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Monitoring, Comparison and Correlation between the Body Mass Index and Spermatozoa with Normal Motility and Putative Fertility Potential among the Population of Adult Men in Plovdiv Region.

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The aim of this retrospective study was to assess the relationships between body mass index and sperm quality and respectively infertility, among the population of adult men in the region of Plovdiv, comparing sperm concentration to the lower reference value for normal fertility. Samples from 918 male partners in subfertile couples, who visited the clinic between January 2017 and July 2019, were analyzed and compared in the groups according to their body mass index. The results clearly indicated that BMI is a factor influencing sperm parameters in the adult male population in Plovdiv region and participants with overweight and even obesity conditions are more likely to be a risk group for potential infertility.

Key words: body mass index (BMI), overweight, obesity, sperm quality, infertility

Introduction

Infertility is a serious health condition that affects about 10% of all families worldwide [3]. Although assisted reproductive technologies provide an opportunity to address some of the causes of this problem, they are far from being able to provide a solution to each specific case. For this reason, identifying and clarifying each and every risk factors for subfertility is a serious task for clinicians and researchers working in the research field of the problem at the present time.

Overweight and obesity are also a global problem, especially in industrialized countries and societies [25]. The reasons for this are often laid down in childhood development, which of course does not always mean mandatory overweight in adulthood [12, 13, 17].

However, the fact is that overweight and obesity are more common in the Bulgarian population compared to European populations according to WHO statistic data [4, 5, 16]. In the last decade, one out of three adults worldwide is overweight and one out of nine is obese, while the trend of increasing obesity rates is progressing [26].

Researchers have found that significant number of couples in reproductive age are overweight or even obese [18] and in about 40 % of the cases this is due to the so-called male factor [7].

Infertility is defined as a state of inability to achieve the desired / planned pregnancy within one year and to overweight and obesity in men is being associated as a risk and predisposing factor [13, 16, 18].

It is generally accepted that obesity affects the GnRH-FSH/LH pulse, impairs the function of Sertoli and Leydig cells, and influences the release of sex hormones and also sperm maturation [24].

Serum testosterone, sex hormone-binding globulin (SHBG), and inhibin B are reported to decrease with increasing body mass index (BMI), whereas estradiol (E_2) increased with increasing BMI [7, 9]. Moreover, researchers in recent years have found obesity in adult men to be linked to low sperm quality [1, 8, 10], and obese men are 3 times more likely to exhibit a reduction in semen quality than men with normal weight. Overweight and obesity have been associated with an increased prevalence of azoospermia or oligozoospermia [19].

Materials and Methods

The participants, 918 men, were the partners in subfertile couples who submitted semen samples for semen analysis or were attending for therapeutic procedures in Medical Centre Bora in Plovdiv between January 2017 and July 2019. The fertility status of their female partners was not considered. Male participants who had definitive pathological conditions capable of affecting sperm quality were excluded, as well as patients with abnormal morphology and concentration /oligospermia and azoospermia/ (according WHO).

The calculation of body mass index (BMI = kg / m^2), as well as the analysis of the semen sample, were performed by the same specialist, qualified and trained according to WHO criteria and algorithms, in order to avoid methodological and assembly errors in the course of the study.

Samples were described and analyzed in terms of patient age, period of sexual abstinence, medication intake, potential harms, volume and pH of the ejaculate.

Other sperm variables used as outcome variables were as follows: sperm concentration (millions per ml), semen volume (ml), total sperm count, relative number of sperm with rapid motility (Type A motility, %), relative number of sperm with less progressive or linear motility (Type B motility, %), percentage of sperm with sluggish and/or undulating motility (Type C motility, %), total motile sperm count, and relative number of normal sperm as assessed by morphology.

All the sperm samples were kept in a 37°C CO_2 incubator to allow them to liquefy and facilitate routine sperm analysis. Analyses were performed with an Olympus IMT2 inverted microscope at 400x and 1000x magnification and a standard Neubauer counting chamber.

For the statistical analyses was used ***Statview*** **version** ***V software*** and ANOVA test for the comparison of BMI groups and sperm count and motility. In all analyzes, differences with $p < 0.05$ were considered as statistically significant.

Results

Patients were divided into groups by BMI (**Table 1, Fig.1**). Group A – normal weight 18–24,99 kg/m^{-2}, group B – overweight 25–29,99 kg/m^{-2}, group C – obese I class 30-34,99 kg/m^{-2} and group D – obese class II and III ***≥35,0*** kg /m^{-2}

Table 1. Groups by BMI

BMI	*A – 18.5-24.99*	*B – 25-29.99*	*C – 30-34,99*	*D – ≥35,0*
n	266	372	195	85

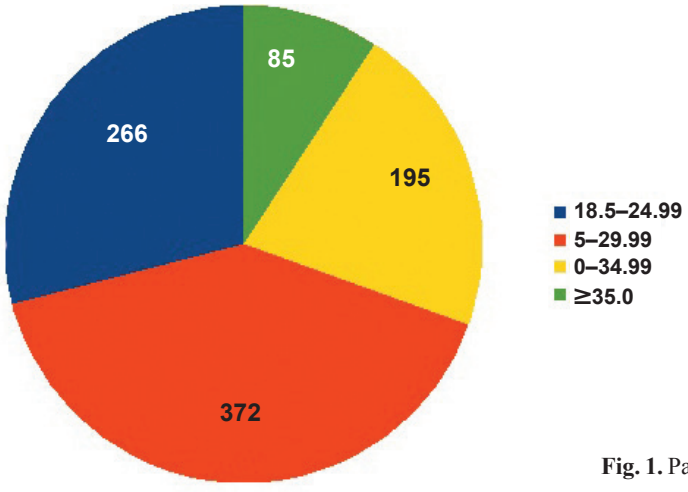

Fig. 1. Patients in the relevant BMI group

As demonstrated in **Table 2** and **Table 3**, we did not find a statistically significant correlation between age and BMI values in the working groups. However, the results indicated significant relationships between BMI and the total sperm count, as well as between BMI and relative amount of type A motility and the relative amount of progressive motility (A + B).

Sperm concentration in the group of overweight and obese men was 20,7± 6.6 mill/ml and 17,5± 5.8 mill /ml, respectively, which was significantly lower than in the subjects with normal BMI where the mean value of total sperm count was 27,7± 5,7 mill/ml.

If we take into account the WHO 2010 criteria, which postulate that men with normal fertility are having no less than $7{,}2\times10^6$ [28] normally motile spermatozoa and after processing and analyzing the obtained results, we observed the following: in group A – with normal weight and BMI values, the ratio fertile to infertile men is 69.56% to

Table 2. Mean age in the relevant BMI groups

BMI group	*A 18.5–24.99*	*B 25–29.99*	*C 30–34,99*	*D ≥35,0*
Age	31,8±2,5	31,2±2,0	32,9±2,9	32,9±1,8
Sperm count x10⁶/ml	27,7± 5,7	20,7± 6.6	17,5± 5.8	

Table 3. Biostatistical data from the applied analyzes

BMI group	*A 18.5–24.99*	*B 25–29.99*	*C 30–34,99*	*D ≥35,0*
Volume	3,1±1,2	2,9±1,1	3,5±1,1	
pH	7,5±0,1	7,5±0,2	7,6±0,1	
Sperm count x10⁶/ ml	27,7± 5,7	20,7± 6.6*	17,5± 5.8*	
Motility in % A+B	37,7± 8,7	39,7± 6.4	35,5± 8.8	
Motility in % C	10,9± 3,1	9,3± 3,8	9,1± 3,6	
Morphology %	7,9± 4,8	7,8± 4,7	7,6± 4,6	

* Significant difference between A and B – C/D; p <0.05 (p-value as differences between BMI groups for one way ANOVA-test)

30.43% – or in general, in the group two out of three men have normal fertility potential. Similar is the ratio in group B – overweight: 70.21% fertile versus 29.78% subfertile – again two out of three men with normal fertile parameters. Significant deviation was observed in the groups of men with obesity I, II, and III degree. The ratio of fertile to infertile men is almost 1:1 (54.54% to 45.45%) as shown in **Fig. 2**.

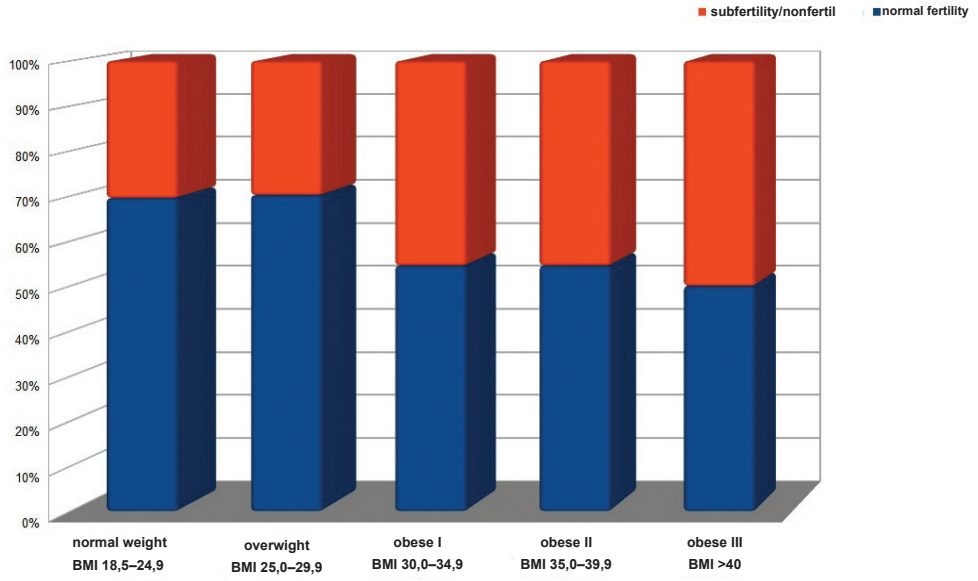

Fig. 2. The ratio of fertile to infertile men

Discussion

The results of this study demonstrate that there were changes in the number and proportions of patients in groups, as well as fertility criteria (total sperm count and number of normally motile sperm cells), which absolutely links to the conclusion, that there is a correlation between the increased BMI values and the reduction of total sperm count. As the body mass index increases, the likelihood of subfertility in a man due to and resulting in a low number of normally motile sperm, increases as well.

Following this sense, our results and their analyses confirm the results published in 2014 by the study of Belloc et al. in France from over 10 600 patients who also demonstrate in their interpretation a clear link between overweight and obesity and spermatogenesis (volume, concentration, motility) [2].

Obesity condition affects negatively the reproductive potential of men, reducing sperm parameters, but also through the physiological and biochemical effects on germ cells in the testes and subsequently the maturation and functionality of sperm [24].

In contrast, there are other studies that show no significant correlation between BMI and semen parameters [5, 6, 20]. A meta-analysis from MacDonald *et al.* found no evidence of a relationship between BMI and sperm concentration or total sperm count, but there was a negative relationship between testosterone, SHBG, and free testosterone with an increased BMI [10].

However, there are some study limits in these reports such as the small number of obese male subjects and the study populations consisting of multinationals. Therefore, our retrospective study was designed and concepted to explore eventual relationship between BMI and sperm parameters in the male population in Plovdiv region, comparing sperm concentration with the lower reference value for normal fertility – sufficient enough to achieve pregnancy, according to the World Health Organization 2010 criteria (WHO 2010).

Conclusion

The current findings and the summary results of our study indicate a prerequisite to confirm, that Body mass index (BMI) is a factor influencing sperm parameters in the adult male population in the Plovdiv region, as overweight and obese individuals fall into the risk group for potential infertility.

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