ORIGINAL RESEARCH

Waist-to-Hip Ratio, BMI, and Sperm Parameters: A Correlation Study

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Abstract

Objective: Male obesity and infertility are growing health concerns, yet the relationship between obesity and sperm parameters remains controversial. This study aimed to investigate the association between waist-to-hip ratio (WHR), body mass index (BMI), and sperm parameters in adult males at a selected center in the Colombo district, Sri Lanka.

Methods: A descriptive study was conducted from September to November 2023 at Colombo South Teaching Hospital (CSTH) with 104 male volunteers. Waist, hip, weight, and height were measured following standard protocols and semen samples were collected after three days of abstinence. WHR categories were ≤0.9 (normal) and >0.9 (obese), while BMI was categorized as normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (>30 kg/m^2). Sperm parameters assessed included volume, viability, count, motility, and morphology. Statistical analysis using SPSS 27.0, employed t-tests, correlation, and regression analysis, with significance at $P < 0.05$.

Results: Males with a WHR>0.9 showed higher semen volume (1.82±0.74 ml), sperm concentration (85.42±55.20 million/ml), sperm count (163.28±142.47 million/ml), and normal sperm morphology (11.04±5.99 %) compared to those with a WHR≤0.9. No consistent linear trend was observed for BMI with sperm concentration (p=0.42), count (p=0.61) or viability (p=0.89). Sperm motility showed slight variations across BMI categories; however, it was statistically non-significant (p=0.95, p=0.617). WHR showed a potential positive association with sperm morphology (r^2=0.06, p=0.05) and was identified as an independent risk factor for sperm morphology in multivariate analysis (95% CI: 48.3–1.08, p=0.041).

Conclusions: WHR and BMI showed no significant correlations with most sperm parameters, however, WHR positively influenced normal sperm morphology, warranting validation in larger studies.

Keywords: Male infertility, obesity, BMI, WHR, sperm parameters.

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Introduction

Infertility is a serious health issue affecting many couples in our society. The World Health Organization (WHO) defines infertility as a disease of the male or female reproductive system, characterized by the failure to achieve pregnancy after 12 months or more of regular unprotected sexual intercourse affecting an estimated 8–12% of couples worldwide (1). Numerous factors contribute to infertility, including hormonal imbalances, age, genetic factors, structural abnormalities, lifestyle factors, infections, and environmental factors (2,3). Male factors account for 30% of infertility cases, female factors for 35%, and 25% involve both partners or remain unexplained (4). In Sri Lanka, infertility is a growing concern, affecting 10–15% of couples and highlighting the need for increased awareness, diagnosis, and treatment options (5). Male infertility is often associated with low sperm count, poor motility, abnormal morphology, erectile dysfunction, or structural abnormalities that impede fertilization (6). Additionally, lifestyle factors such as obesity, smoking, and excessive alcohol consumption significantly contribute to the condition (7).

Obesity, a major health issue, affects millions of people worldwide, with over 400 million adults classified as obese and 1.6 billion as overweight (7). It is a risk factor for diseases such as cardiovascular disease and diabetes and has been shown to impact male fertility (8). It has also been suggested that excess weight can disrupt hormonal balance and increase oxidative stress, potentially interfering with sperm production and function (9).

Published literature shows controversial associations between obesity and sperm parameters, such as semen volume, sperm viability, concentration, count, motility, and morphology which can be evaluated by Seminal Fluid Analysis (SFA). The SFA plays a vital role in evaluating male fertility, guiding appropriate treatment strategies. The WHO's reference values guide the interpretation of these parameters. Semen volume should be >1.5 mL, and sperm viability (54%-97%), concentration (>15 million/ml), motility (>40%) and morphology (>4%) should meet defined thresholds for a single ejaculate to support fertility (10).

Some studies indicate a positive correlation, showing that men with a BMI greater than 30 kg/m² have a 22% lower semen volume compared to those with a BMI of 20–25 kg/m² (2). Another study reported that obesity is linked to decreased sperm viability, possibly due to factors such as hormonal imbalances and oxidative stress (10). Conversely, one study reported no link between BMI and sperm parameters such as sperm motility and sperm morphology (11), and another study showed no significant relationship between WHR and sperm count or viability (6).

Body Mass Index (BMI) is the most frequently used indicator of obesity; however, it does not account for factors such as fat distribution and central adiposity, which are more accurately reflected by the waist-to-hip ratio (WHR) (12). Despite the growing recognition of WHR as a better indicator of these factors, limited studies have investigated its relationship with sperm parameters. To our knowledge, there are no studies published in Sri Lanka that assess the correlation between WHR and sperm parameters. Therefore, this study aimed to explore the association between both WHR and BMI and sperm parameters in adult males. These findings provide valuable insights into the local context, bridging knowledge gaps and contributing to the management of male infertility.

Methods

This descriptive study was conducted in the Andrology Laboratory of the Fertility and Andrology Clinic at the CSTH, Kalubowila, Sri Lanka, from September to November 2023. The study included 104 male participants who attended the clinic for intrauterine insemination (IUI) treatment. The sample size was calculated using the Cochran formula, assuming a 95% confidence level, a population proportion of 50%, and a degree of precision of 0.1. The required sample size was 97, however, 104 participants were recruited to increase the statistical power of the study.

Participants were selected based on predefined inclusion and exclusion criteria. Adult males aged over 18 who volunteered for the study were included. Individuals unable to provide a semen sample or unwilling to undergo anthropometric measurements, high-frequency smokers and individuals with excessive alcohol consumption were excluded. Data collection involved an interviewer-administered questionnaire to gather demographic information such as age, ethnicity, education level, and occupation, lifestyle factors such as smoking status, alcohol consumption and physical activity, and medical history. Anthropometric measurements, including weight, height, waist circumference, and hip circumference, were taken on the same day as semen collection. BMI was calculated as weight in kilograms divided by height in square meters. WHR was calculated by dividing waist circumference by hip circumference, both measured using a non-elastic tape following standardized procedures. Semen samples were collected in sterile containers by masturbation after a three-day period of abstinence. These semen samples were analyzed and results were produced as SFA reports according to the WHO Laboratory Manual for the Examination and Processing of Human Semen, Sixth Edition (2021). Key sperm parameters, such as semen volume, sperm viability, total sperm count, total sperm motility, and normal sperm morphology, were extracted from the SFA reports to be used in the present study analysis.

BMI was categorized into underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (>30.0 kg/m²). WHR values were classified as normal (≤0.9) or overweight (>0.9). The association between BMI, WHR, and sperm parameters was assessed by comparing the sperm parameters of individuals in the normal BMI and WHR groups with those in the other categories. Data were analyzed using IBM SPSS software and Microsoft Office LTSC Standard 2021. Statistical methods, including cross-tabulations, significance tests, and graphical representations, were employed to summarize the results. The ethical approval for the study was obtained from the Ethics Review Committee of CSTH and the Head of the Department of Obstetrics and Gynecology.

Results

A total of 104 male participants were included in this descriptive study conducted at the Fertility and Andrology Clinic of the CSTH from September to November 2023. The mean age of the participants was 35.53±5.89 years (range: 23–53), with a mean BMI of 25.7±3.2 (range: 19.2–35.6) and a mean WHR of 0.94±0.05 (range: 0.80–1.07). Regarding BMI, 46.2% of the participants were classified as "Normal," 40.4% as "Overweight," and 13.5% as "Obese." WHR analysis revealed that 25.0% had a WHR ≤0.9, while 75.0% exceeded this threshold. Among the participants, 93.3% (n=97) reported abstaining from smoking, while 2.9% (n=3) were active smokers with varying cigarette consumption (1–10 cigarettes per day). Regarding alcohol consumption, 62.5% (n=65) abstained entirely, whereas 37.5% (n=39) reported occasional drinking, with quantities ranging from 40 ml to 150 ml. High-frequency smokers and individuals with excessive alcohol consumption were excluded from the study to minimize confounding effects.

In this study, individuals with a WHR >0.9 unexpectedly exhibited a higher sperm concentration (85.42±55.204 million/ml) compared to those with a WHR ≤0.9 (74.58±64.708 million/ml) (Table 1). Despite the similar total sperm motility (WHR≤0.9: 68.08±13.711%; WHR>0.9: 67.42±13.876%) and progressive motility rates (WHR≤0.9: 56.27±16.718%; WHR>0.9: 56.17±15.95%) between both groups, those with a WHR>0.9 exhibited notably higher sperm counts (163.28±142.47 million/ml). Additionally, there were distinctive differences in sperm morphology, individuals with a WHR>0.9 showing significantly higher percentages of normal sperm morphology (11.04±5.99%) compared to those WHR≤0.9 group (9.38±5.756%).

The analysis of sperm parameters across BMI categories revealed intriguing patterns (Table 2). While sperm concentration increased with higher BMI categories, showing the highest concentration in the overweight group (95.86±55.80 million/ml) followed by the normal BMI (76.56±58.68 million/ml) and obese groups (64.36±54.26 million/ml), sperm count did not exhibit a consistent linear trend. Total sperm motility and progressive motility showed slight variations, with higher values observed in the overweight category compared to the normal and obese categories. In contrast, immotile sperm percentages and non-progressive motility did not follow a clear linear trend across BMI categories. Remarkably, sperm morphology displayed distinct patterns, with the overweight category showing higher percentages of normal sperm morphology (11.9±5.75%) compared to both normal BMI (10.25±5.97%) and obese categories (8.07±5.87%).

Table 01: Distribution of sperm parameters by WHR category

Characteristic	WHR	
	≤ 0.9	> 0.9
N	26	78
Participants Age	34.85 ± 6.27	35.76 ± 5.78
Period of Abstinence (days)	4.15 ± 1.69	3.76 ± 1.10
Sperm Concentration (million/ml)	74.58 ± 64.71	85.42 ± 55.20
Sperm Viability (%)	71.15 ± 17.13	74.99 ± 13.67
Sperm Count (million/ml)	125.65 ± 128.13	163.28 ± 142.47
Total Sperm Motility (%)	68.08 ± 13.71	67.42 ± 13.87
Progressive Motility (%)	56.27 ± 16.72	56.17 ± 15.95
Immotile Sperm (%)	32.08 ± 13.63	32.32 ± 13.99
Semen Volume (ml)	1.769 ± 0.863	1.822 ± 0.744
Non-progressive motility (%)	12.15 ± 4.93	11.38 ± 3.46
Sperm Morphology (%)	9.38 ± 5.75	11.04 ± 5.99

Table 02: Distribution of sperm parameters by BMI category

Characteristic	BMI (kg/m2)		
	Normal (18.5-24.9 kg/m^2)	Overweight (25-29.9 kg/m^2)	Obese (>30 kg/m^2)
N	48	42	14
Participants Age	34.9 ± 6.0	36.69 ± 5.706	34.21 ± 5.86
Period of Abstinence (days)	4.02 ± 1.55	3.79 ± 1.02	3.5 ± 0.8
Sperm Concentration (million/ml)	76.56 ± 58.68	95.86 ± 55.81	64.36 ±54.26
Sperm Viability (%)	73.54 ± 16.49	75.45 ± 11.50	71.43 ± 16.65
Sperm Count (million/ml)	150.96 ± 139.46	160.05 ± 111.73	145.36 ± 209.77
Total Sperm Motility (%)	67.42 ± 14.41	69.12 ±12.27	63.57 ± 15.86
Progressive Motility (%)	55.67 ± 16.52	58.48 ± 15.09	51.14 ± 17.14
Immotile Sperm (%)	32.38 ± 1.64	30.74 ± 12.14	36.43 ± 15.86
Semen Volume (ml)	1.854 ± 0.778	1.695 ± 0.654	1.993 ± 1.045
Non-progressive motility (%)	11.94 ± 4.28	10.88 ± 3.73	12.43 ± 2.34
Sperm Morphology (%)	10.25 ± 5.97	11.9 ± 5.7	8.07 ± 5.87

The study examined the correlations between BMI and WHR with various sperm parameters, revealing predominantly weak and statistically non-significant associations. BMI did not significantly affect sperm parameters, with weak correlations for sperm concentration (p=0.422), viability (p=0.894), count (p=0.617), motility (total p=0.958, progressive p=0.795, non-progressive p=0.296), immotile sperm percentage (p=0.987), morphology (p=0.907), and semen volume (p=0.759) (Table 3). WHR also showed weak associations, though it had a slightly stronger correlation with sperm count and a trend toward a positive link with sperm morphology (p = 0.050), suggesting higher central adiposity may reduce normal sperm morphology.

Univariate analysis (Table 4) revealed no statistically significant associations ($p > 0.05$) between BMI, WHR, or any other demographic, lifestyle, or medical factors with sperm parameters, except for WHR and normal sperm morphology (96% CI: 39.79-0.36, p=0.039). Similarly, multivariate analysis identified no significant independent factors influencing sperm parameters, except for WHR, which emerged as an independent risk factor for sperm morphology (95% CI: 48.3–1.088, *p*=0.041).

Table 03: Correlations of WHR and BMI with sperm parameters

Variable	BMI (kg/m^2)	p value	WHR	p value
Sperm Concentration (million/ml)	0.08	0.422	0.106	0.286
Sperm Viability (%)	0.013	0.894	0.106	0.284
Sperm Count (million/ml)	0.05	0.617	0.13	0.189
Total Sperm Motility (%)	0.005	0.958	0.07	0.478
Progressive Motility (%)	0.026	0.795	0.074	0.456
Non progressive motility (%)	-0.103	0.296	-0.055	0.579
Immotile Sperm (%)	-0.002	0.987	-0.082	0.405
Sperm Morphology (%)	0.012	0.907	0.189	0.050
Semen Volume (ml)	-0.03	0.759	0.024	0.81

Table 04: Univariate and multivariate logistic analysis for screening the independent Influencing factors of normal sperm morphology

	Univariate Analysis		Multivariate Analysis	
Variable	**95% C.I.**	**p value**	**95% C.I.**	**p value**
Age (years)	(0.119-0.276)	0.434	(0.132-0.315)	0.419
BMI	(0.37-0.33)	0.907	(0.302-0.591)	0.522
WHR	(39.79-0.36)	0.039	(48.31-1.08)	0.041
Period of Abstinence (days)	(1.627-0.177)	0.114	(1.705-0.244)	0.14
Smoking Status	(2.44-2.78)	0.898	(2.808-2.886)	0.978
Drinking Status	(2.14-2.66)	0.83	(2.723-2.569)	0.954
Diabetes	(4.66-2.35)	0.516	(7.351-1.58)	0.202
High Blood Pressure	(1.20-6.01)	0.19	(0.577-8.144)	0.088
Ethnicity	(4.722-3.017)	0.663	(4.986-4.598)	0.936
Education Level	(2.36-0.74)	0.305	(2.883-3.495)	0.849
Physical activity	(0.029-0.045)	0.672	(0.40-0.04)	0.961
Occupation Type	(0.27-1.91)	0.138	(1.366-3.275)	0.416

Discussion

This study has investigated the association of WHR with semen volume, sperm viability, total sperm count, total sperm motility, progressive motility, non-progressive motility, immotile sperm, and normal sperm morphology, in a total 104 participants who visited the fertility and andrology clinic of CSTH, Kalubowila, Sri Lanka. Further, the association of BMI with semen volume, sperm viability, total sperm count, total sperm motility, progressive motility, non-progressive motility, immotile sperm, and normal sperm morphology was analyzed along with multivariate logistic analysis of the independent risk factors for sperm parameters.

Statistical analysis showed weak correlations between both WHR and BMI with sperm parameters, with no clear trends in semen volume, sperm motility, or other parameters based on either WHR or BMI classification. While the overweight group showed slightly better sperm concentration, viability, and count, the obese group had mixed results. WHR exhibited a slight correlation with sperm morphology, suggesting a possible link between central adiposity and sperm quality; however, no strong associations were found with other sperm parameters. In contrast, BMI did not show a significant association with sperm morphology. The univariate and multivariate logistic analyses examined a wide range of factors, including demographic, lifestyle, and health-related variables. Despite exploring these numerous factors, the only statistically significant finding was the association between WHR and sperm morphology (p=0.039), with higher WHR associated with reduced normal sperm morphology.

Our study did not find BMI to be an independent risk factor for sperm parameters, consistent with the findings from most published literatures. For example, a 2009 study of 6,793 males reported no association between BMI and sperm parameters (13). Similarly, a study conducted by Relwani MD in 2011 found no significant correlation between male BMI and sperm parameters such as concentration, motility, or morphology (14). Conversely, some studies have identified significant associations between BMI and sperm parameters. For instance, J. Ma et al. (2020) and Hammiche F. et al. (2012) reported that increased BMI was significantly associated to lower sperm count, semen volume, and sperm motility (15,16). The inconsistencies among studies may stem from differences in sample sizes, population characteristics, and methodologies. In that case larger studies, such as MacDonald et al.'s analysis of 6,793 participants, tend to provide more robust results claiming no association between BMI and sperm parameters (13).

However, we observed a trend toward a positive correlation between WHR and sperm morphology (p = 0.050). Supporting this, Wang (2017) reported a significant association between WHR and sperm morphology (7). This suggests that WHR, as a measure of central adiposity, might be more sensitive than BMI in detecting subtle changes in sperm parameters, likely due to factors such as increased oxidative stress, hormonal imbalances, and elevated scrotal temperature associated with abdominal fat (7, 17).

Overall, these variations in findings emphasize the importance of considering not only BMI but also WHR, in understanding male reproductive health. In light of these findings, we should be mindful about lifestyle factors such as diet, smoking, and physical activity, as well as genetic and environmental influences, that could further contribute to the observed differences (10). A holistic approach that incorporates both BMI and WHR, alongside other obesity-related markers such as skinfold thickness and body adiposity index (BAI), may provide a clearer understanding of their effects on sperm parameters across diverse populations.

Conclusion

Individuals with a WHR >0.9 exhibited higher sperm concentration, count, and normal morphology compared to those with a WHR ≤ 0.9, although no significant differences were observed in motility or viability. Sperm concentration increased with higher BMI; however, sperm count did not follow a linear trend. Notably, the overweight group demonstrated the highest normal sperm morphology. However, none of the above were statistically significant changes. While correlations between BMI and WHR with sperm parameters were predominantly weak and statistically non-significant, multivariate analysis identified WHR as an independent risk factor for sperm morphology (95% CI: 48.31–1.08, p = 0.041).

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References

1. Nguyen., Aggerholm AS., Thulstrup AM, Toft G., Ramlau-Hansen CH., Bonde JP. 2007. Men’s and infertility. Human reproduction, 90(3):619–26.
2. Syndro., Stephen W. Leslie., Taylor L. Soon-Sutton., Moien AB Khan. 2021. The Prevalence and Components of Metabolic Syndrome in Men from Infertile Couples and Its Relation on Semen Analysis’. J Indiana State Med Assoc, 56:871–5.
3. Tennakoon, V., Yasawardene, S. G., & Weerasekera, D. S. (2012). Antisperm antibodies: Incidence, isotypes and location on spermatozoa, their implications on fertilization and on pregnancy rate at a selected Centre in Sri Lanka. *Sri Lanka Journal of Obstetrics and Gynaecology*, *32*(1):8-16. DOI: http://dx.doi.org/10.4038/sljog.v32i1.3971
4. Dubeux VT., Renovato T., Esteves AC., André L., De Oliveira A., Penna IA. 2016. The impact of obesity on male fecundity: A Brazilian study. J Bras Reprod Assist, 20(3):137–41.
5. Fernando R, Jayawardane M. Does the male BMI affect seminal parameters? Sri Lanka Anatomy Journal. 2023;7(2):11–20.
6. Palihawadana, T.S., Wijesinghe., P.S. and Seneviratne., H.R. (2012). Aetiology of infertility among females seeking treatment at a tertiary care hospital in Sri Lanka. Reprod Health, 57(2);79–83.
7. Liu., Zhang J., Zhu Q., Xie W., Wang Y., Dai Y. 2017. Obesity, a serious etiologic factor for male subfertility in modern society. Reproduction, 20(1):1–9.
8. Maksymyuk., Faure C., Fezeu L., Shayeb AG., Bonde JP., Jensen TK. 2020. Body Mass Index and Sperm Quality: Is there a Relationship? Hum Reprod Update, 19(3):221–31.
9. Eskandar., Juhl CR., Kjøller ET., Lundgren JR., Janus C., Dehestani Y. 2012. Impact of male obesity on semen quality and serum sex hormones. Advance in Urology, 1;37(7):1414–22.
10. Kozopas NM., Chornenka OI., Vorobets MZ., Lapovets LY., Maksymyuk HV. 2020 Body mass index and sperm quality: Is there a relationship. J Hum Reprod Sci, 13(2):110–3.
11. Sunder M., Leslie SW. 2021. The Prevalence and Components of Metabolic Syndrome in Men from Infertile Couples and Its Relation on Semen Analysis [Internet], 1453-1463. Available from: https://www.ncbi.nlm.nih.gov/books/NBK564369/
12. Ma JX., Wang B., Li HS., Jiang XJ., Yu J., Ding CF. 2020. Association between obesity-associated markers and semen quality

parameters and serum reproductive hormones in Chinese infertile men. Reprod Biol Endocrinol, 29;18(1).

13. MacDonald AA., Herbison GP., Showell M., Farquhar CM. 2009. The impact of body mass index on semen parameters and reproductive hormones in human males: A systematic review with meta-analysis. Vol. 16, Human Reproduction Update, p. 293–311.
14. Relwani R., Berger D., Santoro N., Hickmon C., Nihsen M., Zapantis A. 2011. Semen parameters are unrelated to BMI but vary with SSRI use and prior urological surgery. Reprod Sci, 18(4):391–7.
15. Al’ MD., Ja2., ’ L., Mkb3 W., Hpa W. 2015. Effect of Obesity on Semen Volurne and Sperm Counts of Sri Lankan Male, 3(7):156-27.
16. Hammiche F., Laven JSE., Twigt JM., Boellaard WPA., Steegers EAP., Steegers-Theunissen RP. 2012. Body mass index and central adiposity are associated with sperm quality in men of subfertile couples. Hum Reprod, 27(8):2365–72.
17. Ahamad., Le MT., Nguyen HTT., Dang H., Van Nguyen T. 2016. Abdominal Obesity Indicators: Waist Circumference or Waist - to - hip Ratio in Malaysian Adults Population. Basic Clin Androl, 1;31(1).