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Evaluation of the Role of Visceral Adiposity Index in the Prediction of Erectile Dysfunction in Hyperlipidemia

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ABSTRACT

Background: Normal anatomy of penis could be directly harmed by hyperlipidemia, which can lead to corpora cavernosum fibrosis, which can compromise erectile function and endothelial dysfunction. Substantial number of men and their spouses suffer with erectile dysfunction, which is very common health issue. **Aim:** Aim of this research had been to evaluate ability of visceral adiposity index (VAI) to predict ED among patients with hyperlipidemia.
Subject and Techniques: Total of 111 men were recruited from Andrology and Cardiology Outpatient Clinics of Mansoura University Hospitals, Egypt. These participants were divided into 3 groups: a) hyperlipidemic ED patient (37 cases), b) hyperlipidemic non-ED patients (37 cases) and c) control healthy men (37 persons). All participants were subjected to measurement of 5-item International Index of Erectile Function (IIEF5) questionnaire, waist circumference (WC) and body mass index (BMI), calculation of visceral adiposity index and full lipogram. **Results:** VAI and IIEF5 were greater among group A compared with the control group and group B. Receiver operating curve finds that best cut off point of VAI to detect group A was found ≥4.23 with sensitivity of one hundred percent, specificity of 97.3 percent, positive predictive value (PPV) of 97.4%, negative predictive value (NPV) of one hundred percent and total accuracy of 98.6%. **Conclusion:** In individuals with hyperlipidemia, VAI has been more accurate than WC, BMI, triglycerides (TG), and high-denisty lipoproteins (HDL) for assessing impact of visceral adiposity on ED.
Keywords: Visceral Adiposity Index, Erectile Dysfunction and Hyperlipidemia.

INTRODUCTION

Constant inability to obtain and sustain erection strong enough for satisfying sexual performance has been known as erectile dysfunction. Substantial number of men and their spouses' quality of life are impacted by ED, very common health issue. It is estimated that fifty two percent of men among ages of forty and seventy have ED [(1)]. Higher levels of low-denisty lipoproteins (LDL)-cholesterol had been linked to higher levels of testosterone (T), but they had been also linked to higher prevalence of ED. Hyperlipidemia can affect erectile function by directly affecting penis' natural structure and by producing corpora cavernosum fibrosis [(2)]. Moreover, endothelial dysfunction is symptom of ED and is necessary for penile erection, vascular event, to occur [(3)]. Circulating LDL particles may cross endothelium and produce oxidation, inflammation, and damage to adjacent smooth muscle cells and overlaying endothelium, which all contribute to pathophysiology of ED [(4)]. Number of metabolic, cardiac, and vascular disorders have been linked to obesity. Higher body fatness that leads to cardiometabolic and atherosclerotic illnesses is assumed to be indicated by increased body mass index [(5)]. Obesity and metabolic syndrome have been known to worsen synthesis of nitric oxide in vascular bed, reduce plasma testosterone levels, cause endothelial dysfunction, and cause dyslipidemia, all of which contribute to pathophysiology of sexual dysfunction, even though connection among obesity and ED has not yet been fully understood [(6)]. Visceral adiposity index is gender-specific empirical mathematical model depend on functional parameters such as triglycerides and high-density lipoprotein cholesterol and simple anthropometric measurements such as waist circumference (WC) and BMI [(7)]. Goal of this research had been to assess ability of visceral adiposity index to predict ED among patients with hyperlipidemia.

Studied cases and techniques

Total of 111 men had been recruited from Andrology and Cardiology outpatient clinics of Mansoura University Hospitals. These sujects were divided into 3 groups and sample size was calculated according to the work of **Akdemir *et al*.** [(8)] a) Hyperlipidemic ED patient (37 cases), b) Hyperlipidemic non-ED patients (37 cases) and c) Control healthy men: healthy non obese subjects with normal fat distribution and normal TG and HDL levels (37 cases).

Inclusion Criteria: The age of the participants ranged between 25 - 60 years. Marriage that is stable.
5-item International Index of Erectile Function had been used to assess studied cases with organic ED, erectile function, and hyperlipidemia throughout course of previous year from 2010 to 2023 .
Control group was also included (matched healthy subjects who have no signs or symptoms of any other disease had been recruited from public).
-If these participants' IIEF-5 was greater than 22, they were included.

Exclusion criteria: Patient with other organic disorders such as diabetes mellitus (DM), Hypertension, Cardio- and/or cerebrovascular accident, patients complaining of sexual symptoms of hypogonadism other than ED, neurological disorders, urinary tract disorders, pelvic surgery, drug intake, patients complaining of or treated for psychiatric disorders, unmarried studied cases, years old under 25 and above sixty, smoking, studied cases suffering from local disorders such as: Peyronie's disease, penile implants and patients suffering from other sexual disorders: such as disorders of ejaculation

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and orgasm, desire disorders, and abnormal sexual orientation.

METHODS

All participants had been subjected to: Full history taking including cardio- and cerebrovascular events: coronary heart disease and myocardial infarction; and transient ischemic attack and ischemic stroke. The IIEF-5 questionnaire, other sexual complaints and previous medications or interventions, complete general and genital examination, waist circumference and body mass index and calculation of visceral adiposity index.

The following laboratory investigations; Full lipogram and hormonal assessement of serum testosterone and prolactin.

Serum cholesterol, serum triglycerides, HDL, LDL: were assayed using biomed diagnostics, schffgraben 41, colometric kits supplied by Hannover, Germany.

LDL Cholesterol = total cholesterol – (HDL Cholesterol + TG/5).

Ethical consideration: Institutional Review Board of Mansoura Faculty of Medicine accepted this report (MS.20.08.1216), and all data had been used solely for research after studied cases gave their informed consent and all privacy concerns had been addressed. Declaration of Helsinki, International Medical Association's code of ethics for studies involving humans, guided conduct of this work.

Statistical analysis and data interpretation: acquired data were statistically analysed using IBM's SPSS statistics for Windows (version 25, 2017). Shapiro-Wilk test had been employed to determine whether data distribution was normal. P value of <0.05 or lower had been regarded as statistically significant.

Receiver operating characteristic curve analysis was used to assess test's diagnostic performance or its precision in separating diseased cases from non-diseased cases. curve was used to identify sensitivity and specificity, and cross-tabulation calculations of PPV, NPV, and accuracy had been performed.

Quantitative data were presented as mean and standard deviation (SD) or median and range, and they were compared by one-Way ANOVA test if data were normally distributed with the post-hoc Tukey test or by Kriskal-Wallis test if the data were abnormally distributed.

RESULTS

Subject features are found in table 1. There was no statistical variation among control group, group A and group B regarding age and marital duration. Weight and BMI were significantly higher among hyperlipidemic groups compared with healthy control group. WC was higher among group A compared with the control group and group B. VAI and IIEF5 were higher among group A compared with the control group and group B.

Table (1): Comparing among control group, group A and group B

	Control (N=37)	Group A (N=37)	Group B (N=37)	P	within group significance
Age/years (Mean ±SD)	48.86±8.76	50.89±6.72	47.19±9.62	P=0.174	-
Marital duration /years median (range)	24(1-38)	24(3-39)	21(2-38)	P=0.181	-
Weight/kg	82.15±11.0	89.95±11.31	83.35±11.10	P=0.007*	P1=0.009* P2=0.643 P3=0.032*
Height /m	174.57±6.59	172.57±4.79	173±4.31	P=0.212	-
BMI (Kg/m2)	26.96±3.57	30.28±3.59	27.82±3.38	P<0.001*	P1<0.001* P2=0.291 P3=0.003*
Waist circumference /cm	102.76±16.28	108.88±18.15	97.50±14.17	P=0.013*	P1=0.109 P2=0.168 P3=0.003*
VAI	**2.76±0.64**	**12.18 ±3.70**	**8.74±2.81**	**P<0.001***	**P1<0.001*** **P2<0.001*** **P3<0.001***
IIEF5	**22.86±0.86**	**15.70±2.22**	**23.24±0.68**	**P<0.001***	**P1<0.001*** **P2=0.258** **P3<0.001***
IIEF5 by age groups (Year) 23-33	**22.0±1.0**	**19.0±0.0**	**23.33±0.58**	**P<0.001***	**P1<0.001*** **P2<0.001*** **P3<0.001***
Age:34-54	**22.57±0.59**	**16.21±2.15**	**23.05±0.38**	**P<0.001***	**P1<0.001*** **P2=0.255** **P3<0.001***
Age: ≥55	**23.54±0.78**	**14.54±1.85**	**23.54±0.97**	**P<0.001***	**P1<0.001*** **P2=1.0** **P3<0.001***

P1: variation among control and group A, P2: variation among control and group B, p3: variation among groups A and B
Visceral adiposity index (VAI), 5-item International Index of Erectile Function (IIEF5), Body mass index (BMI),*: significant

As showed in Table 2; Cholesterol and TGS were higher among group A compared with the control group and group B. Serum total T was significantly lower among hyperlipidemic groups compared with control group, and there was no variation among 2 hyperlipidemic groups in terms of serum T levels. Additionally, in most patients' serum total T levels were within normal range. In this context, although serum prolactin (PRL) levels were higher among hyperlipidemic groups compared with control group, in most of the patient's serum PRL levels were within the normal range.

Table (2): Comparing between control group, group A and group B regarding cholesterol, TGS, HDL and LDL

	Control N=37	Group A N=37	Group B N=37	P	Within group significance
Cholesterol (mg/dl)	**127.16±23.0**	**218.11±6.04**	**173.59±5.67**	**P<0.001***	**P1<0.001*** **P2<0.001*** **P3<0.001***
TGS (mg/dl)	**102.73±12.75**	**307.14±9.61**	**245.97±63.33**	**P<0.001***	**P1<0.001*** **P2<0.001*** **P3<0.001***
HDL (mg/dl)	**54.70±6.76**	**36.49±7.15**	**38.97±6.09**	**P<0.001***	**P1<0.001*** **P2<0.001*** **P3=0.252**
LDL (mg/dl)	**52.76±4.33**	**120.89±6.83**	**85.35±5.10**	**P<0.001***	**P1<0.001*** **P2=0.004*** **P3=0.002***

P1: variation among control and group A, P2: variation among control and group B, p3: variation among groups A and B

As showed in Table 3; In our research, ROC analysis discovered that optimal VAI cut-off to detect ED was ≥11.51 in hyperlipidemic patients and ≥4.23 to ≥5.03 in the whole population (Table 3).

Table (3): ROC curve between different groups regarding VAI

	Cut of point	AUC (95% CI)	Sensitivity	Specificity	PPV	NPV	P value	Accuracy%
Control group and group A:								
VAI	≥4.23	1.0 (1.0-1.0)	100.0	97.3	97.4	100	<0.001*	98.6
Control group and group B:								
VAI	≥5.03	1.0 (1.0-1.0)	97.3	100.0	100.0	97.4	<0.001*	98.6
Group A and group B:								
VAI	≥11.51	0.780 (0.676-0.885)	81.1	56.8	65.2	75.0	<0.001*	68.9

AUC: Area under curve, PPV: Positive predictive value, NPV: Negative predictive value

Table 4 shows that in group A, there was statical positive relationship among VAI and TGS (mg/dl), and there was statical negative relashionship among VAI, HDL (mg/dl) and LDL (mg/dl).

Table (4): Correlation between VAI with sociodemographic and laboratory findings among ED hyperlidemic patients (Group A)

Group A		VAI
IIEF5	rs	0.305
	p value	0.066
age(years)	rs	-0.146
	p value	0.390
marriage duration(years)	rs	0.060
	p value	0.725
BMI (Kg /m^2)	rs	0.241
	p value	0.150
waist circumference / cm	rs	0.188
	p value	0.265
Cholesterol (mg/dl)	rs	-0.324
	p value	0.050
TGS(mg/dl)	rs	0.702*
	p value	0.001
HDL(mg/dl)	rs	-0.329*
	p value	0.047
LDL(mg/dl)	rs	-0.485*
	p value	0.002
Testosterone (ng/dl)	rs	0.002
	p value	0.988
Prolactin(ng/ml)	rs	-0.079
	p value	0.644
Duration of ED/YEARS	rs	0.167
	p value	0.324

rs: Spearman correlation coefficient, *: Statistically significant

Lastly, table 5 shows that there were 2 predictors of ED among studied groups, the first was VAI and the second was serum prolactin (ng/ml).

Table (5): predictors of ED between studied groups

Predictors	β	P-value	Odds ratio	95.0% C.I.for odds ratio	
				Lower	**Upper**
VAI	.426	<0.001*	1.532	1.277	1.837
IIEF5	-4.34	0.99	0.013	Undefined	
Testosterone (ng/dl)	.070	0.687	1.073	0.762	1.511
Prolactin (ng/ml)	.131	0.010*	1.140	1.032	1.259
Constant	-6.812	<0.001*	0.001	–	–

DISCUSSION

Inadequate penile erection or the inability to maintain erection long enough to ensure good sexual performance is referred to as ED [9] and it has been predicted that by 2025, 322 million men will be affected by this condition worldwide. Most common aetiological factors for ED are chronic diseases like hypertension, diabetes mellitus, and coronary artery disease, and side effects of some medications [10].

Numerous cardiac, vascular, and metabolic problems have been linked to obesity. Enhanced body fatness, that could lead to cardiometabolic and atherosclerotic illnesses, is thought to be indicated by increased body mass index [5]. Obesity and metabolic syndrome have been known to worsen synthesis of nitric oxide in vascular bed, decrease plasma testosterone levels, cause endothelial dysfunction, and cause dyslipidaemia, all of which contribute to pathophysiology of sexual dysfunction, even though connection among obesity and ED has not yet been fully understood [6].

Several research have examined utility of VAI to distinguish existence of ED in hyperlipidemia, have set cut-off points, and have advocated it as best predictor of ED given necessity for early detection and treatment of ED to limit its morbidity [8,11,12]. Several studies have demonstrated a connection among ED and measurements of fat accumulation such VAI. It was proposed that VAI could serve as valid indicator of ED as it computes not only serum lipids, like HDL cholesterol and TGs, but also WC and BMI.

Bolat *et al*. [11] reported that, higher VAI values than 4.33 can be risk factor for ED. In our study, ROC analysis recognized that optimal VAI cut-off to distinguish ED was ≥11.51 in hyperlipidemic patients and ≥4.23 to ≥5.03 in the whole population. As we expected, our outcomes agree with some previous studies. Additionally, our analysis revealed that VAI itself was a significant predictor of ED than its components. Because the VAI formulates both structural and functional elements meaning that VAI contains both physical and metabolic parameters, so, VAI could be valuable index of both fat distribution and function. In agreement with our research, other reports of **Akdemir *et al*.** [8], **Aleksandra *et al*.** [12] showed that evaluation utilising indices like VAI, which showed that excessive visceral fat accumulation increases risk of developing ED, appears to be more reliable than using anthropometric parameters like BMI or WC. Consistent with our findings and that of the others, it has been demonstrated that VAI was independently related to cardiovascular events [8, 13]. This relationship has showed that there is positive relationship among level of VAI and risk of atherosclerosis, subclinical atherosclerosis, hypertension, and coronary heart disease [14-16], which, implicats these disorders as a possible etiopathogenetic factors for induction of ED in hyperlidemic patients. However, the relationship between VAI and cardiovascular diseases is not linear [17]. This finding could explain the absence of significant correlation between VAI score and IIEF5 score in our study suggesting that there are numerous factors, which may influence development of ED in hyperlipidemic patients, like genetics, lifestyle, dietary behavior, age, secondary behavior, and cardiometabolic diseases [18].

Based on these previous findings, it could be anticipated that prolactin is one of the predictors of ED among studied groups. However, there were not significant correlations between PRL levels and both VAI and IIEF5. This could be attributed to the fact that several factors may influence development of ED in hyperlipidemic patients, like genetics, lifestyle, dietary behavior, age, secondary behavior, and cardiometabolic diseases 23. Additionally, although serum PRL levels were higher among hyperlipidemic groups compared with control group, in most of the patient's serum PRL levels were within the normal range.

Previous observational researches have demonstrated that serum testosterone levels directly correlate with HDL cholesterol [18,19]. However, outcomes of present research found that serum T level did not predict the occurrence of ED among the studied groups. This negative finding may be attributed to the fact that in most of our patients the serum T levels were within normal range. Additionally, there was no variation among 2 hyperlipidemic groups in terms of serum T levels or between different age groups suggesting a minimal role of hypogonadism in induction of ED in this group of hyperlipidemic patients. Furthermore, it should be recognized that there were no significant associations between both VAI and IIEF5 and serum T levels. These findings may suggest that low T do not necessarily to be the causative of ED in this group of hyperlipidemic group. For instance, it is likely that both aberrant lipid pattern and low serum T levels are caused by high BMI and associated metabolic problems. Thus, the occurrence of ED may be confounded. Not unexpectedly, the absence of significant correlations between IIEF5 and both BMI and WC may support these explanations that the occurrence of ED may be confounded and vaculogenic factors (such as reduction in nitric oxide activity and endothelial dysfunction) may have a role. It is important to mention that visceral adipose tissue accumulation findings in increased immune cell infiltration, secretion of vasoconstrictor mediators, decreasing production and increasing ROS-mediated destruction of NO, dysfunctional remodeling and stiffness of vasculature, and increased endothelial permeability [20] that may jeopardize.

According to prior research, males with BMI of twenty five kg/m^2 had higher prevalence of ED than men with BMI of less than twenty five kg/m^2 [13] suggesting that obesity 1.5- 3 times increasing risk of developing ED. On other hand, prevalence of MS and

obesity were shown to be at greater rate in ED studied cases [(21)].

CONCLUSION

VAI and IIEF5 were greater among group A compared with the control group and group B. Receiver operating curve finds that best cut off point of VAI to detect group A was found ≥4.23 with sensitivity of one hundred percent, specificity of 97.3 percent, positive predictive value (PPV) of 97.4%, negative predictive value (NPV) of one hundred percent and total accuracy of 98.6%. In individuals with hyperlipidemia, VAI has been more accurate than WC, BMI, triglycerides (TG), and high-denisty lipoproteins (HDL) for assessing impact of visceral adiposity on ED.

DECLARATIONS

- **Consent for publication:**
- I certify that all writers have given their consent to submit work.
- **Availability of data and material:**
- Available
- **Competing interests:**
- None
- **Funding:**
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- **Conflicts of interest:**
- no conflicts of interest.

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