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**Original Research Article**

# Impact of obesity on semen quality in men of infertile couples: a cross-sectional study in a tertiary care centre

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## ABSTRACT

**Background:** Obesity is an emerging problem worldwide. The aim of the study was to determine the association of Body mass index and central obesity with semen parameters in men of infertile couples.
**Methods:** This was a descriptive study conducted in a population that included 219 men of infertile couples who attended the infertility clinic. A detailed history was taken from the participants and measurements of height, weight, waist circumference and hip circumference were done by standard methods. General, systemic and urogenital tract examinations were done. The participants were advised to collect semen specimens and semen was analyzed and various semen parameters were noted based on WHO criteria 2010.
**Results:** Among the overweight and obese men, 12.7% and 20.5% were oligozoospermic respectively. Asthenozoospermia was seen in 21.2% and 25% of overweight and obese men. Among men with waist circumference ≥102 cm, 14.3% had oligozoospermia and 35.7% of men had asthenozoospermia. Around 12.2% of men with a Waist-hip ratio >0.9 had oligozoospermia and 19.8% of them had asthenozoospermia.
**Conclusions:** A significant negative association was seen between WHR and sperm concentration, total sperm count, total progressive motility and total motility were seen to be removed. There was no significant association between WC, BMI and sperm concentration, total sperm count, total progressive motility, and total motility.

**Keywords:** Male infertility, Obesity, BMI, Waist circumference, Waist-hip ratio, Semen quality

## INTRODUCTION

Infertility is a disease of the reproductive system defined by the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse.[1] Prevalence of infertility is 10-15% in couples of reproductive age group and male factors solely account for infertility in 20% of cases.[2] Obesity is an emerging problem worldwide.

Recently, lifestyle factors and obesity have been found to influence semen quality and various studies have been done to find out the impact of poor lifestyles on semen quality. Obesity seems to adversely affect male fertility by causing a significant disturbance in the reproductive hormonal profile.[3] The aim of the study was to analyse the association of Body mass index (BMI) and central obesity measured as waist circumference and hip circumference with the standard semen parameters.

## METHODS

The study was conducted in the department of obstetrics and gynecology at JIPMER (Jawaharlal Institute of Postgraduate Medical Education and Research), Puducherry, India. It was a descriptive study that included a sample population of 219 calculated based on a 95% confidence interval and 70% power using Open Epi software. The study was approved by the Institute Ethics Committee.

The study included men of infertile couples who attended the infertility clinic during the period from January 2013 to July 2014. Informed consent was taken from all the participants. A detailed history was collected from the patients regarding age, educational status, occupation, number of years of infertility, type of infertility (primary/secondary), coital frequency and difficulty, diabetes/hypertension, history of smoking/alcohol consumption, tobacco usage, sexually transmitted infections, chronic drug intake, surgeries in the past, childhood illness. History was followed by a general physical examination. The height, weight, waist circumference and hip circumference were measured using standard methods. Waist circumference was measured midway between the lower margin of the last palpable rib and the top of the iliac crest. Hip circumference was measured around the widest portion of the buttocks with an inch tape parallel to the floor. The men were categorised into various groups based on BMI for the Asian population.[4] Waist circumference, hip circumference and Waist–hip ratio were used as measures of central obesity. The waist circumference of 102 cm and 88 cm are used as the cutoff in men and women respectively.

The waist-hip ratio of 0.9 in men and 0.85 in women are taken as cutoffs to measure central obesity.[5] Examination of all other systems and local examination of the male urogenital tract to exclude anatomical causes of infertility was also done. Men with undescended testes, varicocoele, testicular failure and surgeries which are likely to affect semen parameters were excluded from the study. The participants were advised to collect semen after 2-5 days of abstinence. After liquefaction, the semen was analysed with a Makler counting chamber, and various semen parameters were noted based on WHO criteria 2010.[6] The parameters studied were body mass index, waist/ hip ratio and the semen parameters (ejaculate volume, sperm concentration, total sperm count, total progressive motility and immotile spermatozoa). The semen parameters were expressed as mean and the number of men in each BMI group was expressed as proportions. Chi-square test or Fisher's exact test were used for comparing proportions between the groups and ANOVA to compare the means between the groups. Logistic regression analysis was done to study the significant determinants of poor semen quality. Data were analysed using SPSS version 19.0 and p value<0.05 was set as significant levels.

## RESULTS

In our study, the cohort consisted of men in the age group of 21-48 years. The majority of men (59.8%) were in the age group of 30-39 years. Primary infertility was noted in 83.1% of men and secondary infertility in 16.9% (Table 1). The study population was categorized into groups based on BMI according to WHO standards for the Asian population. In the study population, the lowest BMI was 15.6 and the highest was 45.5. Around 53.9 % of men were in the BMI range of 23-27.5 kg/m$^2$ (overweight) and 20.1% of men had BMI>27.5 kg/m$^2$ (obese). Among the overweight and obese men, 12.7% and 20.5% had oligozoospermia respectively. Asthenozoospermia was seen in 21.2% and 25% of overweight and obese men respectively. No significant association was seen between BMI and semen parameters (sperm concentration, total sperm count, total progressive motility and total motility) (Table 2 and 3). Waist circumference is a good measure of central adiposity. Around 6.4% of men had a waist circumference of more than 102 cm. Among the men with oligozoospermia and asthenozoospermia, waist circumference ≥102 cm was seen in 6.1% and 9.3% of men respectively (Table 4). There was no significant association between waist circumference and semen parameters (sperm concentration, total sperm count, total progressive motility, and total motility).

Waist- hip ratio>0.9 was seen in 78.5% of men. Among the men with oligozoospermia and asthenozoospermia, a waist-hip ratio >0.9 was seen in 63.6% and 62.9% of men respectively (Table 4). A significant negative association was seen between Waist-hip ratio and semen parameters (sperm concentration, total sperm count, total progressive motility and total motility). Multivariate logistic regression analysis was done to look for determinants of poor semen quality also showed a negative association between waist-hip ratio and semen quality but was not significant. Multivariate logistic regression analysis did not show any significant association for the other variables (Table 5).

**Table 1: Baseline characteristics of the study population.**

| Characteristics | Frequency (N=219) | Percentage (%) |
|---|---|---|
| **Age (years)** | | |
| 20-29 | 71 | 32.4 |
| 30-39 | 131 | 59.8 |
| 40-49 | 17 | 7.7 |
| **Type of infertility** | | |
| Primary infertility | 182 | 83.1 |
| Secondary infertility | 37 | 16.9 |
| **Characteristics** | | |
| Diabetes mellitus | 10 | 4.6 |
| Smoking | 42 | 19.2 |
| Alcohol consumption | 55 | 25.1 |

Continued.

| Characteristics | Frequency (N=219) | Percentage (%) |
|---|---|---|
| Childhood illness | 2 | 0.9 |
| Chronic drug intake | 11 | 5 |
| Ejaculation disorder | 1 | 0.5 |

**Table 2: Association of BMI with sperm concentration and sperm count**

| BMI category (kg/m$^2$) | Frequency (N=219) | Mean sperm concentration N (million/ml)±SD | Number of men with sperm concentration (<15 million/ml) (%) | P value | Mean total sperm count (million/ ejaculate)±SD | Number of men with total sperm count (<39 million) (%) | P value |
|---|---|---|---|---|---|---|---|
| **<18.5** | 8 | 50.75±17.83 | 0 | 0.341 | 147.43±78.63 | 0 | 0.313 |
| **18.5-23** | 49 | 39.39±31.20 | 9 (18.4) | | 108.87±133.55 | 13 (26.5) | |
| **23-27.5** | 118 | 46.79±36.41 | 15 (12.7) | | 144.24±161.90 | 22 (18.6) | |
| **>27.5** | 44 | 49.41±38.90 | 9 (20.5) | | 195.54±194.58 | 8 (18.2) | |
| **Total** | 219 | 45.84±35.34 | 33 (15.1) | | 146.75±162.69 | 43 (19.6) | |

**Table 3: Association of BMI with sperm motility.**

| BMI category (kg/m$^2$) | Frequency (N=219) | Mean progressive motility (%)±SD | Number of men men with progressive motility (<32%) (%) | P value | Mean total motility (%)±SD | Number of men with total motility (<40%) (%) | P value |
|---|---|---|---|---|---|---|---|
| **<18.5** | 8 | 47.12±28.16 | 3 (37.5) | 0.491 | 61.50±28.29 | 2 (25) | 0.125 |
| **18.5-23** | 49 | 44.24±22.61 | 15 (30.6) | | 54.35±23.85 | 11 (22.4) | |
| **23-27.5** | 118 | 54.60±24.20 | 25 (21.2) | | 65.03±23.55 | 12 (10.2) | |
| **>27.5** | 44 | 48.93±27.03 | 11 (25) | | 59.93±28.37 | 9 (20.5) | |
| **Total** | 219 | 50.87±24.80 | 54 (24.7) | | 61.49±25.028 | 34 (15.5) | |

**Table 4: Association of waist circumference and WHR with semen parameters.**

| Variables | N (%) | | | P value |
|---|---|---|---|---|
| | <102 (n=205) | ≥102 (n=14) | Total (n=219) | |
| **Waist circumference (cm)** | | | | |
| Frequency of sperm concentration (<15 million/ml) | 31 (93.9) | 2 (6.1) | 33 (15.1) | 0.646 |
| Frequency of total sperm count (<39 million) | 41 (95.3) | 2 (4.7) | 43 (19.6) | 0.457 |
| Frequency of total progressive motility (<32%) | 49 (90.7) | 5 (9.3) | 54 (24.7) | 0.243 |
| Frequency of total motility (<40%) | 30 (88.2) | 4 (11.8) | 34 (15.5) | 0.154 |
| **WHR** | <0.9 (n=47) | ≥0.9 (n=172) | Total (n=219) | |
| Frequency of sperm concentration (<15 million/ml) | 12 (36.4) | 21 (63.6) | 33 (15.1) | 0.025 |
| Frequency of total sperm count (<39 million) | 16 (37.2) | 27 (62.8) | 43 (19.6) | 0.006 |
| Frequency of total progressive motility (<32%) | 20 (37.1) | 34 (62.9) | 54 (24.7) | 0.002 |
| Frequency of total motility (<40%) | 14 (41.2) | 20 (58.8) | 34 (15.5) | 0.004 |

**Table 5: Determinants of poor semen quality (multivariate logistic regression analysis)**

| Variables | B value | P value |
|---|---|---|
| **Age** | 0.061 | 0.102 |
| **No of years of infertility** | 0.087 | 0.146 |
| **DM/ HT** | -0.633 | 0.467 |
| **Smoking** | 0.195 | 0.678 |
| **Alcohol consumption** | 0.663 | 0.121 |
| **Chronic drug intake** | 0.287 | 0.687 |
| **BMI** | 0.052 | 0.473 |

Continued.

| Variables | B value | P value |
|---|---|---|
| **WHR** | -1.356 | 0.779 |
| **WC** | 0.002 | 0.964 |

## DISCUSSION

Obesity is reaching pandemic proportions and is being increasingly associated with non-communicable diseases.[7] It is also seen to have an impact on male and female reproductive function. The results of a large Danish National Birth Cohort study showed that the Odds ratio (OR) of subfertility among couples where both partners were overweight or obese was 1.41 and 2.74 respectively and the odds ratio of subfertility was higher in obese women than in obese men.[8] Negative influence of obesity on female reproduction is already well recognized.[9] Similarly, obesity has been seen to cause a disturbance in the reproductive hormonal milieu in men and results in an alteration of semen parameters.[3] In men, the duration of time to pregnancy was noted to have a significant positive correlation with increasing sperm concentration and obesity has a negative influence on male fertility.[8] The obese males show relative hypogonadal hypogonadism and the BMI of men who have previously fathered a child was found to be in the lower range.[10] Even fertile obese men have significantly reduced total sperm count, inhibin B, Sex hormone binding globulin (SHBG) and testosterone levels.[11] The importance for men to have a normal BMI was also stressed in studies that showed that low sperm concentration and low total sperm count were associated with both high and low BMI.[3] A large study conducted among couples showed that the prevalence of infertility was around 12%.[12] A trend of increased infertility with increased male BMI was seen and the OR of infertility among men with higher BMI (BMI 30-34.9 kg/m$^2$) was 1.36.[12] Analysis of data from the LIFE study also showed a negative correlation between BMI and sperm concentration and total sperm count and 19 times higher odds of a low total sperm count compared with men with a normal BMI.[13] A study showed that the prevalence of oligozoospermia among overweight and obese men was 9.52% and 15.62% respectively and the incidence of oligozoospermia was seen to increase with increasing BMI.[14] The OR of oligozoospermia and abnormal sperm morphology in obese patients was 3.3 and 1.6 respectively.[14] A negative association was also seen between BMI and total sperm motility with the number of progressively motile sperms declining with increasing BMI (OR=3.4).[14] A similar study reported a negative association between BMI and total sperm motility but found no association between BMI and total sperm concentration.[15]

The prevalence of obesity (BMI>27.5 kg/m$^2$) in our study group was 20.1% and no significant association was seen between BMI and semen parameters (sperm concentration, total sperm count, total progressive motility and total motility). In concurrence with our study, few other studies found no significant association between BMI and semen parameters.[10,16] A study among 1400 sub-fertile couples concluded that there was no association between BMI and percentage of motile sperms, sperm morphology and sperm concentration. The prevalence of obesity (BMI>30 kg/m$^2$) in this sample population was 10.4%.[17] Another study among men attending infertility clinic also found no significant association between BMI and total sperm count.[18] One of the studies evaluating the semen quality in obese men showed no association between BMI and semen parameters but in a scenario of normal semen parameters, high sperm DNA damage was noted in obese men.[16] Also in men with obesity, a negative influence was seen on male reproductive potential which was noted as a decreasing trend in serum testosterone, SHBG and Inhibin B levels.[10,11,16] A meta-analysis was done to study the impact of BMI on semen parameters found no association between BMI and semen parameters (sperm concentration, total sperm count, sperm motility and sperm morphology and semen volume) but strong evidence of a negative relationship between BMI and testosterone and SHBG levels was seen.[19] A negative association was also found between higher BMI and Neutral alpha-glucosidase levels (NAG levels) which is a marker of epididymal function.[15]

Although BMI, which is calculated based on the individual's height and weight is an inexpensive tool to assess obesity, it is not a specific marker of central obesity. Waist circumference (WC) and Waist hip ratio (WHR) are measures of central adiposity and they overcome the disadvantage of BMI.

In our study, the impact of WC and WHR on semen parameters was analysed. Waist circumference above 102 cm was seen in 6.4% of men. Among the men with oligozoospermia and asthenozoospermia, waist circumference ≥102 cm was seen in 6.1% and 9.3% of men respectively (Table 4). There was no significant association between WC and semen parameters (sperm concentration, total sperm count, total progressive motility, and total motility). Similar to our study, analysis of data from the LIFE study showed no significant relationship between WC and sperm concentration, motility, morphology, vitality and DNA fragmentation index though it found a linear association between WC and total sperm count.[13] The LIFE study also showed that men with higher WC had 22% lower sperm count and the OR of oligozoospermia increased to 7 when the WC was 101.6 cm and above.[13] In contrast to our study, a study among subfertile couples concluded that men with higher WC (≥102 cm) had significantly lower sperm concentration, lower total sperm count and lower total motile sperm count.[20] Another study conducted among men attending the infertility clinic also showed that both the waist circumference and hip circumference had a negative association with total sperm count, total number of motile sperms and rapidly progressive motile sperm count.[21]

WHR is another measure of central obesity and in our study, 78.5% of men had WHR>0.9. Among the men with oligozoospermia and asthenozoospermia, waist-hip ratio >0.9 was seen in 63.6% and 62.9% of men respectively. In our study, a significant negative association was seen between WHR and semen parameters (sperm concentration, total sperm count, total progressive motility and total motility). In contrast to our study, no association was seen between the sperm parameters and the waist-hip ratio in a study conducted among men attending an infertility clinic but a negative correlation was noted between waist-hip ratio and testosterone, SHBG levels and the testosterone/17β-estradiol ratio. But the sample size of this study was small compared to our study.[21]

There were few limitations in our study like only single semen sampling was taken into consideration and the impact of obesity on sperm morphology was not studied. The impact of obesity on reproductive hormone levels was also not included in our study.

## CONCLUSION

A significant negative association was seen between WHR and all sperm parameters (sperm concentration, total sperm count, total progressive motility and total motility). No significant association was seen between WC, BMI and semen parameters. In comparison to other studies, our study has the advantage of classifying men based on BMI set for Asian standards as Asians are predisposed to various non-communicable diseases at a lower BMI cut-off compared to other ethnic groups. There are also very few studies evaluating the impact of central obesity measures like waist circumference and waist-hip ratio on the semen parameters.

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