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Original Research Article

Effect of anthropometric factors on semen quality: a prospective cohort study

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ABSTRACT

Background: Aim was to evaluate the association between anthropometric factors and semen parameters. Prospective analysis of relation between the anthropometric factors and semen parameters of male patients attending the OPD for infertility evaluation in institute of reproductive medicine, Madras medical mission hospital, Chennai

Methods: Male patients attending the OPD from December 2023 to May 2024. The study included 105 patients according to inclusion criteria whose age, height (cm), weight (kg), body mass index (BMI) (kg/m^2), waist circumference (WC) (cm), hip circumference (cm) and waist hip ratio (WHR) were measured in their first visit and compared with seminal volume, concentration, count, total motility and morphology.

Results: In this study as the age increases, the sperm concentration, count and total motility is found to be deteriorating. However, the volume and morphology does not have any association. BMI was found to have inverse relation with the seminal parameters and statistical association with the sperm concentration, count, total motility and morphology. The sperm concentration, count and morphology were found to be reducing with increased WC. WHR affects the concentration, motility and morphology negatively.

Conclusions: This study concluded that age and BMI statistically has negative correlation on semen parameters, however measures of central obesity like WC and WHR does not have any statistical correlation with the semen parameters.

Keywords: Age, BMI, WC, WHR, Semen parameters, Anthropometric factors

INTRODUCTION

All these years infertility treatments were mainly focussed on the female, however the recent advances in medical field have given a new spectrum where the male infertility issues been addressed. The aetiology for male infertility can be as simple as unhealthy lifestyle to complex genetic mutations and medical diseases.¹ Male infertility contributes to 30 to 40 % alone and in addition to female factors the contribution increases by 30%.²

On considering the extensive lifestyle changes over few decades, obesity was found to be adversely influencing the general as well as the reproductive health. The endocrine

changes were identified to be the cause for this pandemic of obesity leading to reduced seminal parameters in males.² The dysregulated steroidogenesis caused by the adipokine not only decrease the fertility potential in males but also alters the insulin sensitivity and inflammatory mechanisms.

The recent studies have found the potential role of central obesity affecting the seminal parameters, measured by the WC and WHR.³ On the other hand, BMI considers the whole weight of the individual missing the pattern of fat distribution and deposition. Various hormones like leptin, ghrelin and resisting aggravates the inflammatory pathways and cytokine release in Sertoli and Leydig cells

affecting the testosterone production as well as the process of spermatogenesis. These multiple mediators dysregulate the hypothalamic pituitary-testosterone axis leading to the vicious cycle of obesity and hypogonadism.⁴

The rapidly rising overall weight and central obesity in adults and adolescents have paved the way for studies to identify the relation between the fat distribution in males and its effect on the semen quality.⁵ The anthropometric factors like BMI, WC and WHR are widely used to assess obesity as they are inexpensive and reproducible. Hence this study aims to identify this knowledge gap between the central obesity and overall raised BMI reflecting the fertility potential of males.

METHODS

This was a prospective cohort study conducted in institute of reproductive medicine, the madras medical mission hospital. The institutional scientific and ethical committee approval was obtained and data was from December 2023 to May 2024. Males of age less than 40 years without any co morbid conditions and able to produce semen sample were included in the study. Men with co morbid condition, previous history of testicular surgery and medications for increasing semen quality, substance abusers like alcoholic, smokers were excluded from this study.

All men attending the IRM OPD was analysed and recruited based on the selection criteria. Age and anthropometric measurements like height (cm), weight (kg), BMI (kg/m²), WC (cm) and hip circumference (cm) was measured after getting the consent from the patient. The waist circumference was measured at the level of umbilicus and hip circumference at the largest circumference around the buttocks. WHR was calculated by dividing the waist and hip circumference.

The semen sample was collected in the andrology lab and analysed as per WHO guidelines (6th edition). Among the seminal parameters, volume of semen, concentration, sperm count, total motility and morphology were considered to find its effect in terms with the anthropometric factors. The data was grouped into three categories as normal (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²) and obese (>30 kg/m²) based on the BMI. The cut off values for waist circumference and WHR was taken as 90 cm and 0.9 respectively in this study. Pearson correlation coefficient and chi square test were used to determine the association between the anthropometric factors and seminal parameters. P value of less than 0.05 was taken as statistically significant.

RESULTS

In this study total of 110 samples were collected (n=110), out of which 5 patients were found to have 1-2 or nil sperms. Hence the statistical analysis of data from 105 patients has been considered for analysis. The data was separated into 2 groups based on the age and more men

were in higher age group 31 to 40 years contributing 68.6%. Among the 3 groups of BMI there were 37.1% in normal range, 35.2% in the overweight category and 27.6% in the obese category. The 57.1% men in this study were found to have the waist circumference of more than 90 cm whereas the WHR was normal in majority contributing 59% of the sample size (Table 1).

Table 1: Variable distribution, (n=105).

Variables	N (%)
Age (in years)	
21 to ≤30	33 (31.4)
31 to <40	72 (68.6)
BMI (kg/m²)	
18.5 to 24.9	39 (37.1)
25 to 29.9	37 (35.2)
≥30	29 (27.6)
WC (cm)	
≤90	45 (42.9)
>90	60 (57.1)
WHR	
≤0.9	62 (59)
>0.9	43 (41)

On analysing the mean values for those 5 samples with few sperms the mean age was found to be 34.6 years, BMI was in overweight category, 28.6 kg/m². Waist circumference mean was 95.8 cm and the WHR was in the normal range which is 0.8. The mean semen volume for those 5 samples were 2.1 ml. As the data size was very small the statistical analysis could not be performed. Based on the mean values, it was clear that as the age and weight increase the risk of reduced semen quality increases. The volume of semen was however not found to be affected in these men.

In this study on comparing the role of increasing age (Table 2) with the semen parameters of 105 men, it was found that the mean seminal volume was almost insignificant in both groups. The concentration, count and the motility was found to be drastically decreasing as the age increases with the negative correlation in the Pearson coefficient -0.203, -0.213 and -0.197 respectively. The morphology of the sperms did not have impact in both groups and statistically no correlation was found.

The BMI also did not show any relation between the groups normal, overweight and obese group with the seminal volume (Table 3). However, it was noticed that as the BMI increases, the concentration, count and motility decreases. The mean concentration in normal weight group dropped from 49.3 million to 40.5 million in obese group. Similar to this the count and motility was also found to be decreased in normal weight and obesity group from 74.8 million to 46.1 million and 48.1% to 45.1% respectively.

In this study, the WC (Table 4) and WHR (Table 5) as found in the recent literature did not have any statistical correlation with the seminal parameters. The concentration

and the count were found to be decreased as the WC increases leaving no notable changes in the other semen parameters. The relation between WHR semen parameters also showed that concentration, count and motility and

morphology decrease as the ratio rises up. In spite of these reduction in the seminal parameters, the statistical correlation or significance could not be elicited in the WC, WHR with the seminal parameters.

Table 2: Comparison of age with semen parameters

Age (in years) (n=105)	Volume (ml)	Conc. (million/ml)	Count (million/ejaculate)	Motility (%)	Morphology (%)
21 to ≤30, (n=33)	2.29	51.96	86.78	50.93	2.9
31 to <40, (n=72)	2.36	40.23	65.44	44.5	2.6
Pearson coefficient (mean)	0.109	-0.203	-0.213	-0.197	0.144

Table 3: Comparison of BMI with semen parameters.

BMI (kg/m ²), (n=105)	Volume (ml)	Conc. (million/ml)	Count (million/ejaculate)	Motility (%)	Morphology (%)
18.5 to 24.9, (n=39)	2.36	49.3	74.8	48.1	3
25 to 29.9, (n=37)	2.34	40.8	65.6	45.08	2.4
≥30, (n=29)	2.30	40.5	46.1	45.1	2.6
Pearson coefficient (mean)	0.145	-0.039	-0.014	-0.017	-0.056

Table 4: Comparison of WC with semen parameters.

WC (cm), (n=105)	Volume (ml)	Conc. (million/ml)	Count (million/ejaculate)	Motility (%)	Morphology (%)
≤90, (n=45)	2.30	48.64	78.26	46.5	2.65
>90, (n=60)	2.36	40.33	74.01	47.23	2.56
P value	0.509	0.357	0.720	0.416	0.153

Table 5: Comparison of WHR with semen parameters.

WHR (ratio), (n=105)	Volume (ml)	Conc. (million/ejaculate)	Count (million/ml)	Motility (%)	Morphology (%)
≤0.90, (n=62)	2.366	49.38	74.87	48.15	3.00
>0.9, (n=43)	2.345	40.81	75.91	45.08	2.4
P value	0.926	0.357	0.195	0.197	0.194

DISCUSSION

The imbalance in the endocrine functions in males was found to be caused by the various factors which in turn leads to the obesity. The defective GnRH pulse release affecting the Sertoli and Leydig cell function, the multiple inflammatory mediators and cytokines, increased oxidative stress, aromatization of testosterone to estrogen plays a pivotal role in male infertility influenced by increased adiposity in the body.^{4,6} Thus this study further confirms that increased fat distribution leads to suboptimal seminal parameters. The testosterone levels were found to be falling after 30 years of age at the rate of 1-2% annually as stated in Martin et al study.⁷

In the recent meta-analysis by Guo et al which included 25 studies covering 26814 participants, also found similar results to this study where the increasing BMI had a negative effect on the seminal parameters.⁸

Joseph et al conducted a study to evaluate the relation between anthropometric factors and seminal parameters in 1185 samples found that BMI and WC negatively affect the semen parameters. They also concluded that weight gain during the adolescence also impacted adversely on the seminal parameters.⁹

In a study by Keszthelyi et al potential role of central obesity measured by WC and WHR was analysed for its effect on the semen parameters. This study showed that both BMI and WHR correlates with the seminal values. On considering WHR as independent variable, they found that WHR had a remarkable negative correlation statistically with low sperm count and motility. The sperm concentration and morphology were not affected by the central adiposity in this study.³

In a cross-sectional study by Teja et al including 140 males found that BMI (>25 kg/m²) and waist circumference (≥90

cm) affected the motility of the sperms and increased sperm concentration was found with increased BMI, waist circumference to WHR in contrary to the previous literature and various studies evaluating the effect of anthropometric factors on semen quality.¹⁰

Uzun et al studied the effect of BMI and waist circumference not only in terms of reproductive potential in males but also their metabolic complications. This study also found that increased BMI showed an inverse association with sperm count similar to our study but the waist circumference was exhibited to have negative correlation with many seminal parameters like sperm count, concentration and morphology of sperm. They also concluded that basal metabolic rate was also found to have positive relation with the testicular volume and the testosterone levels. waist circumference was also found to be negatively influencing the FSH and other male hormones.¹¹

In a cross-sectional study conducted by Tsao et al Taiwanese males, it was noted that age was inversely related to semen parameters with statistical significance for sperm total motility ($p < 0.001$), progressive motility ($p < 0.001$) normal sperm morphology ($p < 0.001$) and sperm concentration ($p = 0.004$). BMI caused reduced seminal parameter except sperm motility. This study found significant reduction in morphology as the waist circumference WHR increases.¹²

In spite of contributions from various literatures supporting this study, lesser sample size and small cohort of males only from a tertiary care centre being included in this study are considered to be the limitations of this study. In order to bring out clear picture on the central obesity in future, studies with higher number of males from general population and better understanding on endocrine mechanism associated with obesity and particularly fat distribution should be evaluated to improve the management and treatment plans in association with male infertility.

CONCLUSION

This study concludes that age and BMI are the crucial factors in determining the fertility in males. Age, being an unmodifiable factor, it brings out an awareness among men in starting family earlier. The obesity was found to be affecting the essential parameters in semen like concentration, count, total motility and morphology. Even though the WC was found to be affecting the sperm count and concentration there was no statistical association. WHR does not have any statistical significance with the seminal parameters. Thus, study points out the importance of healthy life style, early identification of problems, timely intervention and be thoughtful in age factor in males to bring out a healthy generation in future.

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REFERENCES

1. Fainberg J, Kashanian JA. Recent advances in understanding and managing male infertility. *F1000Research*. 2019;8:670.
2. Katib A. Mechanisms linking obesity with male infertility. *Cent Eur J Urol*. 2015;68(1):79-85.
3. Keszthelyi M, Gyarmathy VA, Kaposi A, Kopa Z. The potential role of central obesity in male infertility: body mass index versus waist to hip ratio as they relate to selected semen parameters. *BMC Public Health*. 2020;20(1):307.
4. George BT, Jhancy M, Dube R, Kar SS, Annamma LM. The Molecular Basis of Male Infertility in Obesity: A Literature Review. *Int J Mol Sci*. 2023;25(1):179.
5. Hammiche F, Laven JSE, Twigt JM, Boellaard WPA, Steegers EAP, Steegers-Theunissen RP. Body mass index and central adiposity are associated with sperm quality in men of sub fertile couples. *Hum Reprod*. 2012;27(8):2365-72.
6. Hammoud AO, Wilde N, Gibson M, Parks A, Carrell DT, Meikle AW. Male obesity and alteration in sperm parameters. *Fertil Steril*. 2008;90(6):2222-5.
7. Martins Da Silva S, Anderson RA. Reproductive axis ageing and fertility in men. *Rev Endocr Metab Disord*. 2022;23(6):1109-21.
8. Guo D, Wu W, Tang Q, Qiao S, Chen Y, Chen M, et al. The impact of BMI on sperm parameters and the metabolite changes of seminal plasma concomitantly. *Oncotarget*. 2017;8(30):48619-34.
9. Joseph MD, Hatch EE, Koenig MR, Eisenberg ML, Wang TR, Sommer GJ, et al. A North American study of anthropometric factors and semen quality. *Fertil Steril*. 2023;120(3):586-96.
10. Teja GK, Satyavathi GAL. Study on anthropometric profile of male partners of infertile couples. *Obsgyne Rev J Obstet Gynecol*. 2019;5(3):153-60.
11. Uzun H, Huner M, Kivrak M, Zengin E, Ozsagır YÖ, Sönmez B, et al. The relationship between anthropometric and metabolic risk factors and testicular function in healthy young men. *Clin Exp Reprod Med*. 2024;51(1):48-56.
12. Tsao CW, Liu CY, Chou YC, Cha TL, Chen SC, Hsu CY. Exploration of the Association between Obesity and Semen Quality in a 7630 Male Population. Meyre D, editor. *PLOS One*. 2015;10(3):e0119458.

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