questionnaire paying a particular attention to any previous genital disease, smoking habits and anthropometric measurements (weight, height and BMI).

All men were assessed by general and genital physical examination, CDUS (Color Doppler Ultrasound) and semen analysis.

Smoking habits were investigated and categorized as "non smokers", "mild" (≤ 10 cigarettes/day), "moderate" (10-20 cigarettes/day) and "heavy smokers" (> 20 cigarettes/day).

Men were divided into 4 groups according to their BMI following reference values proposed by the World Health Organization (2000) (13): BMI <18.5 Kg/m2; BMI ≥ 18.5 and <25 Kg/m2; BMI ≥25 to <30 Kg/m2 and BMI ≥ 30 Kg/m2.

According to the previous information and in order to reduce potential confounding factors, 144 men meeting the below reported criteria were (excluded) from the study:

a) azoospermia
b) disorders of the reproductive organs as well as varicocele, abnormal location of the testes, torsion of the testis and history of severe trauma
c) previous surgery on the genital and pelvic area, including vasectomy, orchidopexy and hernia surgery.
d) exposure to particular environmental factors known to compromise semen parameters, such as pesticide factory workers or welders.
e) moderate and heavy smoking

Thus, a total of 156 subjects aged 22 to 53 years (age average 36.9 ± 5.8) were included in the study and considered in the statistical analysis.

Semen of all patients was collected into a sterile container and analyzed within one hour of production.

The study was approved by the Institutional Review Board of the University Hospital "P.Giaccone" of Palermo.

Semen Processing

Semen samples were obtained by masturbation after 3-5 days of sexual abstinence. After liquefaction at room temperature, ejaculate volume, sperm concentration, motility and normal morphology were assessed by a Zeiss microscope according to the World Health Organization guidelines for semen analyses (WHO 2010)[14]. Semen volume was measured in a graded tube with 0.1 ml accuracy. Sperm concentration was

counted in a Makler chamber. Sperm motility was assessed by grading the sperm cells as either progressive motile (grade a and b) or immotile (grade c and d). Sperm morphology was studied on Papanicolaou stained smears, counting a minimum of 200 spermatozoa using oil-immersion lens (100x magnification). A single semen sample was collected from each man. Sperm analysis was performed in one single centre and in one laboratory.

Statistical analysis

The statistical analyses were performed using the R statistical software package (R Development Core Team. R statistical software package, version 2.13.0, 2011)[15]. Two sided tests were used and p-values of <0.05 were considered to be statistically significant. Absolute and relative frequencies were calculated for qualitative variables. Quantitative variables were evaluated for normality of distribution (Shapiro-Wilk test p>0.05) and summarized as mean (standard deviation) when normally distributed, otherwise as median (interquartile range). The Kruskal-Wallis test was used for comparisons between groups.

RESULTS

A total of 156 semen specimens were analyzed as described. **Table 1** summarizes the general characteristics of the 156 men included in the study and stratified according to the BMI categories.

81/156 subjects (52%) were overweight or obese and a large majority of them had never smoked (71%). **Table 2** summarizes the semen characteristics. Overall, 27% of men (42/156) had a normal semen analysis while 34% (53/156) had a sperm concentration below 15 million/ml, 61% (96/156) had less than 32% motile sperm and 15.3% of men (24/156) had less than 4% normal morphology sperm.

As depicted in **Figure 1**, BMI was not statistically significantly associated with ejaculate volume and sperm concentration. Nevertheless sperm concentration in obese men was below the WHO threshold (althought this was not significant) and lower than in overweight and normal weight men (medians 14 x 106 vs 32 x 106 and 30 x 106 cells/ml, respectively; p=0.13).

The distribution of sperm motility showed a statistically significant negative association with BMI (p=0.0043): overweight and obese men showed a percentage of progressive motility

Table 1.
General characteristics of men included in the study.

	Study population (N=156)		
A) Anthropometrics parameters			
	Age in years, mean (SD)	36.9	(5.8)
	Height in cm, mean (SD)	174	(7.1)
	Weight in Kg, median (IQR)	75	(69-85)
	BMI, mean (SD)	26.1	(3.9)
	BMI categorization, N (%)		
	- <18.5 1 (0.65)	1	(0.65)
	- 18.5 to <25	73	(47.15)
	- 25 to <30	55	(35.48)
	- ≥30	26	(16.77)
B) Smoking habits, N (%)			
	- Non smokers	111	(71.15)
	- ≤10 cigarettes/day	45	(28.85)

Table 2.
Semen parameters of men included in the study (N=156).

Volume (ml) , median (IQR)	3	(2.1-4.6)
Sperm concentration (10 median (IQR)	27.5	(6- 61.5)
Type a, b motility %, median (IQR)	20	(0.5-40)
Abnormal morphology %, median (IQR)	70	(60-93)
Normozoospermic samples, N (%) 42 (27%)	42	(27%)
Oligozoospermic samples, N (%) (< 5° pctl WHO)	53	(34%)
Asthenozoospermic samples, N (%) (<5°pctl WHO)	96	(61%)
Teratozoospermic sample, N (%) (<5°pctl WHO)	24	(15.3%)

(medians 20% and 10%, respectively) lower than that reported in normal-weight men (median 30%). No statistically significant difference was observed between BMI and abnormal morphology ($p<0.001$).

DISCUSSION

Among the factors influencing the semen quality, lifestyle factors like BMI alterations have attracted much attention in recent times.

Study of semen parameters as well as ejaculate volume, sperm motility, sperm count and sperm morphology have conventionally been used to assess the semen quality even if none of these parameters can be considered diagnostic of infertility. In our study we investigated the influence of BMI on the four main semen variables by evaluating the semen samples of patients who attended our infertility clinic.

Several studies have linked male obesity to poor semen quality raising concerns about its possible role in male infertility[9,12,16,17]. In our study, we observed a not significant reduction in sperm concentration in obese men, which is the most consistent finding across the studies[13,18,19]. In addition, a statistically significant inverse association between BMI and progressive motility was found. In contrast with literature data, no statistically significant difference was observed between BMI and abnormal morphology.

This finding is probably due to the small sample size of cohort evaluated. Unfortunately, the mechanism explaining the relationship between obesity and male infertility is not fully understood and several hypotheses have been proposed. Among these, higher DNA fragmentation indexes

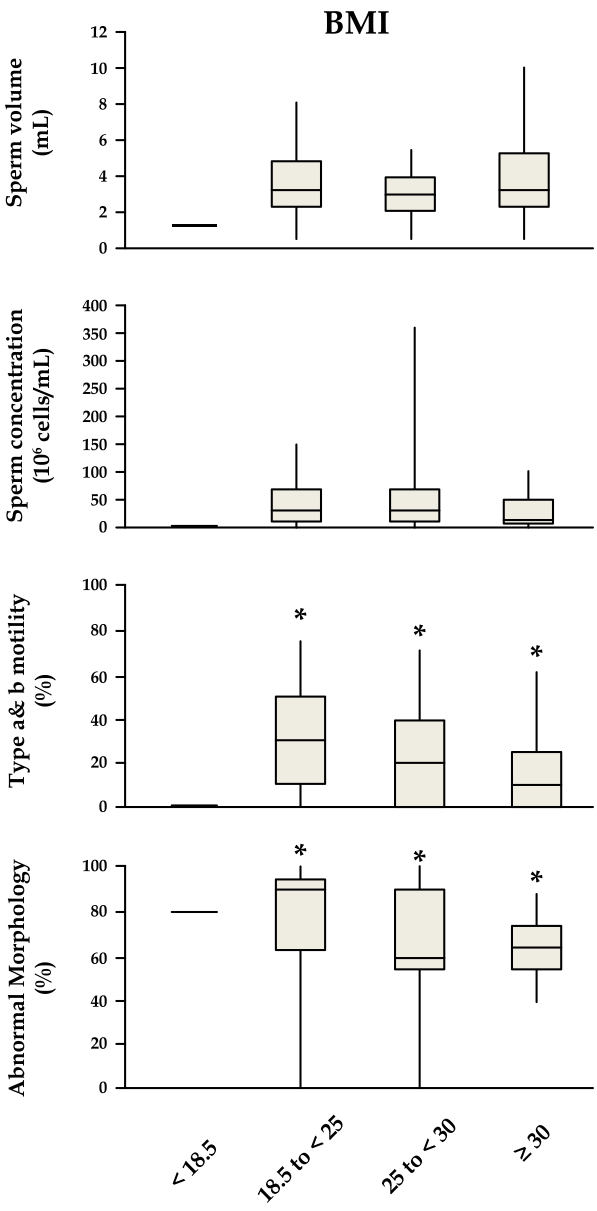

Figure 1.
Distribution of the semen parameters (medians) stratified by BMI.
** Statistically significant (Kruskal-Wallis test)*

in obese males[20], increased oxidative stress[21], and hormonal imbalance[22] have been suggested as possible mechanisms of obesity-associated subfertility.

CONCLUSION

Our results suggest that modifiable risk factors as obesity could play a major role in modifying the quality of semen parameters.

Our study may suffer from some possible limitation, first, it has been performed in males of infertile couples, which limits its external validity

with the consequence that the results cannot be extrapolated to the general population. Further studies including larger sample sizes and collecting more accurate informations on the simultaneous presence of other lifestyle risk factors may need for better elucidating our findings.

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