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Original Research Article

Impact of Body Mass Index (BMI) on Sperm Functional Parameters and Serum Hormonal Profile of Infertile Males

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ABSTRACT

Introduction: Obesity is a global problem and levels are intensifying all over the world. Infertility is more prevalent among men with elevated BMIs. This study assesses the effect of body mass index (BMI) on sperm functional parameters and serum hormonal profile.
Material & methods: Clinical examination of 142 subjects was carried out and information on age, height, weight, etc. were recorded. Subjects were divided into four groups according to calculated BMI as follows: (underweight <18.5 kg/m^2, normal 18.5-24 kg/m^2, overweight 25- 30 kg/m^2, obese > 30 kg/m^2). Parameters of seminal characteristics, sperm functional test and serum hormone were analyzed.
Results: The results revealed a significant decrement in sperm concentration, motility (p=0.02, 0.001) and vitality (p=0.05, 0.001) in overweight and obese males as compared to normal. Sperm functional (HOS, NCD, AIT, SMAI) parameter also declined in obese group as compared to normal group However, no definite trend was found among sperm functional parameters and BMI groups. Serum FSH, testosterone levels were significantly (p<0.001) low in obese males as compared to normal group however, there was no significant difference in LH, Prolactin, and PSA levels in overweight and obese groups as compared to normal group. A negative correlation (r=-0.30,-0.42) was found in testosterone level and BMI of group III and IV.
Conclusion: This concludes that increased BMI is associated with decreased sperm functions and serum FSH and testosterone level, the study also confirms that men with excess body weight are at increased risk of infertility.

Key words: Body mass index, obesity, sperm function, serum hormone.

INTRODUCTION

Concerns over global decline in sperm quality have attracted the attention of scientific community and public alike. The weight of a person has reflective impact on sperm quality. [1] To classify the overweight and obesity in adult population and individuals, body mass index (BMI) is a simple index of the weight-to-height ratio. The subsequent drop off in male fertility and fecundity may be explained analogous to obesity. [2] Excess weight is not only linked to increased risk of chronic disease, [3] but also increases the risk of reproductive problems. [4] Considering the patho-physiology of obesity it has negative impact

on male fertility. [5] In female excessive weight can lead to spontaneous abortions and an increased risk of birth defects. [6,7] These adverse effects may be reversible with weight loss. [8-10] The reproductive hormonal profiles of most obese men deviate from the normal. Obese men tend to present elevated estrogen and low testosterone and FSH levels. Giagulli et al [11] demonstrated that central obesity is associated with a decrease in circulating androgen levels and proportional to the degree of obesity. Obese males usually expressed a ''hyperestrogenic hypogonadotropic hypogonadism.'' account for problems with erectile dysfunction and spermatogenesis. [2] In fact, both total and free blood testosterone levels have shown to be decreased in obese men.

Analysis of retrospective data indicates that sperm counts may have declined in some parts of the world. There seem to be geographical variation in the semen quality. [12-14] The reason for geographical variations in semen characteristics is unclear but may be due to environmental, nutritional, socioeconomic or other unknown causes. [15] In view of high population density, heterogeneous nature of the Indian population, climatic difference and dietary habits, it is necessary to know whether similar trend exist within the different parts of the India. BMI has been already established to affect female fertility; however, information regarding increased body weight of male and its effect on sperm functional parameters is scare in context to Indian scenario. It is important to evaluate the consequences of obesity with regard to sperm function in men. Therefore, the current study is an effort to show the relationship of BMI with seminal characteristics, sperm functional test and also with serum hormones level.

MATERIALS AND METHODS

1. Subject Recruitment

Five hundred infertile couples were selected for initial screening. After exclusion of infertility through female factors, males above 45 years, aspermic patients, any known reproductive pathology (e.g. genital tract infections, prostatitis, epididymitis, etc.) or any hormonal therapy in the last six months and patients with erectile dysfunction, 142 subjects were primarily recruited for the present investigation from the Division of Infertility, Department of Urology, SMS Hospital, Jaipur, Rajasthan, India. All the subjects signed an informed consent form in order to undergo a full medical consultation, clinical examination, sample collection and relevant biochemical testing. Clinical examination of all the subjects was carried out and information on age, health problems, history of infertility in the family, height, weight, etc. was recorded. The study was approved by the institute ethical committee (IEC).

2. Body mass index (BMI):

Height (m) and body weight (kg) of all subjects were recorded on the day of their visit. The BMI was calculated as kg/m^2 and divided into four groups according to World health organization, [16] as follows:

All subjects were allocated into following four groups:

Group I : Underweight subjects (n= 16) with BMI< 18.5 kg/m^2

Group II : Normal subjects (n= 63) with18.5- 24 kg/m^2

Group III : Overweight subjects (n= 33) with 25- 30 kg/m^2

Group IV : Obese subjects (n= 30) with greater than, 30 kg/m^2

3. Semen Collection and Analysis:

Semen samples were collected by masturbation into a clean sterile sample collection vial, under aseptic condition. Subjects were instructed to abstain for at least 48 hours prior to collection the semen sample. The samples were liquefied for at

least 20 minutes in a water bath at 37°C, but no longer than 1 hour prior to performing a routine semen analysis. Semen colour, pH, appearance, consistency, agglutination, volume, sperm count, motility, vitality and morphology were carried out. [17]

4. Sperm functional test:

Sperm functional test Hypo-osmotic swelling (HOS) which indicates membrane integrity and viability and acrosome intactness test (AIT)) for acrosome status, nuclear decondensation test (NCD) for nuclear integrity, [18] sperm mitochondrial activity index test (SMAI) for motility and flagellar disorder were carried out using the validated test kits obtained from National Institute of Health & Family Welfare (NIHFW), New Delhi.

5. Hormone Analysis:

Blood samples were collected by venipuncture in a clean sterile tube and allowed to clot at room temperature. Serum was separated by centrifugation at 3000 rpm for 15 min. Serums were stored at - 70° C until analysis and serum FSH, LH, testosterone, Prolactin and Prostatic specific antigen (PSA) were assayed with commercially available ELISA kits (United Bio Chem Inc., USA).

6. Statistical Analysis

Values were represented as mean ± standard deviation (SD). One-way analysis of variance (ANOVA) was employed for statistical comparison. The difference between means was analyzed by Holm-Sidak multiple comparison test to detect the inter-group difference by using the statistical software SPSS version 11.5 (SPSS Inc., Chicago, IL, USA). The P value less than 0.05 were considered as significant. Relationship between two variables was determined by Karl Pearson's coefficient of correlation.

RESULTS

Out of 142 infertile subjects, 16 (11.26 %) subjects were found underweight (group I), 63 (44.36%) were normal (group II), 33 (23.23%) were overweight (group III), and 30 (21.12 %) were found obese (group IV). The overall population showed BMI (23.36± 0.56), which classified the total 142 subjects as normal.

1. Semen Analysis

There was no significant difference in semen liquefaction time, consistency and pH in underweight, overweight, and obese male as compared to normal group. There was a vide variation exists in the semen volume of the subjects however; difference in semen volume was nonsignificant in group I, III and IV as compared to group II. The semen volume in groups I, II, III and IV had been shown in Table 1.

1.1 Sperm Concentration

Sperm count in group I-IV had been shown in Table 1. A significant (p=0.02, 0.001) declination in sperm count of overweight (group III) and obese (group IV) subjects was observed when compared with normal (group II) weight subjects. Underweight (group I) also showed a markedly decreased sperm count as compared to normal weight subjects (group II).

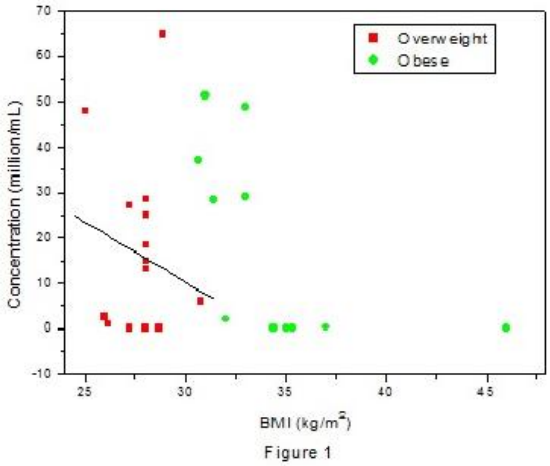

Figure 1: The relationship between BMI of group III and IV with sperm concentration (Million/mL). Individual data points are shown and relationship between variables indicated by linear regression lines. A significant inverse correlation was found with sperm concentration and BMI in group III and group IV.

A significant inverse (r= - 0.19, - 0.33, p<0.05) correlation was observed between sperm concentration and BMI of overweight (group III) and obese (group IV) subjects (Fig.1).

1.2 Sperm Motility

Table 1 shows the sperm motility in group I-IV. A significant (p=0.02, p=0.001) declination in sperm motility in overweight (group III) and obese (group IV) subjects as compared to normal (group II) weight subjects. Underweight (group I) also showed a strikingly less sperm motility as compared to normal weight subjects (group II).

Motility show a negative (r= - 0.09, - 0.62, p<0.001) and significant correlation with Body mass index (BMI) of overweight (group III) and obese (group IV) subjects (Fig. 2).

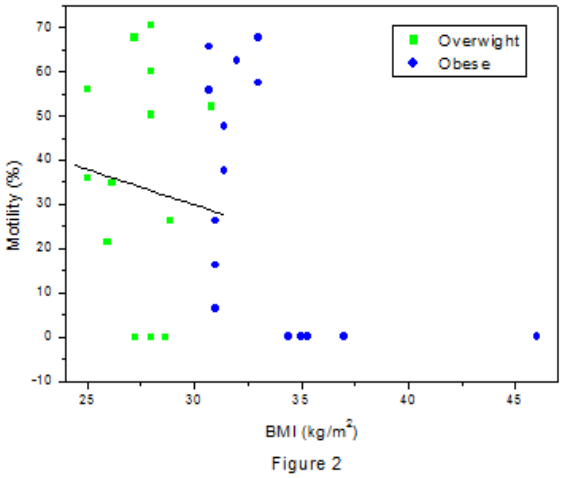

Figure 2: The relationship between BMI of group III and IV with sperm motility (%). Individual data points are shown and relationship between variables indicated by linear regression lines. Note a significant and negative correlation among sperm motility and BMI in group III and group IV.

1.3 Sperm Vitality

Referring sperm vitality in group I-IV from Table1 shows a significant (p=0.05, 0.001) declination in overweight (group III) and obese (group IV) subjects as compared to normal (group II) weight subjects. Underweight (group I) also showed a prominently less sperm vitality as compared to normal weight subjects (group II).

Vitality was inversely significantly (r= -0.21, -0.60, p<0.001) correlated with Body mass index (BMI) of overweight and obese subjects (Fig. 3).

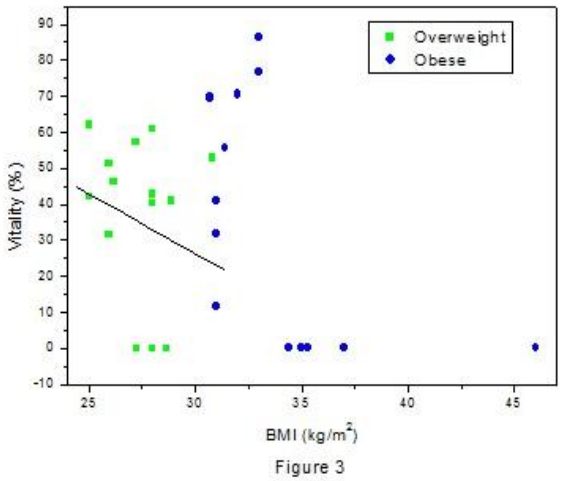

Figure 3: The relationship between BMI of groups III and IV with sperm vitality (%) shows a significant and negative correlation in sperm vitality with BMI in group III and group IV. Individual data points are shown and relationship between variables indicated by linear regression lines.

1.4 Sperm Morphology

Normal sperm morphology in group I-IV had been shown in (Table 1). A declination in normal sperm morphology was observed in all BMI group as compared to normal group. However, a nonsignificant difference was observed in overweight and obese group as compared to normal group.

Table 1. Semen analysis of different BMI groups

Semen parameters	Group I	Group II	Group III	Group IV
volume (mL)	2.44±0.36	2.81±0.19	3.37±0.42	2.53±0.32
sperm concentration (%)	17.72±5.33	32.94±7.45	16.95**±3.55	13.87***±3.73
Sperm motility (%)	26.66±8.29	37.44±4.48	33.93**±4.26	19.10***±4.95
Sperm vitality (%)	37.36±9.43	45.14±4.53	34.74*±3.97	24.23***±6.06
Normal sperm morphology (%)	32.98±8.62	34.34±3.83	33.73±4.49	32.19±7.36
Mean (SEM) * statically significant difference (*p<0.05, **<0.02,***<0.001)				

2. Sperm functional parameter

Sperm functional parameters i.e., HOS, AIT, NCD and SMAI in group I-IV had been shown in Table 2. A significant ($p<0.01$) declination in HOS score and NCD was observed in obese subjects as compared to normal weight subjects.

Table 2. Sperm functional tests of different BMI groups

	Group I	Group II	Group III	Group IV
Hypoosmotic swelling test (HOS) %	37.47±7.47	38.68±4.24	37.84 ±5.20	19.79**±6.18
Acrosomal intactness test (AIT) %	37.98±7.53	33.90±4.07	33.95±3.98	30.81±7.10
Nuclear intactness test (NCD) %	44.50±8.77	45.60±9.48	43.95±5.39	26.62**±6.17
Sperm mitochondrial activity index test (SMAI) %	36.23±8.48	37.27±4.28	37.05±5.28	32.81±7.56
Mean (SEM) * statically significant difference (*p<0.05, **<0.01)				

Sperm functional parameters HOS and NCD were inversely correlated with body mass index of overweight (group III) (r=- 0.30, -0.18) and obese (group IV) (r= - 0.59, -0.59) subjects.

3. Hormone Analysis

Serum FSH, Testosterone, LH, Prolactin and PSA in group I-IV had been shown in Table 3. A non significant decline in LH, Prolactin, and PSA in overweight (group III) and obese (group IV) subjects as compared to normal (group II) weight subjects, however, FSH levels were found to be significantly ($p<0.001$) decreased in both the overweight (group III) and obese (group IV) subjects as compared to the normal (group II) weight subjects.

Table 3. Serum hormone profile of different BMI groups

	Group I	Group II	Group III	Group IV
Follicle stimulating hormone (FSH) (mIU/mL)	8.81±0.69	10.22±1.05	6.49**±0.54	7.11**±1.29
Leutaniging hormone (LH) (mIU/mL)	3.04±0.54	4.15±0.32	3.50±0.49	4.26±0.52
Prolactin (ng/mL)	8.45±1.34	8.78±0.82	6.53±0.66	4.97±0.86
Testosterone (ng/mL)	4.61±0.69	5.40±0.62	4.23±0.37	3.78**±0.63
Prostatic specific antigen (PSA) (ng/mL)	0.75±0.13	1.70±0.67	0.75±0.11	1.49±0.38
Mean (SEM) * statically significant difference (*p<0.05, **<0.001)				

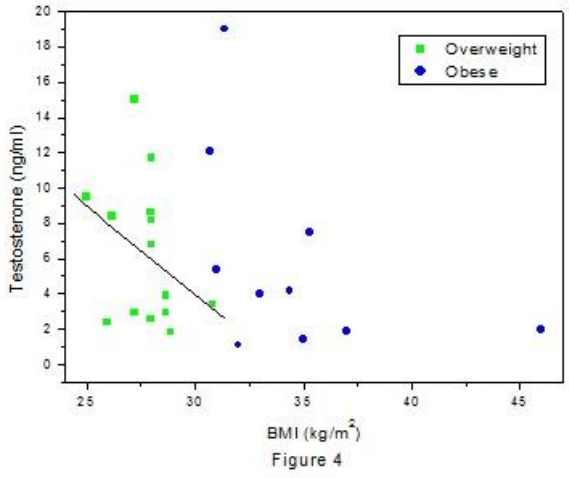

Figure 4: The relationship of BMI in groups III and IV with serum testosterone (ng/mL) shows a decreasing trend in levels of testosterone in overweight (group III) and obese (group IV) subjects as compared to normal (group II) weight subjects. Individual data points are shown and relationship between variables indicated by linear regression lines.

Serum testosterone shows a significant ($p<0.001$) decrement in obese (group IV) subjects as compared to normal (group II) weight subjects. Serum testosterone shows a negative correlation (r= - 0.38, - 0.54) with BMI in overweight and obese group (Fig. 4).

DISCUSSION

High fat deposits in the suprapubic and inner thigh areas may result in altered sperm production or chromatin integrity. Patients presenting with excess suprapubic fat have poor semen quality. [19] It is well documented that women who are overweight or obese, are at higher risk of reproductive problems; including reduced fertility. [20] Jensen et al, [21] studied over 1558 younger men having paramilitary physical and found that overweight men had

reduced sperm concentration as compared with normal weight. The effect of BMI on sperm parameters has been apparently investigated in several scientific studies which document that prevalence of azoospermia or oligozoospermia were associated with an increased overweight and obesity. [22] The rising evidence suggests that male obesity had a negative impact on male reproductive potential, not only reducing sperm quality, but in particular altering the physical and molecular structure of germ cells in the testes and ultimately mature sperm. [23,24] A negative effect of obesity on sperm parameters is not consistent, there is a clear dose-response mechanism reported. [23,25] Our study documents, the relationship between body mass index and sperm function including their serum hormone levels. Sperm function with sperm concentration, motility and vitality shows a significant and negative relationship with body mass index (BMI); In contradictory to Thomsen et al, [26] investigation, our results shows a significant declination in sperm concentration, motility and vitality in overweight and obese male as compared to normal male. However, sperm morphology is least affected with elevated BMI. Underweight men also showed markedly decreased sperm function as compared to normal weight subjects. Our results are in accordance with Kort et al., study [27] which shows a negative relationship and declination in motility and vitality in per BMI group as compared to normal BMI group.

Sperm functional test hypo-osmotic swelling score (HOS) and nuclear decondensation test (NCD) was significantly decreased in obese (group IV) subjects as compared to normal group however, acrosomal intactness (AIT) and sperm mitochondrial activity (SMAI) also decreases as body mass index increases, but these test cannot fully explain the association between BMI and semen quality. There was no specific correlation or definite trend observed between Acrosomal intactness test and Sperm mitochondrial activity test in different BMI groups.

Increased BMI associated with low testosterone and sex hormone. Intratesticular testosterone levels normally low fold greater than circulating concentrations are correlated with spermatogenesis. [28] It is not known whether the modest reduction in testosterone levels associated with obesity are accompanied by a reduction in intra testicular testosterone concentration sufficient to explain the reduction in sperm count that have been observed in obese subjects. Our study revealed that serum testosterone levels was significantly and negatively correlated with BMI of higher weight subjects, and the levels of testosterone were significantly decreased in obese (group IV) subjects as compared to normal (group II) group. The observed decrement in testosterone levels in obese males is likely due to several factors, including decreased synthesis of testosterone, inhibition of SHBG synthesis, and decreased gonadotropin secretion. [29] Zumoff et al, [30] also reported a negative correlation between free testosterone and body mass index. Serum FSH, LH, Prolactin, PSA were also shows a reduction in overweight (group III), obese (group IV) subjects as compared to normal group but their levels was nonsignificant as compared to normal weight subjects. Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) levels were normal or low in obese men. [31-33] Reproductive hormones FSH, LH, Prolactin, and PSA cannot explain the association between BMI and semen quality. Thus, our data suggest that men's with excess weight or reduced weight may contribute to infertility. Aside from the underweight men who themselves had increased risk of infertility, we found that

infertility increased with men's BMI, The increased risk seen in the obese presumably represents a different biological mechanism from those mechanisms accounting for the general increase with heavier weights.

CONCLUSION

The evidence cited thus far leads to the conclusion that obesity negatively influences sperm function (concentration, motility and vitality). But, because the study population is small in per group, though further studies will be required to settle whether this effect is convincingly a cause for infertility attributed able to obesity by itself. This study adds further support that men with excess body weight are at increased risk of infertility. Therefore, one to ensure maximum fertility potential may be advised to reduce their body weight and more research is needed to see if weight loss improves fertility for these men.

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