Original Article

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Association of BMI with Semen Parameters in the Male Partners of Infertile Couples: A Cross-sectional Study

Physiology Section

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ABSTRACT

Introduction: In today's scenario, obesity is increasing in children and young adolescents, and they are more likely to continue as obese adults. Temporal trends indicate that obesity is increasing while fertility is decreasing. Studies worldwide have reported a negative association between obesity and male fertility, but studies from India are scarce. Hence, there is a need to study the extent of the association between obesity and infertility.

Aim: To evaluate the association between Body Mass Index (BMI) and semen parameters in the male partners of infertile couples.

Materials and Methods: A cross-sectional study was conducted in the Department of Physiology, Government Medical College Aurangabad, Maharashtra, India, from August 2021 to August 2022. On total of 66 participants divided into two groups: Group A consisted of overweight and obese participants (BMI ≥23.0 kg/m^2), and Group B consisted of participants with normal BMI (BMI <23 kg/m^2). The semen parameters studied were semen volume, sperm concentration, total sperm count, total motility, and progressive motility. Semen samples were analysed according to the WHO 2010 guidelines. Continuous variables were expressed as mean±standard deviation. Unpaired t-test was used to compare the groups.

Results: The mean age in Group A and Group B was 30.18±4.5 and 28.27±4.35 years, respectively (p<0.08). The mean BMI in Group A and Group B was 27.01±2.94 kg/m^2 and 20.29±1.69 kg/m^2, respectively (p<0.0001). The mean sperm concentration in Group A was 37.01±42.6 million, and in Group B, it was 90.24±56.11 million (p<0.0001). Total motility in Group A was 27.8±31.36%, and in Group B, it was 57.9±28.41% (p<0.0001). Progressive motility in Group A was 18.75±24.79%, and in Group B, it was 42.63±26.15% (p<0.0003).

Conclusion: In the present study, high BMI (obesity and overweight) was significantly associated with low sperm concentration, count, and motility.

Keywords: Body mass index, Infertility, Obesity, Overweight, Semen quality

INTRODUCTION

Infertility is defined as the inability to achieve a pregnancy after one year or more of regular unprotected intercourse. According to data from the World Health Organisation (WHO), there are 48 million couples and 186 million individuals worldwide who experience infertility [1]. Fertility is considered a fundamental human right, and infertility can cause significant mental and social distress for the entire family. It can be caused by male factors, female factors, or a combination of both, but the evaluation and treatment of male factors are often less prioritised compared to female factors. In 1974, Nelson CMK and Bunge RG reported for the first time that the average sperm count and semen volume were lower than the values reported by Macleod J and Gold RZ in 1951 [2,3]. In 1992, a meta-analysis by Carlsen E et al., showed a nearly 50% decrease in the mean sperm concentration from 113 million/mL to 66 million/mL over the past 50 years (1938 to 1990) [4]. In India, Mishra P et al., conducted a systematic review of studies published between 1979 and 2016 and found a decreasing trend in seminal quality (sperm concentration and morphology) among Indian men [5].

Male infertility can be caused by various factors that affect the hypothalamo-pituitary-gonadal axis and semen parameters. Obesity is one significant factor that negatively influences male fertility. According to the WHO, global obesity rates have nearly tripled since 1975. In 2016, more than 1.9 billion adults (39%) were overweight, with over 650 million (13%) classified as obese. Additionally, in 2016, more than 340 million children and adolescents aged 5-19 years were overweight or obese, and 39 million children under the age of 5 were obese in 2020. These children are more likely to continue as obese adults in the future [6,7]. Numerous studies worldwide have demonstrated a negative association between obesity and male infertility [8-12]. However, research on the association between obesity and infertility in India is limited.

Therefore, the present study was conducted to assess the association between BMI and semen parameters, including semen volume, sperm concentration, total sperm count, total motility, and progressive motility, in male partners of infertile couples attending the reproductive biology unit for male fertility evaluation.

MATERIALS AND METHODS

A cross-sectional study was conducted at the Department of Physiology, Government Medical College Aurangabad, Maharashtra, India, from August 2021 to August 2022. Prior to conducting the study, ethical approval was obtained from the Institutional Ethics Committee (approval No. Pharma/IEC-GMCA/3/2020 dated 12-11-2020).

Inclusion criteria: The study included all male partners of infertile couples, aged between 21-40 years, who presented to the reproductive biology unit for semen analysis and willingly participated in the study by providing written, informed consent.

Exclusion criteria: Participants with a history of or risk factors that could affect the study parameters were excluded. These risk factors included solitary testis, varicocele, undescended testis, testicular tumour, genital tract infections, history of scrotal surgery, hormonal disorders, psychological diseases, tobacco or alcohol addiction, and ongoing medications for chronic illnesses.

Sample size: The sample size was determined based on a time-bound approach. A total of 66 male partners of infertile couples who attended the reproductive biology unit for semen analysis and met the inclusion and exclusion criteria within the study duration were enrolled using purposive sampling.

Procedure

Data collection: Participants were provided with a consent form, and the study procedure was explained to them in their native language. Detailed histories focusing on chief complaints, past history, personal history, family history, dietary history, treatment history, and surgical history of the patients were recorded. Physical examinations, including general and systemic examinations, were conducted while considering the inclusion and exclusion criteria. Relevant participant details were recorded in the case record form.

Semen analysis: Semen samples were analysed according to the WHO 2010 guidelines for semen volume, sperm concentration, total sperm count, total motility, and progressive motility [13]. Participants were given appointments and instructed to maintain sexual abstinence for four days before returning to the morning Outpatient Department (OPD) on Mondays and Fridays.

The semen sample collection process involved providing clear instructions to the participants. They were instructed to collect the semen sample through masturbation into a clean and sterile wide-mouthed semen container in a designated room within the Reproductive Biology Unit. Any loss of sample during collection was duly noted. The collected samples were labeled with the patient's name, MRD number, date, and time of collection.

Macroscopic semen analysis: The collected samples were allowed to undergo liquefaction for 30 minutes at 37°C. After this period, the semen samples were assessed for semen volume [13,14].

Microscopic semen analysis: The semen samples were evaluated for sperm concentration and motility using a ten-micron-depth chamber, following the WHO guidelines.

Sperm concentration [13]: Sperm concentration refers to the number of spermatozoa per unit volume of semen, typically expressed as million per milliliter. It is calculated based on the number of sperm counted in 10 squares and expressed as a concentration in a million per milliliter.

Lower reference limit for sperm concentration: The lower reference cut-off for sperm concentration is 15×106 spermatozoa per milliliter (5th centile, 95% CI 12-16×106) [13].

Total sperm count: Total sperm count represents the overall number of spermatozoa in the entire ejaculate and is obtained by multiplying the sperm concentration by the semen volume [13]. Total sperm count (million per ejaculate)=sperm concentration (million per milliliter)×semen volume in milliliters.

Lower reference limit for total sperm count: The lower reference limit for total sperm count is 39×106 spermatozoa per ejaculate (5th centile, 95% CI 33-46×106) [13].

Sperm motility assessment was performed at room temperature within one hour following ejaculation. When scoring spermatozoa in two stages, a count of 200 was completed before counting all motility categories from that area. Counting continued beyond 200 until all motility categories had been counted to avoid bias towards the first scored motility category [13].

Lower reference limit: The lower cut-off for total motility (progressive motility+non-progressive motility) is 40% (5th centile, 95% CI 38-42). The lower cut-off for progressive motility is 32% (5th centile, 95% CI 31-34) [13].

Weight was measured using an electronic weighing scale in kilograms with minimal clothing. Height was measured in meters using a wall-mounted stadiometer. Participants were instructed to remove their footwear and headgear, stand against the wall with their feet together, heels against the wall, knees straight, and look straight ahead to ensure that their eyes were at the same level as their ears. The measuring tape of the stadiometer was lowered onto their head, and the height measurement was displayed.

The BMI was calculated by dividing the weight in kilograms by the height in meters squared. According to the WHO, for Asians, the cut-off for overweight is ≥23.0 kg/m^2, and for obesity, it is ≥25.0 kg/m^2 [15]. All participants were divided into two groups.

- Group A included participants with a BMI equal to or above the cut-off value (≥23.0 kg/m^2), indicating overweight and obesity.
- Group B consisted of participants with a BMI below the cut-off value (<23 kg/m^2).

STATISTICAL ANALYSIS

The patients' data obtained was kept confidential, and only the study parameter data, which does not identify the patient, was used for analysis and publication. For analysis, the data were entered into an MS Excel worksheet, and a master chart was prepared. All statistical tests were performed using the Statistical Package for Social Sciences (SPSS) trial version 25. Mean±SD values of all study variables were calculated. An unpaired t-test was used to compare the groups. Statistical significance was considered at the level of p<0.05.

RESULTS

In the present study, the two groups were age-matched (p-value 0.08) and height-matched (p-value 0.39), indicating that age and height were not confounding factors. The BMI and weight were significantly higher in the high BMI group compared to the low BMI group, with a p-value of 0.0001 [Table/Fig-1].

S. No.	Demographic parameters (n=66)	High BMI group (Mean±SD) n=33 (50%)	Normal BMI group (Mean±SD) n=33 (50%)	t value	p-value (Unpaired t-test)
1	Age (years)	30.18±4.51	28.27±4.35	-2.216	0.08
2	Height (cm)	166.75±5.2	165.42±7.27	-0.853	0.39
3	Weight (kg)	75.30±9.81	55.72±5.77	-9.883	**0.0001**
4	BMI (kg/m^2)	27.01±2.94	20.29±1.69	-11.384	**0.0001**

[Table/Fig-1]: Comparison of demographic parameters among hign and normal BMI groups.

Regarding semen parameters, there was no statistically significant difference in semen volume between the high BMI group and the normal BMI group. However, the sperm concentration, total sperm count, total motility, and progressive motility were significantly higher in the normal BMI group compared to the high BMI group [Table/Fig-2].

S. No.	Semen parameters	High BMI group (Mean±SD)	Normal BMI group (Mean±SD)	t value	p-value
1	Semen volume	2.98±1.79	3.30±1.41	0.807	0.4228
2	Sperm concentration (×10^6/mL)	37.60±42.60	90.24±56.11	4.292	**<0.0001**
3	Total sperm count (×10^6/ejaculate)	116.12±169.4	297.03±191.96	4.059	**<0.0001**
4	Total motility	27.8±31.36%	57.9±28.41%	4.086	**<0.0001**
5	Progressive motility (%)	18.75±24.79%	42.63±26.15%	3.807	**<0.0003**

[Table/Fig-2]: Semen parameters in two groups.

DISCUSSION

The present study aimed to evaluate the association between BMI and semen parameters, including semen volume, sperm concentration, total sperm count, total motility, and progressive motility in male partners of infertile couples.

The results of the present study demonstrated a highly significant decrease in sperm concentration, total sperm count, total motility, and progressive motility with increasing BMI. Although there was a decrease in semen volume with increasing BMI, it was not statistically significant. The findings indicate that obesity and overweight are associated with a decline in semen quality. Similar results were

observed in other studies. Hammoud AO et al., reported a higher incidence of oligozoospermia (decreased sperm concentration) and a lower prevalence of progressive motility with increasing BMI [11]. Hofny ER et al., found a significant negative correlation between BMI and sperm concentration and motility [12]. Hakonsen LB et al., demonstrated a negative association between BMI and sperm concentration, total sperm count, sperm morphology, and sperm motility [16].

A systematic review conducted by Sermondade N et al., also supported the link between overweight/obesity and an increased prevalence of azoospermia or oligozoospermia [8]. Hammiche F et al., found that overweight was negatively associated with progressive motility, while obesity was negatively associated with ejaculate volume, sperm concentration, and total motile sperm count [9]. Eisenberg ML et al., in their Longitudinal Investigation of Fertility and the Environment (LIFE) study, identified a linear decline in ejaculate volume with increasing BMI [10].

A study conducted by Maghsoumi NL et al., in Iran reported that being overweight and obese may worsen the infertility situation [17]. However, Imtiaz R et al., found no relationship between semen parameters and BMI in their research [18]. Similarly, Alahmar AT et al., found no link between obesity and semen quality [19].

Over the past few decades, there has been a simultaneous increase in obesity rates and a decrease in fertility. Globally, the prevalence of infertility is increasing, with a significant rise in both females and males from 1990 to 2017 [20]. The possible pathophysiology behind the effect of increasing BMI on semen parameters involves increased aromatisation of testosterone to estradiol in adipose tissue. Elevated estradiol levels negatively impact gonadotropin pulses, leading to reduced gonadotropin levels, decreased testosterone production, and impaired spermatogenesis. Additionally, increased scrotal adiposity can raise testicular temperature, directly affecting spermatogenesis [11].

In the present study, the lack of a significant decline in semen volume can be attributed to extreme values. Overall, the findings indicate that an increase in BMI, specifically overweight and obesity, has a negative impact on semen parameters. It is important for clinicians to advise male partners of infertile couples to maintain a healthy weight to optimise semen parameters. The highly significant statistical results in the present study corroborate the findings of previous studies.

Limitation(s)

The limitations of the present study include the relatively small sample size. Additionally, could not not analyse other semen parameters such as sperm morphology, sperm vitality, sperm DNA fragmentation index, seminal fructose, and seminal zinc. Furthermore, hormonal analysis was not conducted.

CONCLUSION(S)

There is a highly significant association between an increase in BMI and a decrease in semen parameters, including sperm concentration, total sperm count, total motility, and progressive motility, in male partners of infertile couples. Therefore, obesity and overweight are associated with a decline in semen parameters compared to normal-weight individuals. Further studies should evaluate the effect of weight loss on semen parameters in obese males.

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