Original Article

Body Mass Index and Sperm Quality: Is there a Relationship?

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Abstract

Context: Obesity and infertility are the major global public health problems. The evidences of adverse impact of adiposity on male fertility are contradictory. **Aim:** The objective of the study was to determine the effect of overweight and obesity on ejaculate quality, in particular, sperm parameters and biochemical markers. **Subject and Design:** The study involved 152 men who were distributed into three groups according to the body mass index (BMI, kg/m^2): control group with normal values (18.5–24.9), preobese (25.0–29.9), and obese (≥30.0). **Materials and Methods:** Semen analysis included parameters: volume, sperm concentration and total count, morphology, progressive (PR) and total motility. Levels of fructose, citric acid, and zinc were measured in seminal plasma. **Statistic:** The results of the studies were analyzed using StatPlus: mac (AnalystSoft Inc., version 6)**.** The Mann–Whitney U-test was used to compare groups. Pearson's correlation coefficient was calculated. $P < 0.05$ was considered statistically significant. **Results:** No significant differences of the semen parameters were observed between preobese and control group, except for increasing the number of abnormal spermatozoa. The obese group revealed lower concentration and total number of sperm, PR motility. BMI was negatively correlated with most semen parameters. The overweight group showed a decreasing of fructose levels and increasing of citric acid and zinc concentration, while no significant changes were observed in the obese group, except for a decreasing in fructose. **Conclusions:** The present study confirms that with the growth of BMI, the sperm quality deteriorates. Based on these results, we can assume that obesity may be an injurious factor of male infertility.

Keywords: *Body mass index, infertility, obesity, overweight, sperm*

Introduction

Obesity and infertility are the major global public health problems. In 2016, it was stated by the World Health Organization (WHO) that 39% of the population aged 18 years and older were overweight, and about 13% of the adults were obese. Notably, the proportions of men in these two cases were 39% and 11%, respectively.[1]

The exacerbation of this situation had led to the development of a comprehensive guideline of male infertility which was prepared by the WHO in 2012.[2] The working group also analyzed the research data which supported the potential influence of obesity on the reproductive function. Accordingly, it was founded that supporting evidence of this theory was conflicting. In particular, Sermondade *et al*.[3] suggest that overweight and obesity in men was associated with rise of azoospermia and oligozoospermia, while one of the largest meta-analyses in this area by MacDonald

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et al.[4] reports no correlation between body mass index (BMI) with sperm concentration and sperm count.

However, the WHO experts strongly recommended that men with fertility problems should be advised on a weight loss strategy if their waist circumference and BMI demonstrated the overweight or obesity.[2]

It is known that many infertile couples seek help in specialized clinics. Today, the range of assisted reproductive technologies is quite wide, but the effectiveness of their application depends on many factors. In particular, research results have suggested that paternal obesity adversely affects clinical pregnancy rates after *in vitro* fertilization.[5,6]

In addition, recent studies have affirmed that weight loss in obese men is affiliated with an improvement in sperm parameters; however, it is difficult to investigate the direct negative impact of BMI growth on the ejaculate quality.[7,8]

Therefore, the aim of the presented work is to establish the effect of overweight and obesity on sperm counts and biochemical parameters of male ejaculate quality. Given the discrepancies in the results of various studies that inspected the effects of obesity on male fertility,[3,4] and the tendency to decreasing in the sperm quality in the population,[9] further investigations are required.

The present work is aimed to establish the effect of overweight and obesity on sperm parameters and biochemical markers which display the ejaculate quality.

Materials and Methods

Patients

The study included 152 men who were observed for infertility at a reproductive clinic during 2018. BMI was computed for each patient (BMI, kg/m^2). Based on these data, three groups were formed: normal (18.5–24.9), overweight or preobesity (25.0–29.9), and obesity (≥30.0). Patients with any disorders of the reproductive system (congenital pathologies, varicocele, epididymitis, prostatitis, and postoperative conditions) were excluded from the study.

Semen analysis

Semen samples were obtained by masturbation after 2–7 days of sexual abstinence in a special clinic room. The material was collected into sterile containers.

The ejaculate was evaluated after dilution in accordance to the WHO Guidelines 2010[10] and included parameters: volume, sperm concentration and total count, progressive (PR) and total motility (PR + nonprogressive), immotile spermatozoa, percentage of normal morphological forms, and concentration of white blood cells. Patients with leukospermia (>1 × 10^6/ml) and azoospermia were excluded from the study. The main sperm parameters were determined using the sperm quality analyzer SQA-V V. 2.47 (Medical Electronic Systems Ltd, Caesarea Industrial Park, Israel).

Biochemical markers of seminal plasma were determined by spectrophotometry using the biochemical analyzer BioSystem (Biosystems S.A., Barcelona, 2011) and included fructose,[11] citric acid,[12] and zinc.[13]

Ethics

We undersign, certificate that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008 (5), as well as the national law.

Statistical analysis

The results of the studies were analyzed using StatPlus:mac LE software, version 6.1.25 (StatPlus:mac, AnalystSoft Inc., 2016). The Mann–Whitney U-test was used to compare groups. The data were expressed as median and range (minimum–maximum value). Pearson's correlation coefficient was also calculated. $P < 0.05$ was considered as statistically significant.

Results

This study involved 152 men, aged 21–53 years, who were included in the control and two study groups, depending on the BMI. The clinical data and routine sperm parameters of the study groups are described in Table 1.

No significant differences of the semen parameters were observed between patients with overweight and control group, except for an increasing in the number of pathological forms of sperm. Whereas in the obesity group revealed a significant deterioration of sperm quality, in particular, lower concentration and total number of spermatozoa in ejaculate and lower PR motility.

The biochemical analysis of seminal plasma [Table 2] in the preobesity group showed a decreasing of fructose levels (μmol/ejaculate) by 23% compared to the control group ($P < 0.05$), increasing in citric acid (μmol/ejaculate) levels by 27%, and higher zinc concentration (μmol/L) by 20% compared to the control group ($P < 0.05$). On the other hand, no significant changes in biochemical parameters were observed in the obesity group, except for a decreasing in fructose concentration compared to the control group.

Correlation analysis revealed a tendency for increasing in BMI value with growing age of men ($r = 0.36$;

Table 1: Clinical and main sperm parameters in groups

Parameters	Control group (*n*=63)	Preobesity (*n*=66)	Obesity (*n*=23)
Age (years)	30.0 (21.0-49.0)	31.5 (23.0-56.0)*	37.0 (25.0-53.0)*
BMI (kg/m^2)	22.5 (18.5-24.4)	27.7 (25.1-29.8)*	33.0 (30.1-41.1)*
Volume (mL)	4.2 (2.0-8.5)	3.5 (1.0-9.5)	3.0 (1.0-9.5)
Sperm concentration (million/mL)	54.5 (6.0-185.5)	44.5 (2.4-269.0)	40.6 (2.5-126.8)*
Total sperm count (million/ejaculate)	206.8 (15.0-165.0)	136.1 (8.4-1023.0)	120.6 (12.5-378.0)*
PR (%)	45.0 (27.0-65.1)	45.0 (0-63.6)	36.0 (0.8-70.8)*
PR+NP (%)	57.2 (35.7-82.5)	59.8 (12.5-80.4)	51.0 (6.3-85.4)*
IM (%)	42.8 (12.0-76.1)	40.2 (17.9-87.5)	49.0 (16.7-93.8)*
Sperm morphology (normal forms) (%)	30.0 (17.5-64.4)	23.0 (4.0-63.0)*	21.0 (5.0-51.0)*

Data are expressed as median (range), *P<0.05. BMI: Body mass index, PR: Progressive motility, PR+NP: Total (progressive + nonprogressive) motility, IM: Immotile spermatozoa

Table 2: Seminal biochemical parameters of studied group

Parameters	Control group (*n*=63)	Preobesity (*n*=66)	Obesity (*n*=23)
Fructose (mmol/L)	18.2 (7.6-44.6)	13.95 (3.5-64.1)*	13.5 (2.6-35.9)*
Fructose (μmol/ejaculate)	62.6 (22.0-245.1)	53.4 (4.2-256.4)	53.6 (18.4-180.1)
Citric acid (mmol/L)	38.5 (7.41-74.7)	49.0 (10.5-209.0)*	39.9 (16.3-71.1)
Citric acid (μmol/ejaculate)	153.0 (33.6-462.0)	155.9 (21.0-609.3)	201.6 (35.3-665.0)
Zinc (μmol/L)	1417.0 (288.6-4327.0)	1711.4 (411.0-5817.0)*	1249.0 (525.0-4115.0)

Data are expressed as median (range), *P<0.05

$P < 0.05$). In all patients, a BMI negatively correlated with concentration ($r = -0.17$; $P < 0.05$) and total number of spermatozoa in the ejaculate ($r = 0.21$; $P < 0.05$), normal morphology ($r = -0.27$; $P < 0.05$), and PR and total motility ($r = 0.18$, $P < 0.05$; $r = -0.22$, $P < 0.05$, accordingly). Levels of biochemical markers in seminal plasma did not significantly correlate with BMI ($P > 0.05$ in all cases).

Discussion

This study showed that with the increase of BMI and with the progress of adiposity, the quality of ejaculate significantly deteriorates, in particular, sperm concentration, total number of spermatozoa and motility.

Various studies have reported about negative correlation between obesity, increasing BMI, and basic sperm parameters, including volume, sperm count, and motility.[14] Jensen *et al*., 2004 and[15] Bieniek *et al*.[16] found that men with obesity were more likely to have oligozoospermia and azoospermia. Our findings also are consistent with recent studies reporting an association of BMI with decreased total sperm count[17-19] and sperm motility.[16,20]

Preobese and obese men in this study had lower seminal fructose levels compared to men with normal weight. However, data from numerous studies that evaluated fructose concentration in seminal plasma are quite controversial. For example, Luque *et al*.[21] had reported about reducing seminal fructose levels in morbidly obese men, and another studies have found a positive[22] or no correlation of BMI with seminal fructose.[23,24]

Interestingly, the rising concentration of seminal zinc was found only in the preobese group. Kasperczyk *et al*.[25] reported that the increasing zinc in seminal plasma is associated with an improvement of semen parameters. Obviously, this is due to the involvement of zinc in the stabilization processes of membranes and germ cells chromatin as well as due to zinc-induced reduction of the oxidative stress in overweight men.[25,26]

Since citric acid has antioxidant and anti-inflammatory functions in tissues damaged by environmental factors,[27] we assume that increasing its concentration in studied samples of preobese group was associated with low-grade systemic inflammation and oxidative stress.

An evaluation of the biochemical parameters of ejaculate such as fructose, citric acid, and zinc as markers of accessory sex glands is necessary in further studies, especially in the progression of adiposity.

Conclusions

The present study confirms that with the growth of BMI the sperm quality deteriorates. Based on these results, we can assume that obesity may be an injurious factor of male infertility. Further studies are required to elucidate the mechanism of negative impact of obesity on male reproductive function.

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Conflicts of interest

There are no conflicts of interest.

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