The Egyptian Journal of Hospital Medicine (Apr. 2016) Vol. 63, Page 195- 205

Relation of Body Mass Index and Waist Circumference to Some Fertility Markers among Male Partner of Infertile Couples

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ABSTRACT
Background: Global estimates of infertility range between 8% and 12% of couples with women of childbearing age, affecting 50–80 million people. Excess weight is not only linked to increased risk of chronic disease but has also been shown to increase risk of reproductive problems. The consequences of obesity in female fertility have been widely studied, but studies in the male population are less frequent.
Aim of the study: The aim of this study to clarify the role of body mass Index and waist circumference on some male-fertility laboratory markers among Egyptian males of infertile couples.
Subjects and methods: A descriptive cross sectional study was carried out on a total sample of 59 males of infertile couples for at least one year after regular unprotected reproductive activity. BMI and WC were assessed, and a morning blood sample was taken assessing serum levels of testosterone, sex hormone-binding globulin, prolactin, luteinizing hormone (LH), follicle-stimulating hormone, and estradiol. Semen-analysis parameters were also measured.
Results: In the present study, it was found that there was no statistical significant difference in relation of BMI or WC and sperm count. The likelihood of athenospermia was increased at higher BMI and WC values. BMI was not found to be associated with mean numeric values of the semen-analysis parameters, including sperm count, sperm morphology, and sperm motility. BMI was not significantly correlated with some hormone levels, such as LH and prolactin. However, a statistically significant inverse correlations was observed between WC and testosterone (r=-0.3&$p=0.04$). A different pattern of associations in this study was observed when the associations between BMI &WC and sexual hormone levels were compared between (fertile and subfertile) from infertile men.
Conclusion: The association explored between WC and testosterone as well as different patterns of this association between (fertile and subfertile) from infertile men.
Keywords: Male infertility, body mass index, waist circumference, sperm analysis, sexual hormones

INTRODUCTION
A person's weight can have a profound impact on fertility, men who are either under or over their ideal weight have a higher risk of experiencing infertility. [(1)] WHO defined infertility as the failure of a couple to conceive after regular unprotected intercourse for at least one full year. It has a high worldwide psychosocial burden. Male infertility has a substantial share of the total infertility burden. [(2)]
Body Mass Index (BMI) is a simple and widely used method for estimating body fat. [(3)]The pattern in reproductive hormones differed between the different BMI groups, and it could be speculated that hormonal imbalance may be Involved in the decreased semen quality in men with BMI < 20 kg/m² or > 25 kg/m², although the mechanisms behind the decreased semen quality in the slim and overweight men may not be the same. [(4)]
The distribution of body fat specifically in the central abdominal region has also been used to diagnose a patient as obese and currently waist circumference is believed to be a more accurate marker of obesity. [(5)] The interaction between obesity and fertility has received increased attention owing to the rapid increase in the prevalence of obesity. [(6)] Indeed, the American Medical Association recently classified obesity as a disease. [(7)]

Received: 01/01/2016
Accepted: 15/01/2016
DOI : 10.12816/0023845

It has been postulated that BMI of more than 25 kg/m^2 is associated with an average 25% reduction in sperm count and sperm motility [8, 6] found that obesity was shown to affect the GnRH–LH/FSH pulse that may impair Leydig and Sertoli cell functions and interfere with the release of sex hormones with consequent effect on sperm maturation. He added that this altered reproductive hormonal profile suggests that the endocrine dysregulation in obese men could explain increased risk of altered semen parameters. Otherwise, other studies have found no relationship between male BMI and semen parameters. [9, 11]

Reports have suggested that the distribution of body fat, as assessed by Waist Circumference (WC), may provide a more strong measure of the adverse metabolic implications of excess body size rather than BMI. [12]

The available evidence on the role of body mass index and waist circumference on male infertility has been controversial or inconclusive to some extent.

AIM OF THE WORK

The aim of current study is to evaluate the role of BMI and waist circumference on some male-fertility laboratory markers (Semen-analysis parameters, serum testosterone, prolactin, LH, FSH and estradiol) among Egyptian males of infertile couples.

PATIENTS AND METHODS

The current study is a descriptive cross sectional study. The partners were selected from Al-Azhar University Hospitals (Al Hussien and International Islamic Center for Population Studies and Researches). The inclusion criteria were being a male partner of an infertile couple at least for 1 year, having regular intercourse, and seeking infertility treatment over the study period. The exclusion criteria were being infertile male who had obstructive azoospermia by clinical examination & laboratory investigations, genital tract infections, associated varicocele, and those with chronic severe debilitating medical illness (cerebrovascular, cardiovascular, hypertension, diabetes, hereditary hyperlipidemia, thromboembolic events) also those who used systemic medication (steroids, antihyperlipidemics).

Through consecutive sampling, 160 subjects were screened over 8 months 101 of whom were excluded due to exclusion criteria as described above. The remaining 59 male patients were investigated. So, the study was conducted on a total sample of 59 males of infertile couples for at least one year after regular unprotected reproductive activity.

1- Personal history was taken as (age, occupation, duration of marriage and special habits ...etc).

2- Clinical examination: including (Male sexual characters, Penis, Testes, Epididymides and vasa deferentia)

3- Physical examination:

Standard and calibrated tools were used to do the measurements. Height was measured with participants standing without shoes, with the shoulders in relaxed position and arms hanging free using a standard metal ruler. Weight was measured while light clothes were worn. BMI was calculated by dividing the patient's weight by their squared height in meters (kg/m^2). To analyze the data, the BMI was categorized as underweight, $\leq 18.5\ kg/m^2$; normal-weight, 18.5–24.9 kg/m^2; overweight, 25–29.9 kg/m^2; and obese, $\geq 30 kg/m^2$ [13] .

Waist circumference was also measured: the individual stand with feet close together, arms at the side and body weight evenly distributed, and relaxed, and the measurements taken at the end of a normal expiration, the tape measure placed directly on skin, waist circumference measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest. It was categorized as < 94 cm (normal), 94 – 102 cm (high) and ≥ 102 cm (very high) [14].

4- Laboratory investigations: a morning blood sample was obtained of 5 mL volume and sent to an authorized laboratory to assess serum levels of: total testosterone (Ng/mL), Prolactin (PRL) (mIu/mL), Luteinizing hormone (LH) (mIu/mL), Follicle-stimulating hormone (FSH) (mIu/mL), Estradiol (E2) (Pg/mL).

Semen analysis parameters were measured. The semen-analysis was done according to lower reference limits [(15)]. Two semen analyses were examined separated by one week after abstinence for 2-6 days.

5- Statistical analysis: data were analyzed using SPSS (VERSION, 16) to determine the mean and standard deviation, and the relationship of sample parameters. The ANOVA was adopted for comparison of quantitative data between the groups and Chi square-test (χ^2) for qualitative data. To assess the correlation between normally distributed numeric scales, the Pearson correlation coefficient was calculated. All the statistical tests were done on a two-tailed basis, the *P* value <0.05 considered to be significant. The study was approved by the medical ethics committee of Al-Azhar University. Informed consent was obtained from all the study participants.

RESULTS

In the present study fitted examination of 59 blood specimens for infertile patients their ages ranged between 24-61 years and the mean age was (35.7 ± 7.8), 67.8% of them were either overweight and obese, 56.9% of them with WC more than 94 cm. Based on the analysis of the semen parameters, (25.74%) was presented with normal semen parameters and (74.6%) was presented with abnormal semen parameters.

Regarding anthropometric measures, it was found that the mean weight, height, BMI & waist circumference of those with abnormal semen parameters were (82.4 Kg ±20.3), (171.7 cm ±7), (28.1±5.9) & (98.4 cm ±14) respectively. These figures were found to be nearly equal to those with normal semen parameters (82 Kg ±16), (172 cm ±8), (28.5±5.4) & (98 cm ±13) respectively **(table 1).** Most of overweight men (66.6%) and obese men (79.0%), also all those with underweight were with abnormal semen analysis **(table 2)**.All these differences were statistically insignificant (*P* >0.05).

Among infertile men (with abnormal semen parameters),the highest mean of BMI (34.5±5.3&28±1.1), also the highest mean of WC (112.5±7.7&98.4±2.3) were recorded among obese and overweight respectively with statistical significant difference $P < 0.05$ **(table 3&4)**.

However, the majority of overweight (66.7%) and obese (63.2%) were normospermia, and most of those normal BMI (64.7%) were with oligospermia **(Figure 1)** with no statistical significant difference (*P* >0.05). Also, there was no statistical significant difference in relation of WC and sperm count **(Figure 2)**.

Concerning the relation between sperm motility and BMI, it was found that most (60.0%&52.7%) of overweight and obese men respectively were with athenospermia **(table 5)**. While, in relation to WC, most (85.7%) of men with WC between 94cm -102cm were with athenospermia, while those with WC ≥ 102cm were either athenospermia or normspermia (45%) with insignificant statistical difference **(table 6)**.

It was found that BMI was not associated with mean numeric values of the semen-analysis parameters, including sperm count, sperm morphology, and sperm motility. Also, BMI was not significantly correlated with some hormone levels, such as FSH, LH, prolactin and E2 **(table 7)**. In addition, no significant correlation was explored between BMI and semen parameters & sex hormones **(table 8)**.

There were statistically significant inverse correlations between WC and testosterone (*r*=-

0.3&*p=0.04)*. No other significant correlation was observed **(table 9** & **figure 3)**.

The association of BMI & WC with semen-analysis parameters and sex-hormone levels was also assessed separately for normal and abnormal semen parameters males. The results showed that among males with abnormal semen parameters, WC was inversely correlated with testosterone only (r=-0.3&p=0.04). No other significant correlation was explored between BMI &WC and other sex hormone levels, such as LH, EST, FSH, LH/FSH, and PRL. Among males with normal semen parameters, there was positive significant correlation between BMI and motility (r = o.5, P = 0.01), also, there were inverse correlation between WC and sperm count (r=-0.6&p=0.03). &while positive correlation with motility (r=0.6&p=0.03).

DISCUSSION

Increase body weight is a major health issue and the relationships between BMI and male infertility has been proposed to affect male fertility both directly and indirectly, by inducing alteration in sleep and sexual behavior, hormonal profiles, scrotal temperature and semen parameters. [16]

In the present study the role of BMI and waist circumference on male-fertility laboratory markers {Semen-analysis parameters, serum testosterone, prolactin, LH, FSH and estradiol} among males of infertile couples were evaluated. As regard the sperm count, no statistical significant difference in relation to BMI and WC. This finding was in agreement with **Chavarro *et al.*** [17] who did not observe statistically significant differences in sperm morphology, sperm motility or sperm concentration in relation with levels of BMI. Also, **Duits *et al.*** [18] found no association between BMI and sperm motility & sperm count.

In contrast, **Sermondade *et al.*** [19] on meta-analysis study showed that overweight and obese men had a significantly elevated risk of abnormal sperm count compared with normal weight men.

Concerning the relation between sperm motility and BMI &WC, it was found that most of overweight and obese men also those with WC more than 94cm presented with athenospermia but with no statistical significant difference (*P* >0.05). In consistency to [20] who found no adverse effect of obesity on spermatozoa motility, this supported by the finding that the sperm acquire their motility in the epididymis.

On the other hand, **Hammoud *et al.*** [8] retrospectively examined infertile patients and found that oligospermia and a low progressively motile sperms were more frequent with increasing BMI. However, the study was limited by the use of self-reported height and weight measurements. Also, **Kort *et al.*** [21] found that the number of spermatozoa was correlated negatively with body mass index in semen analysis. In addition, **Hammiche *et al.*** [22] found that a WC ≥102 cm was negatively associated with sperm motility. They supported the results of **Hammoud *et al.*** [8] regarding that overweight and obesity, particularly when central, have been shown to affect the GnRH-LH/FSH pulse, which may impair leydig and Sertoli cell functions and thus interfere with the release of sex hormones and production and maturation of sperm.

Some authors have suggested that obesity may directly alter spermatogenesis and Sertoli cell function, [23] as indicated by the more severe decrease of inhibin B levels compared with the decrease of FSH. Another hypothesis is that overweight & obese men frequently suffer from erectile dysfunction which is a cause of infertility [24] .Sedentary life, prolonged setting and fat deposition in the lower abdomen can reduce male fertility through increase testicular temperature to the level of body core temperature. [25, 27]

In the present study, BMI was not significantly associated with mean numeric values of the semen-analysis parameters, including sperm count, sperm morphology, and sperm motility; also, with some sex hormone levels, such as FSH, LH, prolactin and E2**.** In addition, no significant correlation was explored between BMI and semen parameters & sex hormones. However, among males with normal semen parameters, there was positive significant correlation between BMI and motility. This was in agreement with **Hajshafiha *et al.*** [(2)] who reported that BMI was not associated with mean numeric values of the semen-analysis parameters. Also, **MacDonald *et al.*** [(11)] didn't find evidence of an association between increased BMI and semen parameters in a systematic review with meta-analysis. Furthermore, **Kort *et al.*** [(21)] reported that there was no significant correlation between BMI and any of semen and hormonal parameters. Similarly, **Kumar *et al.*** [(9)] clarified by study on males of infertile couples, no significant relation between BMI in males and semen parameters and also they examined the relationship between frequency of intercourse and men's BMI ,but the association was negative thus; the mechanism that explains the BMI effect is likely to involve hormones rather than semen changes or sexual function. In accordance, **Eskandar *et al.*** [(10)] found that there was no significant relation between BMI & testosterone. Furthermore, **Makker *et al.*** [(28)] and **Mara *et al.*** [(29)] found no clear effects of BMI on both hormonal profile and semen quality.

In contrast to these results, studies found a relation between BMI and semen parameters. **Barbosa *et al.*** [(14)] concluded that infertile men with high BMI presented with an abnormal semen analysis represented by decrease in sperm concentration, decrease in sperm motility percent, as well as, increase of abnormal forms of spermatozoa. Also, **Hofny *et al.*** [(6)] found that BMI had significant positive correlation with abnormal sperm morphology & significant negative correlation with sperm motility & sperm concentration. Their studied group was done on obese men only. In addition, **Chavarro *et al.*** [(17)] found strong inverse associations of BMI with serum levels of total testosterone & the authors mentioned that this association was a well documented effect of excess body weight on this hormone & was thought to be due to impaired hypothalamic-pituitary-gonadal axis. These differences can be explained by methodological difference.

BMI may not be the best indicator, as suggested by the questions about thresholds [(30)] and its inability to distinguish body fat composition or distribution, such as with waist circumference or waist-to-hip ratio [(31)] .The current study, revealed a statistically significant inverse correlations between WC and testosterone, no other significant correlation was observed. While, among males with normal semen parameters, there were also inverse correlation between WC and sperm count &and positive correlation with motility.

These results in agreement with **Hammiche *et al.*** [(22)] and **Eisenberg *et al.*** [(7)] who found inverse correlation between WC & sperm count. This supported by **Schlegel** [(32)] who stated that one of the main causes of infertility determined by obesity is closely related to the hyperactivity of aromatase, an enzyme which is present in high percentage in the so called white adipose tissue which convert testosterone into estradiol, that suppressed the hypothalamic and pituitary hormonal secretion and can affect the testis directly. In addition, **Fejes *et al.*** [(33)] showed that both the waist circumference and the hip circumference were correlated with sperm motility.

CONCLUSION

There were no association explored between BMI and some sexual hormones and semen characteristics, but different patterns of this association were between WC and testosterone. Also, among those with abnormal and normal semen parameters, will be of help to broaden understanding of the effect of obesity on some male reproductive physiologic characteristics.

Recommendation: Considering the available information in order to clarify the existing facts, it is recommended for future studies to consider assessing the role of weight loss on improving male fertility status through prospective cohort or interventional studies. Larger sample size is needed to reach a strong conclusion regarding the effect of BMI & WC on semen parameters. Hormonal assay is indicated for infertile men with disturbed semen parameters. More studies are needed to show the relationship between BMI & WC on semen quality and sex hormones.

REFERENCES

1-Bolumar F, Olsen J, Rebagliato M, Saez-Lioret I, and Bisanti L (2000): Body mass index and delayed conception: a European multicenter study on infertility and subfecundity. Am J Epidemiol., 151:1072-1079.

2-Hajshafiha M, Ghareaghaji R, Salemi S, Sadegh-Asadi N, and Sadeghi-Bazargani H (2013): Association of body mass index with some fertility markers among male partners of infertile couples. International journal of general medicine, 6:447.

3-Buss J (2014): Limitations of body mass index to assess body fat. Workplace health & safety, 62(6):264.

4-Brand J S , van der Schouw Y T, Dowsett M , Folkerd E, Luben R N, Wareham N J & et al.,(2012): Testosterone, SHBG and differential white blood cell count in middle-aged and older men. Maturitas.71(3):274-8.

5-Haslam D W and James W P(2005): Obesity. Lancet; 366, 1197–1209.

6-Hofny E R, Ali M E, Abdel-Hafez H Z, Kamal E E D, Mohamed E E, Abd El-Azeem H G *et al.(*2010): Semen parameters and hormonal profile in obese fertile and infertile males. Fertility and sterility, 94(2): 581-4.

7-Eisenberg M L, Kim S, Chen Z, Sundaram R, Schisterman E F & Louis G M B (2013): The relationship between male BMI and waist circumference on semen quality: data from the LIFE study. Human Reproduction, 428:1-8.

8-Hammoud A O, Wilde N, Gibson M, Parks A, Carrell D T & Meikle AW (2008): Male obesity and alteration in sperm parameters. Fertility and sterility,90(6):2222-5.

9-Kumar S, Mohsen N & Malini S(2013): Association of Obesity with Male Infertility among Infertile Couples is not Significant in Mysore, South India. Advanced Studies in Biology,5(7): 319-25.

10-Eskandar M, Al-Asmari M, Babu C S *et al.*(2012): Impact of male obesity on semen quality and serum sex hormones. Adv Urol.,407601:1-4.

11- MacDonald A A, Herbison G P, Showell M & Farquhar C M (2010): The impact of body mass index on semen parameters and reproductive hormones in human males: a systematic review with meta-analysis. Hum Reprod Update, 16:293–311.

12-Janssen I, Katzmarzyk P T & Ross R(2004): Waist circumference and not body mass index explains obesity-related health risk. Am J Clin Nutr.,79:379–84.

13-World health organization (2012): Obesity and Overweight:fact sheet no.311.

14-Barbosa L S, Scala L C N, Ferreira M G (2009): Association between anthropometric markers of body adiposity and hypertension in an adult population of Cuiabá, Mato Grosso. Revista Brasileira de Epidemiologia,12(2):237-47.

15-World Health organization (2010): WHO laboratory manual for the examination and processing of human semen.5th ed.Geneva:World Health Organization;271.

16-AL-Ubaidy S A, AL-Murshedy M K & AL-Murshedy S Y(2014): Effect of Body Mass Index on sperm and semen parameters for infertile Patients.Al-Kufa Journal for Biology,6:1-13.

17-Chavarro J E, Toth T L, Wright D L, Meeker J D & Hauser R(2010): Body mass index in relation to semen quality, sperm DNA integrity, and serum reproductive hormone levels among men attending an infertility clinic. Fertility and sterility,93(7):2222-31.

18-Duits F H, Van Wely M, Van der Veen F & Gianotten J (2010): Healthy overweight male partners of subfertile couples should not worry about their semen quality. Fertil Steril.,94:1356–9.

19-Sermondade N, Faure C, Fezeu L, Shayeb A G, Bonde J P, Jensen T K, Van Wely M, Cao J, Martini A C, Eskandar M *et al.*(2013) : BMI in relation to sperm count: an updated systematic review and collaborative meta-analysis. Hum Reprod Update,19: 221–31.

20-Aggerholm A S, Thulstrup A M, Toft G, Ramlau-Hansen C H Bonde J P(2008): Is overweight a risk factor for reduced semen quality and altered serum sex hormone profile?. Fertil Steril.,90:619–26.

21-Kort H I, Massey J B, Elsner C W, Mitchell-Leef D, Shapiro D B& Witt M A(2006): Impact of body mass index values on sperm quantity and quality. J Androl ,27:450–2.

22-Hammiche F, Laven J S, Twigt J M, Boellaard W P, Steegers E A& Steegers Theunissen R P(2012): Body mass index and central adiposity are associated with sperm quality in men of subfertile couples. Human Reproduction, 27(8):2365-72.

23-Winters S J, Wang C, Abdelrahaman E, Hadeed V, Dyky M A& Brufsky A(2006): Inhibin-B levels in healthy young adult men and prepubertal boys: is obesity the cause for the contemporary decline in sperm count because of fewer Sertoli cells? J Androl.,27:560–4.

24-Feeley R J& Traish A M(2009): Obesity and erectile dysfunction: is androgen deficiency the common link? The Scientific World Journal, 9:676-84.

25-Du Plessis S S, Cabler S, McAlister D A, Sabanegh E& Agarwal A(2010): The effect of obesity on sperm disorders and male infertility. Nature Reviews Urology, 7(3):153-61.

26-Yassin A A, Saad F& Gooren L J(2008): Metabolic syndrome, testosterone deficiency and erectile dysfunction never come alone. Andrologia, 40:259-64.

27-Shafik A and Olfat S (1981): Scrotal lipomatosis. Br J Urol.,53: 50-4.

28-Makker K ,Agarwal A and Sharma R(2009): Oxidative stress and male infertility. Indian. J. Med. Res.,129.357-367.

29-Mara Y, Roth J,Amory K and Stephanie T P (2008): Treatment of male infertility secondary to morbid obesity. Nature Clinical Practical Endocrinology and Metabolism, 4 (7): 415-419.

30-Prentice A M & Jebb S A(2001): Beyond body mass index. Obes Rev.,2:141–7.

31-Akpinar E, Bashan I, Bozdemir N & Saatci E(2007): Which is the best anthropometric technique to identify obesity: body mass index, waist circumference or waist–hip ratio? Coll Antropol .,31:387–93.

32-Schlegel P N (2012): Aromatase inhibitors for male infertility. Fertility and sterility,98(6):1359-62.

33-Fejes I, Koloszar S, Szollosi J, Zavaczki Z & Pal A(2005): Is semen quality affected by male body fat distribution? Andrologia.37:155–9.

Table (1): General characteristics of the studied groups

Studied groups / Variables	Males with normal semen parameters No.15 (25.4%)	Males with abnormal semen parameters No.44 (74.6%)	Total No.59 (100%)	Sig. test *P.* value
Age : **Range** **Mean years ± SD**	25 – 61 years 36.4 ± 8.1	24 – 57 years 35 ± 1.1	24-61 years 35 ± 7.8	t. test=0.3 *p.*=0.6
Weight -Mean (Kg ± SD)	82 ± 16	82.4 ± 20.3	82.2 ± 18.3	t. test=0.008 *p.*=0.15
Height -Mean (cm ± SD)	172 ± 8	171 ± 7	171 ± 7.4	t. test=0.1 *p.*=0.7
BMI -Mean (± SD)	28.5 ± 5.4	28.1 ± 5.9	28 ± 5	t. test=0.007 p.=0.8
Waist circumference -Mean (cm ± SD)	98 ± 13	98.4 ± 14	98 ± 13	t. test=0.08 *p.*=0.8

Table (2): Distribution of male infertility frequency over the BMI group

BMI	Fertile men (with normal semen parameters	Infertile men (with abnormal semen parameters	Total	Sig.test *P.*value
BMI≤18.5	0 (0.0%)	2 (100%)	2 (100%)	X^2=59 *p.*=0.1
18.5–24.9	4 (23.5%)	13 (76.5%)	17 (100%)	
25–29.9	7 (34.4%)	14 (66.6%)	21 (100%)	
BMI ≥30	4 (21.0%)	15 (79.0%)	19 (100%)	
Total	15 (25.4%)	44 (74.6%)	59 (100%)	

Table (3): Distribution of male with abnormal semen analysis according to BMI

BMI	Infertile men (with abnormal semen parameters) No.44 (100%)		Mean ±SD of BMI	Sig.test *P.*value
	No.	%		
BMI≤18.5	2	4.7	18.3±0.1	ANOVA F=72 *p.* <0.05*
18.5–24.9	13	30.1	22.4±1.6	
25–29.9	14	32.6	28±1.1	
BMI ≥30	14	32.6	34.5±3.5	

Table (4): Distribution of male with abnormal semen analysis according to WC

WC	Infertile men (with abnormal semen parameters) No.44 (100%)		Mean ±SD of WC	Sig.test *P.*value
	No.	%		
WC≤94	25	43.1	86.2±5.1	ANOVA F=85 *p.* <0.05*
94 < WC < 102	14	22.4	98.4±2.3	
WC ≥102	20	34.5	112.5±7.7	

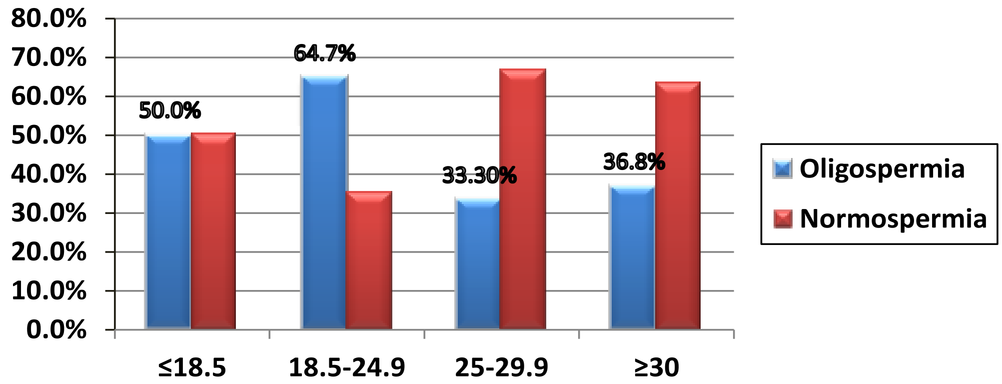

Figure (1): Difference between oligo & normospermia according to BMI

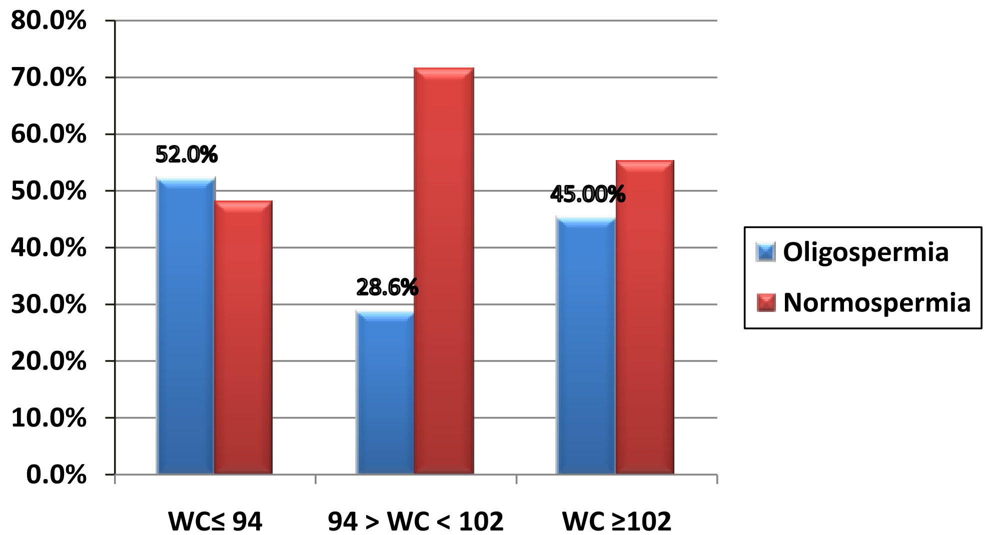

Figure (2): Difference between oligo &normospermia according to WC

Table (5): Relation between BMI & sperm motility

Groups / Items	Athenospermia		Normal		Immotile		Test of significance *P*.value
	No.	%	No.	%	No.	%	
Underweight **Normal weight** **Overweight** **Obese**	2 10 13 10	100 58.8 60.0 52.7	0 4 8 7	0 23.5 40.0 36.8	0 3 0 2	0 17.7 0 10.5	X^2= 5 *P*=0.4
Total	35	58.6	19	32.8	5	8.6	59 (100%)

Table (6): Relation between WC & sperm motility

Groups Items	Athenospermia No.	Athenospermia %	Normal No.	Normal %	Immotile No.	Immotile %	Test of significance *P*.value
WC≤ 94	14	56.0	8	32.0	3	12.0	
94 < WC < 102	12	85.7	2	14.3	0	0.0	X^2= 6
WC ≥102	9	45.0	9	45.0	2	10.0	*P*=0.1
Total	35	58.6	19	32.8	5	8.6	59(100%)

Table (7): Semen-analysis parameters & Sexual hormone levels compared for males over BMI groups

Items	BMI groups: Underweight No.= 2	Normal weight No.=17	Overweight No.=21	Obese No.=19	Test of significance ANOVA
Count -Mean (million/ml± SD)	199.7±22.8	209±32	372±32	313±39	F=0.7 P=0.5
Morphology (abnormal form) -Mean (%± SD)	34±8.4	44.5±9.5	43.6±18	42.4±20	F=0.5 P=1
Motility Mean (%± SD)	20±7	22±8.7	33±13	29.3±9	F=0.8 p=0.6
Prolactin -Mean (ng/ml± SD)	8.2±2.2	13.8±6.6	11.7±7.4	12.1±4.6	F=0.7 P=0.6
FSH Mean(mlU/ml±SD)	8.2±0.5	9.6±3	5±2.4	7.2±4.3	F=1.2 P=0.3
LH Mean(mlU/ml± SD)	5±0.5	6.3±2.6	4.5±3	6.3±3.2	F=0.6 P=0.6
E2 Mean (pg/ml± SD)	37.8±4.6	41±17	30±16	34±15	F=1.5 P=0.2
Testosterone Mean(ng/ml± SD)	6.2±2.3	5.4±2.4	4.7±2	4.7±2.7	F=0.5 P=0.6
TES/ESD - Mean (± SD)	0.161±0.04	0.165±0.1	0.17±0.08	0.17±0.15	F=0.8 P=0.5

Table (8): Correlation between Semen-analysis parameters &sex hormones and BMI among infertile males

Items Correlation with BMI	Count	Morphology	Motility	Prolactin	FSH	LH	E2	Testosterone
R *p.*	0.06 0.6	0.011 0.9	0.13 0.3	0.007 0.9	0.14 0.3	0.002 0.9	0.3 0.4	0.23 0.07

Table (9): Correlation between Semen-analysis parameters & sex hormones and WC among infertile males

Items Correlation with WC	Count	Morphology	Motility	Prolactin	FSH	LH	E2	Testosterone
R *p.*	0.047 0.7	0.05 0.7	0.09 0.5	0.06 0.7	0.09 0.5	0.07 0.6	0.08 0.5	-0.3 0.04*

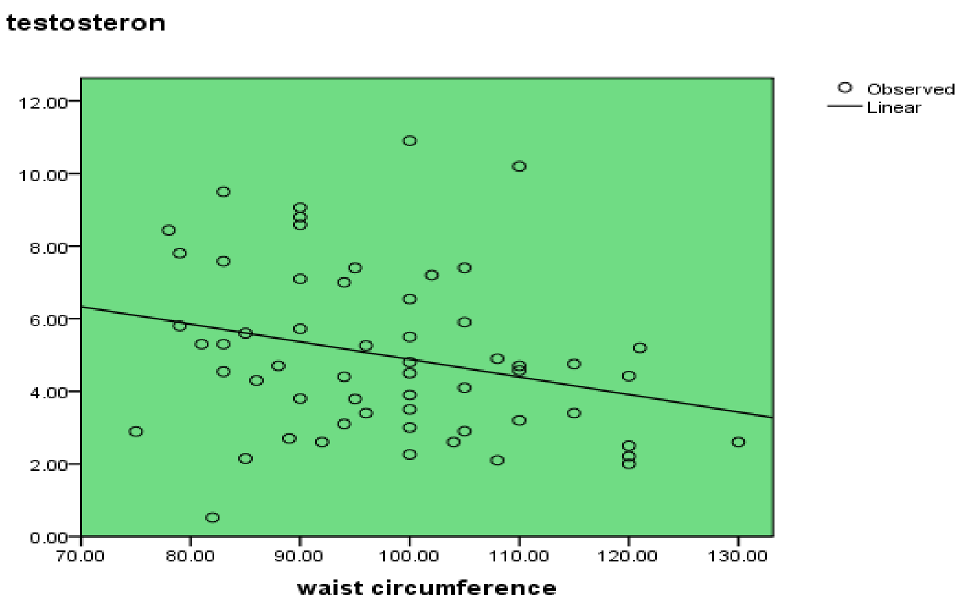

Figure (3): Correlation between waist circumference and testosterone among infertile males