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Does Obesity Negatively Impact Semen Quality? A Cross-Sectional Study in Population of Rahim Yar Khan

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ABSTRACT

Background: Among males of reproductive age, the prevalence of obesity has increased significantly, and it has been found to have adverse effects on the quality of sperm parameters affecting male fertility. **Objective:** To determine the correlation of high Body mass index(kg/m²) with semen parameters among infertile males. **Study Design:** Observational cross-sectional. **Settings:** Urology department, Sheikh Zayed Hospital, Rahim Yar Khan Pakistan. **Duration:** February 2022 to January 2024. **Methods:** Males aged between 20 to 45 years visiting outdoor clinics for workup of infertility with BMI ≥25kg/m² were included. Males with BMI <25kg/m², seropositive for HIV, with a history of chronic medical conditions, and on medications affecting semen quality were all excluded. Semen reference limits have been used provided by WHO. SPSS version 25 was used for data entry and analysis. A p value of less than 0.05 was considered significant. **Results:** The mean age of study subjects was 31.25±8.234years. A statistically significant negative correlation with P-value: 0.004 and r=-0.801 of sperm concentration (millions/ml) was found concerning BMI kg/m². Low sperm concentration <15millions/ml found in 31(21.08%) study subjects having BMI ≤30 kg/m² and in 61(41.49%) study subjects with BMI >30kg/m². While 42(28.57%) were having sperm concentration >15millions/ml in subgroup BMI ≤30kg/m2 and 13(8.84%) subjects with high BMI >30kg/m2 were having sperm concentration >15millions/ml. **Conclusion:** On the basis of our study, it is concluded that high BMI negatively correlates with sperm concentration. No correlation was found between high BMI and other semen parameters such as total sperm number, motility, morphology, and vitality.

Keywords: *Obesity, Body mass index (BMI), Semen parameters, Semen quality.*

INTRODUCTION

Over the last thirty years, the percentage of obese men of reproductive age has been much increased, and this trend is consistent with an increase in male infertility globally. More and more research has been showing that Male obesity negatively impacts a man's capacity for reproduction. It affects the morphological as well as molecular characteristics of the germ cells that eventually grow into mature sperm in the testes, in addition to lowering the quality of sperm.[1,2] Sperm quality, which is referred to as its size, shape, and motility, is necessary for a successful fertilization. In addition to contributing to other associated health issues, being overweight can have an impact on sperm production. Male infertility can result from obesity's detrimental effects on sperm DNA. One hormone that is necessary for the development of sperm is testosterone. A male may suffer from reduced sex drive, erectile dysfunction, and impaired sperm production if his testosterone levels are out of balance. A large concentration of fat cells can cause a rise in leptin production, which can harm this production.[3,4]

Low sperm counts can also result from a high body mass index because testosterone in men converts to estrogen, which lowers sperm production. Additionally, obesity increases the temperature of the scrotum, which is bad for the sperm's health. The man is more likely to become infertile due to these hormonal abnormalities and oxidative damage to the sperm.[5] Through its adverse effects on spermatogenesis and consequent fertility, Male infertility is impacted by the gonadal-pituitary-hypothalamic axis, which is influenced by obesity.[6,7] Evidence specifically suggests that the relative ratio of estrogen to testosterone can be altered by an excess of fat tissue. Additional repercussions include disruptions in insulin, leptin, sex hormone-binding globulin (SHBG) and inhibin B homeostasis, which lead to decreased testosterone synthesis as well as impaired spermatogenesis.[7,8] Obesity-related aberrant spermatogenesis is linked to detrimental effects on sperm chromatin structure, faulty sperm capacitation and binding, and downstream alterations in important semen characteristics. Recent studies on trans-generational epigenetic inheritance also point to the possibility that progeny development may be impacted by changes in DNA methylation, sperm RNA levels, histone acetylation, and protamination brought on by obesity-related poor spermatogenesis.[4,9,10]

It became necessary to assess the relationship between elevated BMI and semen parameters in our population due to the lack of agreement regarding the effect of BMI on male fertility or semen parameters and the increasing number of obese male partners of infertile couples visiting the infertility clinic. This is an effort to better treat and counsel infertile people using the study's findings.

METHODS

A cross-sectional study was conducted in the Urology Department of Sheikh Zayed Hospital in Rahim Yar Khan from February 2022 to January 2024 after ethical clearance from the institutional review board (Ref No:333/IRB/SZMC/SZH dated 11-12-2021). A sample size of 147 was calculated by using a confidence interval of 95%, a margin of error of 8%, and the prevalence of obesity (BMI ≥25kg/m2) among infertile males in Pakistan was reported as 57%. [11]Males aged between 20 to 45 years visiting outdoor clinic for workup of infertility with BMI ≥25kg/m^2 were included. Males with BMI <25kg/m^2, seropositive for HIV, with a history of chronic medical conditions like uncontrolled hypertension or diabetes, on medications like steroids or immunosuppressants affecting spermatogenesis or causing erectile dysfunction, having a history of genital infections, previously undergone groin or scrotal surgery, or males not willing to be included were all excluded. Included study subjects were advised semen analysis and semen sample was collected after 3-5 days of sexual abstinence in the sterile jar provided by the laboratory and collected within the laboratory, subjected to analysis within 30 minutes of collection. Semen reference limits have been used provided by WHO. Data was entered into pre-made proforma. SPSS version 25 was used for data entry and analysis. Standard deviation and mean are used to describe quantitative variables. Qualitative factors that are displayed as percentages and frequencies. Effect modifiers that are stratified-controlled. Following stratification, the statistically significant difference between the subgroups is determined by applying the Chi-square test. A *P*-value less than 0.05 was taken as significant.

RESULTS

Of the total 147 study subjects, mean age was 31.25±8.234years with 78(53.06%) were having ≤32 years of age and 69(46.93%) were having >32years age (Table 1). Mean BMI (kg/m^2) was 30.87±5.286 with 73(49.65%) were having BMI ≤ 30kg/m^2 and 74(50.34%) were having BMI >30kg/m^2 among all 147 study subjects (Table 1). Mean sperm concentration(millions/ml) was 12.23±9.278 with 92(62.58%) were having ≤15millions/ml and 55(37.41%) were having >15millions/ml (Table 1). Of the total 147 study subjects, the mean total sperm number (millions/ ejaculate) was found to be 43.24±6.985, with 67(45.57%) having ≤39 while 80(54.42%) having > 39 million/ejaculate (Table 1). The distribution of study subjects concerning morphology (% normal forms), motility (progressive motility% %), and vitality (% live) has been demonstrated in Table 1.

Table 1: Distribution of study subjects with respect to different variables (n=147)

Variables	Mean ± SD	Sub groups	Frequency	Percentage
Age (Years)	31.25±8.234	≤32 years	78	53.06%
		>32 years	69	46.93%
BMI (kg/m^2)	30.87±5.286	≤ 30	73	49.65%
		>30	74	50.34%
Sperm concentration (millions/ml)	12.23±9.278	≤15	92	62.58%
		>15	55	37.41%
Total sperm number (millions/ ejaculate)	43.24±6.985	≤39	67	45.57%
		>39	80	54.42%
Morphology (% normal forms)	5.18±8.338	≤4	72	48.97%
		>4	75	51.02%
Motility (Progressive motility %)	35.28±7.445	≤32	62	42.17%
		>32	85	57.82%
Vitality (% live)	60.11±7.876	≤58	58	39.45%
		>58	89	60.54%

Cross tabulation of age and semen parameters (total sperm number (millions /ejaculate), Sperm concentration (millions/ml), morphology (% normal forms), motility (Progressive motility %), vitality (% live), concerning BMI (kg/m^2) has been shown in table 2. Statistically significant negative correlation with P-value: 0.004 and r=-0.801 of sperm concentration (millions/ml) has been found for BMI (kg/m²). Low sperm concentration <15millions/ml has been found in 31(21.08%) study subjects having BMI ≤30 kg/m² and in 61(41.49%) study subjects with BMI >30kg/m². While 42(28.57%) had sperm concentration > 15 million/ml in the subgroup BMI ≤30kg/m2, and 13(8.84%) subjects with high BMI >30kg/m2 had sperm concentration > 15 million/ml, as shown in Table 2.

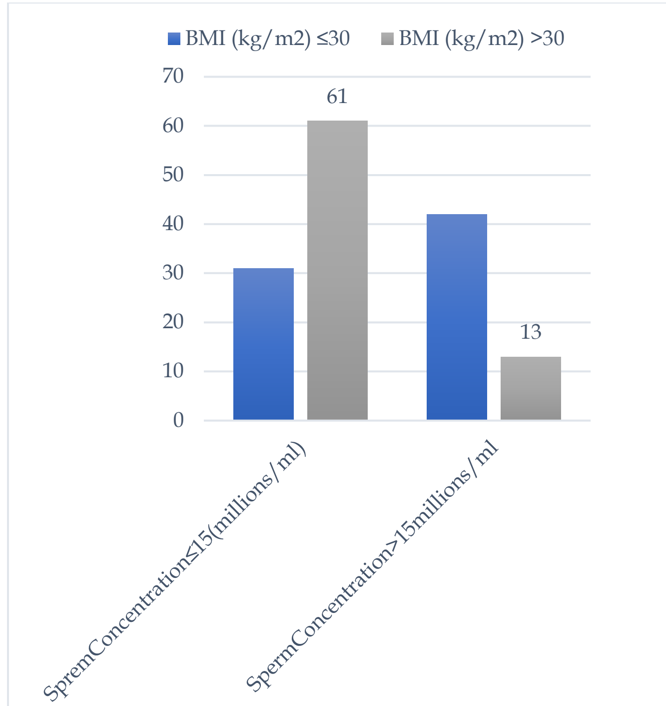
Table 2: Cross tabulation of Age and semen parameters (total sperm number (millions /ejaculate), Sperm concentration (millions/ml), morphology (% normal forms), motility (Progressive motility %), vitality (% live) with respect to BMI (kg/m2) (n=147)

Variables	Sub groups	BMI		Pearson Correlation	P value
		≤30 kg/m²	>30 kg/m²		
Age Years	≤32 years	40 27.21%	38 25.85%	0.211	0.855
	>32 years	33 22.44%	36 24.48%		
	Total	73 49.65%	74 50.34%		
Sperm Concentration millions / ml	≤15	31 21.08%	61 41.49%	-0.801	0.004*
	>15	42 28.57%	13 8.84%		
	Total	73 49.65%	74 50.34%		
Total sperm number millions / ejaculate	≤39	25 17.00%	42 28.57%	0.188	0.615
	>39	48 32.65%	32 21.76%		
	Total	73 49.65%	74 50.34%		
Morphology % normal forms	≤4	38 25.85%	34 23.12%	0.342	0.981
	>4	35 23.80%	40 27.21%		
	Total	73 49.65%	74 50.34%		
Motility Progressive motility %	≤32	34 23.12%	28 19.04%	0.001	0.222
	>32	39 26.53%	46 31.29%		
	Total	73 49.65%	74 50.34%		
Vitality % live	≤58	33 22.44%	25 17.00%	0.211	0.455
	>58	40 27.21%	49 33.33%		
	Total	73 49.65%	74 50.34%		

**P value <0.05 deemed as statistically significant*

Other variables such as age, semen parameters such as total sperm number (millions /ejaculate), morphology (% normal forms), motility (Progressive motility% %), and vitality (% live) did not show a statistically significant correlation concerning BMI (kg/m²). More study subjects were found to have decreased sperm concentration(millions/ml) by increasing BMI (kg/m2), as shown in Figure 1.

Figure 1: Distribution of sperm concentration (millions/ml) with respect to BMI (kg/m2)



DISCUSSION

Obesity is becoming a major public health concern due to its alarming rise in prevalence in both developing and developed countries. It has been well recognized that obesity raises the risk of developing diabetes, cardiac disease, hypertension as well as other chronic illnesses. However, research on the adverse consequences of obesity on the reproductive processes is still in its infancy. Our results corroborate the detrimental effects of obesity on the quality of semen parameters and are consistent with those of previous investigations.[11]

It has been suggested that Obesity affects semen quality, which in turn affects male fertility. Rufus O. *et al*. did a cross-sectional study to determine whether infertile male partners who visited the infertility clinic had lower-quality semen and raised BMI. Based on their research, it had been determined that there was no significant difference found in the pattern of abnormalities in semen parameters or the quality of semen among males with raised and normal BMI with p value 0.813.[12]

In a study conducted by Darand M. *et al*., it was examined that there is any relation between sperm quality indicators and obese infertile males. Researchers discovered a significant inverse connection between normal sperm morphology and BMI [adjusted β 0.074, Confidence Interval (− 0.141 to − 0.008) with P value 0.029] and Waist circumference [adjusted β 0.026, Confidence Interval (− 0.051 to − 0.001) with P value 0.038]. Furthermore, there was a moderately negative connection between visceral fat and non-progressive sperm motility (adjusted β − 0.241, Confidence Interval (− 0.495 to 0.014) with P value 0.063) as well as normal sperm morphology (adjusted β − 0.065, Confidence Interval (− 0.138 to 0.008) with P value 0.079). Their research concluded that normal sperm morphology was negatively correlated with visceral fat, obesity, and abdominal obesity. Nevertheless, no relationship was discovered between sperm concentration, sperm motility (progressive and non-progressive motility), or volume and the indicators related to obesity (Body Mass Index, Waist circumference, visceral fat, and muscle mass).[13]

Examining how obesity affects semen parameters, a number of review studies have published findings that have generated debate. The results do, however, agree with certain semen properties. 14–18 Salas-Huetos A. *et al*.'s investigation revealed a negative association between sperm concentration and obesity, which aligns with our findings. However, they also discovered a negative relation between obesity and both sperm number and overall motility, even though we could detect no correlation between the two. Thus, our results regarding sperm count and motility are contradictory.[14]

Wang *et al*. found that obesity significantly decreased total sperm number and percentage of forward progression. Still, they did not affect sperm concentration or percentage of normal sperm morphology in a meta-analysis of 15 trials comprising 6362 average obese persons. The results don't line up with what our investigation revealed.[15] Guo *et al*. found that high BMI significantly reduced sperm count and concentration but did not affect sperm motility (general or progressive) in a meta-analysis involving 26,814 participants. The results of sperm motility and concentration agree with our study; however, the sperm count results do not.[16] Sperm count, sperm concentration, volume, and sperm motility were found to be negatively correlated with obesity in another study done by Park *et al*. and published as a review paper. Regarding sperm concentration, the results agree with our study but not with other aspects of the semen.[17]

A recent meta-analysis of 20,367 obese individuals found, in contrast to our results, that obesity was linked to decreased sperm count, concentration, and progressive motility.[18] Following the previously described meta-analysis, several new studies have been conducted with fascinating results.[19-22] Esmaeili *et al*. discovered in a cross-sectional study that while positive BMI did not influence sperm volume and concentration, it was adversely connected with normal sperm morphology, sperm total motility, and progressive motility. The findings contradict what our investigation revealed.[19]

Another study conducted by Bahar GUR *et al*. documented the relationship between semen parameters and obesity. It has been discovered that there is no link at all between BMI and the concentration of sperm, their normal morphology, or their progressive motility. Findings are consistent concerning sperm morphology and motility but inconsistent with respect to sperm concentration, as we have established a negative correlation between sperm concentration and obesity.[20] High BMI was found to be negatively correlated with sperm motility, count, motility (progressive), and morphology (normal) by Abbasihormozi *et al*. The findings are inconsistent with our study.[21] In contrast to our findings, Pooladi *et al*. found that sperm motility (general or progressive) and BMI were negatively correlated, but not sperm morphology or count. Again, the findings are inconsistent with our study.[22]

After analyzing the studies, we discovered that the potential causes of the discrepancies may be due to various study designs, sample sizes, BMI cut-off points for defining obesity, and participant health statuses (fertile and healthy) in various studies. The following are some hypothesized mechanisms underlying obesity and sperm quality metrics. A plausible explanation could be the disturbance of the male reproductive endocrine axis, which impacts the hypothalamic-pituitary-testicular axis' regulatory function. Reduced semen volume and count may be indicated by low testosterone levels in obese men as well as by testosterone's effects on spermatocyte maturation and secondary spermatocyte meiosis.[23,24]

CONCLUSION

Based on our study, high BMI negatively correlates with sperm concentration. No correlation has been found between high BMI and other semen parameters such as total sperm number, morphology, motility, and vitality.

LIMITATIONS

However, our study had many shortcomings. First, the sample size was small. Second, estimating the causal association was challenging due to the study's design (cross-sectional). More meticulously planned research should be carried out to address the impact of male obesity on sperm parameters because there is a dearth of information on sperm quality and obesity-related issues.

SUGGESTIONS / RECOMMENDATIONS

A bigger sample size, potentially multi-centered prospective study, and standardized semen analysis technology are required to reach a representative and reasonable conclusion on the impact of BMI on the quality of semen in our context.

CONFLICT OF INTEREST / DISCLOSURE

The authors have no conflict of interest to disclose.

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