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Can a High Body Shape Index (ABSI) Be a Risk Factor for Peyronie's Disease?

Engin Kölükçü, Kenan Yalçın, Fatih Fırat

Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Urology, Tokat, Turkiye

What's known on the subject? and What does the study add?

Peyronie's disease is a wound-healing disorder characterized by penile pain, curvature, and sexual dysfunction. The pathophysiology of Peyronie's disease involves an abnormal healing pattern in response to trauma within the tunica albuginea. Clinical conditions, including hypertension, dyslipidemia, and diabetes mellitus, can increase the incidence of Peyronie's disease by creating a hypoxic microenvironment in erectile tissues. A body shape index (ABSI) is a recent anthropometric measurement of visceral adiposity. This study is the first to define ABSI as a new independent risk factor for Peyronie's disease. We believe that considering ABSI during follow-up and treatment protocols for Peyronie's disease will offer important innovations in andrology practice.

Abstract

Objective: Predisposing factors of Peyronie's disease remain controversial. We know that obesity has extremely negative effects on erectile tissue. Therefore, in our study, we aimed to examine the relationship between Peyronie's disease and the body shape index (ABSI), which is a new parameter for the evaluation of visceral adiposity.

Materials and Methods: In this study, 55 healthy volunteers (group-1) and 50 Peyronie's disease patients (group-2). Age, comorbidities, waist circumference (WC), height, body mass index (BMI), testosterone, fasting glucose, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, International Index of Erectile Function (IIEF), and ABSI scores of all patients were analyzed. In addition, plaque sizes, duration of symptoms, and curvature degrees of patients in group 2 were calculated.

Results: The mean ages of group 1 and group 2 were 57.02±8.34 years and 56.02±10.65 years, respectively ($p>0.05$). Fasting glucose, WC, BMI, and ABSI values were significantly higher in group 2 ($p=0.031$, $p<0.001$, $p=0.026$ and $p<0.001$). LDL and HDLvalues were similar between both groups ($p>0.05$). The IIEF score was observed to be lower in group 2 ($p<0.001$). In terms of ABSI values, the discrimination power of Peyronie's disease was strong. The cut-off value for the ABSI score was 0.08. For this cut-off point, classification success was determined as 88.0% sensitivity and 80.0% selectivity.

Conclusion: ABSI can be a reliable independent risk factor for Peyronie's disease and a predictor of visceral adiposity.

Keywords: Peyronie's disease, a body shape index, men, visceral adiposity

Introduction

Peyronie's disease is a wound-healing disorder characterized by penile pain, curvature, and sexual dysfunction. The pathophysiology of Peyronie's disease involves an abnormal healing pattern in response to trauma within the tunica albuginea (1). Although the etiology has not yet been fully elucidated, numerous studies have linked Peyronie's disease with clinical conditions such as advanced age, diabetes mellitus, obesity, and dyslipidemia, which create a hypoxic microenvironment in erectile tissues (2). In their study evaluating Peyronie's disease in patients aged 40 years, Tefekli et al. (3) reported that more than half of the cases had at least one of the risk factors for vascular disease.

Today, there is a significant increase in the prevalence of obesity and obesity-related health problems directly related to changing

Correspondence: Engin Kölükçü MD, Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Urology, Tokat, Turkiye
Phone: +90 535 400 23 85 **E-mail:** drenginkolukcu@gmail.com **ORCID-ID:** orcid.org/0000-0003-3387-4428
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lifestyles. Obesity leads to endothelial dysfunction by increasing susceptibility to hypertension and metabolic syndrome (4). On the other hand, it can also cause changes in the hormone profile. This condition negatively affects male sexual function (4,5). Visceral fat accumulation significantly increases the risk of metabolic and cardiovascular diseases. Therefore, body fat distribution rather than total adipose tissue content is critical for metabolic abnormalities. The most basic approach to assess fat distribution is the use of detailed diagnostic tools, such as computed tomography or magnetic resonance imaging. However, these diagnostic tools are expensive and are limitedly used in daily practice (6,7). This has recently encouraged health professionals to search for new anthropometric indices using traditional measurements. A body shape index (ABSI) is most important of these indices. The value is calculated using allometric regression of waist circumference (WC), weight, and height. Previous clinical studies have documented a significant relationship between ABSI, metabolic disorders, and cardiovascular pathologies (8,9). On the other hand, in another study we conducted in the past, we observed that the visceral adiposity index, which is a marker of adipose tissue dysfunction, is closely related to Peyronie's disease (10).

This retrospective study aimed to evaluate the relationship between Peyronie's disease and ABSI. To the best of our knowledge, this is the first study in English literature where ABSI was analyzed in Peyronie's disease patients.

Materials and Methods

Patients

The data of patients who applied to our clinics between January 2020 and February 2024 were retrospectively analyzed. Patients who applied for routine care and did not have neuropathology were categorized into group 1. Peyronie's disease patients were defined as group 2. Demographic data, comorbidities, clinical complaints, duration of symptoms, physical examination findings, trauma, pelvic radiotherapy, and surgical histories of the patients were analyzed in detail. The diagnosis of Peyronie's disease was established based on characteristic symptoms and the presence of palpable penile plaque on physical examination.

Plaque size was determined via physical examination. The penile plaque was marked with a marker pen, and its dimensions were measured using a meter. The curvature degree was calculated by reviewing images obtained after intracavernosal injection (11,12). On the other hand, the weight, height, and WC of the patients were also measured. The erectile function of the patients was calculated using the International Index of Erectile Function (4). Blood was collected from all patients between 08.30 and 10.00 after overnight fasting. In our blood analysis, total testosterone, fasting blood glucose, high-density lipoprotein (HDL) cholesterol, and low-density lipoprotein (LDL) cholesterol levels were analyzed.

Our analyses were performed in accordance with the Declaration of Helsinki Principles and with the approval of Tokat Gaziosmanpaşa University Faculty of Medicine Clinical Research Ethics Committee approved this study (decision no: 24-KAEK-138, date: 18.04.2024).

Measurement of BMI, WC, and ABSI

WC was calculated by measuring the circumference of the circle passing through the midpoint of the lines perpendicular to the 10^{th} rib on both sides and the spina iliaca anterior superior. BMI was calculated as weight/height^2 (kg/m^2). ABSI was calculated as WC divided by $BMI^{2/3}$ x $height^{1/2}$ (13).

Exclusion Criteria

Patients with a history of trauma, radiotherapy, malignancy, or pelvic surgery were excluded.

Statistical Analysis

A descriptive statistical work-up was conducted for the study to provide insight into the general characteristics. Data for continuous variables are presented as the arithmetic mean and standard deviation. Levene's test was used to determine whether continuous variables matched with normal distribution or not. Regarding inter-group comparisons of variables indicated with measurements, a t-test was used for independent samples to study inter-group differences. Receiver operating characteristics (ROC) curve analysis was applied to determine the cut-off values of the variables, and the area under the ROC curve (AUC) was also evaluated. Also, correlation and regression analysis were performed to examine the relationships between continuous variables. A p-value 0.05 was considered statistically significant. Calculations were made with available statistical software (IBM SPSS 26, SPSS Inc., an IBM Co., Somers, NY).

Results

The data from a total of 105 male patients were analyzed. Group 1 was the control group, and there were 55 patients. In group 2, 50 patients were diagnosed with Peyronie's disease. Mean age was 57.02±8.34 years and 56.02±10.65 years in groups 1 and 2, respectively. There were no significant differences between the groups in terms of age distribution (p>0.05). The mean symptom duration in group 2 was 19.88±4.58 months. The mean plaque size and penile curvature degree of patients in this group were 16.4±4.87 mm and 48.14±10.15°, respectively. It was determined that diabetes mellitus, hypertension, hyperlipidemia, and smoking were higher in this group than in group 1 (p=0.044, p=0.043, p=0.008, and p=0.019, respectively). On the other hand, no difference was found between groups 1 and 2 in terms of coronary artery disease (p>0.05) (Table 1).

WC and BMI measurements were higher in group 2 than in group 1 (p<0.001 and p=0.026). When blood biochemical analyses were examined, mean fasting glucose, HDL cholesterol, and LDL cholesterol levels in group 2 were 123.69±68.84 mg/dL, 44.14±9.81 mg/dL and 149.08±135.72 mg/dL. Glucose values were found to be significantly higher than in group 1 (p=0.031). HDL-C and LDL-C values were similar between groups 1 and 2 (p>0.05). On the other hand, total testosterone levels were significantly lower in group 2 than in group 1 (p<0.001). The mean ABSI values in groups 1 and 2 were recorded as 0.08±0.01 and 0.09±0.01, respectively. These values were significantly higher in group 2 (p<0.001). Although erectile dysfunction was observed in only 19 (34.54%) patients in group 1, it was detected in 27 (54%) patients in group 2. In this context, the IEFF score of group 2 was significantly lower than that of group 1 (p<0.001) (Table 2).

ROC analysis was performed to determine the success of ABSI scores in the prediction of Peyronie's disease and AUC values, accuracy, sensitivity, selectivity, positive-negative predictive values, and likelihood ratio (+) values together with the 95% confidence intervals calculated as a result of the ROC analysis are shown in Table 3. The ROC curve is shown in Figure 1. As a result of the ROC analysis, the ABSI score was found to be statistically significant between groups 1 and 2 [AUC=0.890 (0.819-0.946); p<0.001]. In terms of ABSI values, the discrimination power of Peyronie's disease was strong. The cut-off value for the ABSI score was 0.08. For this cut-off point, classification success was determined as 88.0% sensitivity and 80.0% selectivity.

Table 1. Distribution of study population by comorbidity

Comorbidity	Group		p-values
	Group 1 (n=55)	Group 2 (n=50)	
Diabetes mellitus	6 (10.9%)	14 (28%)	**0.044***
Hypertension	5 (9.1%)	12 (24%)	**0.043***
Hyperlipidemia	8 (14.5%)	20 (40%)	**0.008***
Coronary artery disease	4 (7.3%)	11 (22%)	0.067
Smoking	12 (21.8%)	23 (46%)	**0.019***

Chi-square test, *: Bold values indicate statistically significant (p<0.05)

Table 2. General characteristics of groups 1 and 2

	Groups		p-values
	Groups 1 (n=55)	Groups 2 (n=50)	
Age (years)	57.02±8.34	56.02±10.65	0.597
Height (cm)	173.22±5.03	170.50±7.08	0.225
BMI (kg/m²)	27.38±2.83	28.94±4.17	**0.026***
WC (cm)	91.98±5.14	105.82±10.90	**<0.001***
ABSI	0.08±0.01	0.09±0.01	**<0.001***
Glucose (mg/dL)	99.15±39.01	123.69±68.84	**0.031***
HDL cholesterol	45.15±9.88	44.14±9.81	0.600
LDL cholesterol	110.89±49.71	149.08±135.72	0.054
Testosterone (ng/dL)	462.49±110.42	346.33±159.29	**<0.001***
IIEF	23.64±3.60	19.02±3.35	**<0.001***

Student's t-test with mean ± standard deviation
*: Bold values indicate statistically significant (p<0.05).
BMI: Body mass index, WC: Waist circumference, ABSI: A body shape index, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, IIEF: International Index of Erectile Function

Discussion

The history of Peyronie's disease dates back to the early 7th century. Despite having an extensive clinical history, there are many uncertainties regarding the etiopathogenesis and treatment approaches of Peyronie's disease. It is estimated that the prevalence of all cases of Peyronie's disease in the world varies between 0.3% and 13.1% (14). On the other hand, the easy availability of treatment options for erectile dysfunction in the modern century has led to a significant increase in the frequency of Peyronie's disease evaluation by healthcare professionals (10). In a recent study in Turkiye, which is also the

Table 3. ROC curve analysis of the ABSI score in disease prediction

	ABSI score
Area under curve	0.895 (0.819-0.946)
Sig. p (area=0.5)	<0.001*
Cut-off	>0.08
Sensitivity (95% CI)	88.0 (75.7-95.5)
Specificity (95% CI)	80.0 (67.0-89.6)

ROC: Receiver operating characteristics, ABSI: A body shape index CI: Confidence interval

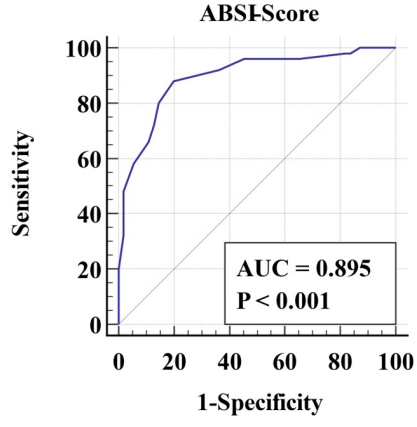

Figure 1. ROC curves for the ABSI score in disease prediction

ABSI: A body shape index, AUC: Area under curve, ROC: Receiver operating characteristics

geographical region of our study, Kadioglu et al. (15) reported the prevalence of Peyronie's disease to be 5.3%. The same study documented that this pathology was associated with a higher incidence of diabetes, hypertension, heart disease, smoking, age, and poor sexual intercourse experience (15). On the other hand, in our study, a close relationship was found between Peyronie's disease and comorbidity. In the physiopathology of Peyronie's disease, which is mainly emphasized, there is tissue damage caused by penile micro-traumas with a cumulative effect in later periods. For this reason, many authors have reported that factors that negatively affect wound healing can also negatively affect the course of Peyronie's disease (10,16).

The adipose tissue is a connective tissue composed mostly of adipocytes. Adipose tissue is divided into two components: Subcutaneous and visceral. Visceral adipose tissue is the most pathogenic component (17). Therefore, the function of adipose tissue is very important for a healthy life. The term adipose tissue dysfunction refers to a condition in which adiponectin production decreases to very low levels, whereas proatherogenic, proinflammatory, and prediabetic adipocytokine are excessively secreted (18). Adiposity is characterized by adipocyte deposition and hypertrophy of visceral adipose tissue (19). It is accepted that adipose tissue dysfunction is a key process in the pathophysiology of obesity-related disorders by negatively affecting oxygenation (20). Previous studies have observed that adipose tissue dysfunction is closely related to high rates of diabetes mellitus, insulin resistance, dementia, stroke, coronary artery disease, hypertension, obstructive sleep apnea, hormonal imbalance, non-alcoholic fatty liver, and many types of cancer in obese patients (21,22).

ABSI is a recent anthropometric measurement indicating visceral adiposity rather than peripheral fat (8,13). It is a useful index for cardiometabolic risk assessment independent of WC and BMI, which was developed by Krakauer and Krakauer (7) in 2012 (7,23). On the other hand, ABSI has been reported to be positively correlated with visceral adiposity estimated by ultrasonic and bioelectrical impedance analysis in clinical analyses. However, Lin and Lin (23) observed that ABSI was more closely associated with impotence than other obesity indices (23). In a study of 607 patients, Bouchi et al. (8) reported that ABSI was an important indicator of arterial stiffening in patients with type 2 diabetes. Haghighatdoost et al. (13) reported that ABSI was a poor predictor of metabolic syndrome and cardiovascular disease. On the other hand, recent studies have also shown that ABSI is a strong predictor of all-cause mortality (24,25). Our study analyzed several factors suspected of the etiopathogenesis of Peyronie's disease in detail and examined the relationship between ABSI and Peyronie's disease. The findings suggest that the ABSI is a risk factor of Peyronie's disease as a predictor of visceral adipose dysfunction.

Testosterone is an endogenous anabolic hormone that plays an important role in wound healing (26,27). It has been observed that previous studies have dealt with Peyronie's disease and testosterone levels in detail. In a series of 121 cases, Moreno and Morgentaler (28) reported that low testosterone levels were correlated with Peyronie's disease. In the same study, it was also reported that there is a relationship between low testosterone levels and the severity of curvature. In a study including 106 patients with Peyronie's disease by Nam et al. (29), they reported that low testosterone levels were associated with erectile dysfunction, plaque size, and penile deformity. Similarly, in the studies of Cavallini et al. (27), it was found that the levels of testosterone were lower in patients with Peyronie's disease compared with the control group. Differently, in the study of Kirby et al. (30), low testosterone levels were not associated with the severity of Peyronie's disease. Similarly, in the study of El-Sakka (31), there was no relationship found between hormonal abnormalities and Peyronie's disease. Obesity and hypotestosteronemia are closely related. In previous studies, it has been noted that depending on the level of obesity, there is a decrease in the level of sex hormone-binding globulin associated with insulin resistance and a suppression in the hypothalamic-pituitary-testicular axis, followed by a decrease in testosterone levels (5,32). Wang et al. (32) reported that obesity and hypogonadism were closely related in males in their study. In our study, we found that there was a decrease in testosterone levels in patients with Peyronie's disease compared with the control group. This trend was directly related to ABSI levels.

Other factors that negatively affect wound healing include comorbid conditions such as diabetes mellitus, dyslipidemia, and hypertension. It is observed that in many clinical studies conducted in the past, the relationship between comorbidity and Peyronie's disease was analyzed in detail, and quite different results were documented. Diabetes mellitus activates transforming growth factor (TGF)-beta 1. Increasing glucose and TGF-beta 1 level upregulated plasminogen activator inhibitors. Thus, although matrix metalloproteinases are inhibited, the tissue inhibitory activity of metalloproteinases is high (33). This condition causes abnormalities in the extracellular matrix composition, such as collagen accumulation, scar formation, and fibrosis, in patients with diabetes mellitus (33,34). In a very large series of 1208 cases by Kadioglu et al. (15), it was reported that 17.5% of Peyronie's disease patients were diagnosed with diabetes mellitus, and this rate was higher than that of the control group. In a similar study, Tefekli et al. (34) reported that patients with Peyronie's disease and diabetes mellitus had much more severe penile deformity. In this study, diabetes mellitus was observed in 19.1% of patients with Peyronie's disease, a significantly higher rate than in the control group.

Hypertension and dyslipidemia are other risk factors that negatively affect the oxygen level in the penile microenvironment (15). It has been observed that many clinical studies conducted in the past have investigated the relationship between Peyronie's disease and hypertension and dyslipidemia. In a study by Bjekic et al. (35) in which they evaluated a total of 328 cases diagnosed with 82 cases of Peyronie's disease, they reported that comorbidities such as diabetes mellitus, hypertension, and hyperlipidemia were more common in this group. In another study, Pavone et al. (36) reported that 44% of patients with Peyronie's disease were diagnosed with hypertension, a rate that was considerably higher than that in the control group. In our study, we found that the incidence of hypertension and hyperlipidemia was higher in patients with Peyronie's disease than in the control group. In a series of 307 cases by Kadioglu et al. (11) reported that 67.5% of patients with Peyronie's disease had at least one risk factor; however, diabetes mellitus and hypercholesterolemia were the most common comorbidities. These systemic conditions have repercussions in the penile microenvironment, such as chronic inflammation, increased levels of reactive oxygen species, disruption of intercellular connections, and endothelial dysfunction (37). In this context, the physiopathology of Peyronie's disease has been analyzed from a broad perspective in our study by analyzing ABSI, which is closely related to a wide range of pathologies, such as hypertension, insulin resistance, pre-diabetes, diabetes mellitus, dyslipidemia, and hormonal disorders. Our study documented the relationship between ABSI and Peyronie's disease for the first time in the literature.

Study Limitations

The main limitation of our study is that it was conducted retrospectively with a limited number of patients. On the other hand, due to the inadequacy of our technical conditions, the fact that a detailed biochemical analysis could not be performed, the plaque size and penile arterial and venous system blood flow could not be documented with Doppler ultrasonography were other limitations of our study.

Conclusion

In this retrospective study, ABSI was found to be higher in patients with Peyronie's disease than in controls. In line with our results, we believe that it is extremely important to consider high ABSI as a risk factor for Peyronie's disease. Our study should be supported by prospective, randomized, and large series studies.

Ethics

Ethics Committee Approval: Our analyses were performed in accordance with the Declaration of Helsinki Principles and with the approval of Tokat Gaziosmanpaşa University Faculty of Medicine Clinical Research Ethics Committee approved this study (decision no: 24-KAEK-138, date: 18.04.2024).

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: E.K., K.Y., F.F., Concept: E.K., F.F., Design: E.K., K.Y., Data Collection or Processing: E.K., K.Y., F.F., Analysis or Interpretation: E.K., K.Y., Literature Search: E.K., K.Y., F.F., Writing: E.K., K.Y., F.F.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Ziegelmann MJ, Bajic P, Levine LA. Peyronie's disease: Contemporary evaluation and management. Int J Urol. 2020;27:504-516. [Crossref]
2. Gianazza S, Belladelli F, Leni R, Masci F, Rossi P, Gianesini G, Maggio P, Zaffuto E, Salonia A, Carcano G, Dehò F, Capogrosso P. Peyronie's disease development and management in diabetic men. Andrology. 2023;11:372-378. [Crossref]
3. Tefekli A, Kandirali E, Erol H, Alp T, Köksal T, Kadioğlu A. Peyronie's disease in men under age 40: characteristics and outcome. Int J Impot Res. 2001;13:18-23. [Crossref]
4. Bolat MS, Kocamanoglu F, Ozbek ML, Buyukalpelli R, Asci R. Can High Visceral Adiposity Index Be a Risk Factor for Sexual Dysfunction in Sexually Active Men? J Sex Med. 2020;17:1926-1933. [Crossref]
5. Fui MN, Dupuis P, Grossmann M. Lowered testosterone in male obesity: mechanisms, morbidity and management. Asian J Androl. 2014;16:223-231. [Crossref]
6. Rico-Martín S, Calderón-García JF, Sánchez-Rey P, Franco-Antonio C, Martínez Alvarez M, Sánchez Muñoz-Torrero JF. Effectiveness of body roundness index in predicting metabolic syndrome: A systematic review and meta-analysis. Obes Rev. 2020;21:e13023. [Crossref]
7. Krakauer NY, Krakauer JC. A new body shape index predicts mortality hazard independently of body mass index. PLoS One. 2012;7:e39504. [Crossref]
8. Bouchi R, Asakawa M, Ohara N, Nakano Y, Takeuchi T, Murakami M, Sasahara Y, Numasawa M, Minami I, Izumiyama H, Hashimoto K, Yoshimoto T, Ogawa Y. Indirect measure of visceral adiposity 'A Body Shape Index' (ABSI) is associated with arterial stiffness in patients with type 2 diabetes. BMJ Open Diabetes Res Care. 2016;4:e000188. [Crossref]
9. Bertoli S, Leone A, Krakauer NY, Bedogni G, Vanzulli A, Redaelli VI, De Amicis R, Vignati L, Krakauer JC, Battezzati A. Association of Body Shape Index (ABSI) with cardio-metabolic risk factors: A cross-sectional study of 6081 Caucasian adults. PLoS One. 2017;12:e0185013. [Crossref]
10. Kölükçü E, Bolat MS, Demir M, Sarıkaya K, Saygın H. Relationship Between the Visceral Adiposity Index and Peyronie's Disease. J Urol Surg. 2023;10:220-226. [Crossref]
11. Kadioglu A, Tefekli A, Erol B, Oktar T, Tunc M, Tellaloglu S. A retrospective review of 307 men with Peyronie's disease. J Urol. 2002;168:1075-1079. [Crossref]
12. Culha M, Alici B, Acar O, Mutlu N, Gökalp A. The relationship between diabetes mellitus, impotence and veno-occlusive dysfunction in Peyronie's disease patients. Urol Int. 1998;60:101-104. [Crossref]

13. Haghighatdoost F, Sarrafzadegan N, Mohammadifard N, Asgary S, Boshtam M, Azadbakht L. Assessing body shape index as a risk predictor for cardiovascular diseases and metabolic syndrome among Iranian adults. Nutrition. 2014;30:636-644. [Crossref]
14. Ateş E, Gökçe A. Pathophysiology of peyronie's disease. Androl Bul. 2019;21:161-169. [Crossref]
15. Kadioglu A, Dincer M, Salabas E, Culha MG, Akdere H, Cilesiz NC. A Population-Based Study of Peyronie's Disease in Turkey: Prevalence and Related Comorbidities. Sex Med. 2020;8:679-685. [Crossref]
16. Garaffa G, Trost LW, Serefoglu EC, Ralph D, Hellstrom WJ. Understanding the course of Peyronie's disease. Int J Clin Pract. 2013;67:781-788. [Crossref]
17. Mittal B. Subcutaneous adipose tissue & visceral adipose tissue. Indian J Med Res. 2019;149:571-573. [Crossref]
18. Hajer GR, van Haeften TW, Visseren FL. Adipose tissue dysfunction in obesity, diabetes, and vascular diseases. Eur Heart J. 2008;29:2959-2971. [Crossref]
19. Bermúdez VJ, Salazar J, Anez R, Rivas-Rios JR, Chavez-Castillo M, Torres W, Nunez V, Mejias J, Wilches-Duran S, Cerda M, Graterol M, Graterol R, Hernandez J, Garicano C, Rojas J. Optimal visceral adiposity index cutoff value in a Venezuelan population: Results from the Maracaibo City Metabolic Syndrome Prevalence Study. Rev Silver Endocrinol Metab. 2017;54:176-183. [Crossref]
20. Goossens GH, Blaak EE. Adipose tissue dysfunction and impaired metabolic health in human obesity: a matter of oxygen? Front Endocrinol (Lausanne). 2015 24;6:55. [Crossref]
21. Amato MC, Giordano C, Galia M, Criscimanna A, Vitabile S, Midiri M, Galluzzo A; AlkaMeSy Study Group. Visceral Adiposity Index: a reliable indicator of visceral fat function associated with cardiometabolic risk. Diabetes Care. 2010;33:920-922. [Crossref]
22. Laforest S, Labrecque J, Michaud A, Cianflone K, Tchernof A. Adipocyte size as a determinant of metabolic disease and adipose tissue dysfunction. Crit Rev Clin Lab Sci. 2015;52:301-313. [Crossref]
23. Lin W, Lin ME. Novel anthropometric measures are positively associated with erectile dysfunction: a cross-sectional study. Int Urol Nephrol. 2024;56:855-865. [Crossref]
24. Krakauer NY, Krakauer JC. Dynamic association of mortality hazard with body shape. PLoS One. 2014 20;9:e88793. [Crossref]
25. Dhana K, Kavousi M, Ikram MA, Tiemeier HW, Hofman A, Franco OH. Body shape index in comparison with other anthropometric measures in prediction of total and cause-specific mortality. J Epidemiol Community Health. 2016;70:90-96. [Crossref]
26. Can O, Özbir S, Atalay HA, Çakır SS, Culha MG, Canat HL. The relationship between testosterone levels and Peyronie's disease. Andrologia. 2020;52:e13727. [Crossref]
27. Cavallini G, Biagiotti G, Lo Giudice C. Association between Peyronie disease and low serum testosterone levels: detection and therapeutic considerations. J Androl. 2012;33:381-388. [Crossref]
28. Moreno SA, Morgentaler A. Testosterone deficiency and Peyronie's disease: pilot data suggesting a significant relationship. J Sex Med. 2009;6:1729-1735. [Crossref]
29. Nam HJ, Park HJ, Park NC. Does testosterone deficiency exaggerate the clinical symptoms of Peyronie's disease? Int J Urol. 2011;18:796-800. [Crossref]
30. Kirby EW, Verges D, Matthews J, Carson CC, Coward RM. Low testosterone has a similar prevalence among men with sexual dysfunction due to either Peyronie's disease or erectile dysfunction and does not correlate with Peyronie's disease severity. J Sex Med. 2015;12:690-696. [Crossref]
31. El-Sakka AI. Prevalence of Peyronie's disease among patients with erectile dysfunction. Eur Urol. 2006;49:564-569. [Crossref]
32. Wang N, Zhai H, Han B, Li Q, Chen Y, Chen Y, Xia F, Lin D, Lu Y. Visceral fat dysfunction is positively associated with hypogonadism in Chinese men. Sci Rep. 2016;6:19844. [Crossref]
33. Kendirci M, Trost L, Sikka SC, Hellstrom WJ. Diabetes mellitus is associated with severe Peyronie's disease. BJU Int. 2007;99:383-386. [Crossref]
34. Tefekli A, Kandirali E, Erol B, Tunc M, Kadioglu A. Peyronie's disease: a silent consequence of diabetes mellitus. Asian J Androl. 2006;8:75-79. [Crossref]
35. Bjekic MD, Vlajinac HD, Sipetic SB, Marinkovic JM. Risk factors for Peyronie's disease: a case-control study. BJU Int. 2006;97:570-574. [Crossref]
36. Pavone C, D'Amato F, Dispensa N, Torretta F, Magno C. Smoking, diabetes, blood hypertension: possible etiologic role for Peyronie's disease? Analysis in 279 patients with a control group in Sicily. Arch Ital Urol Androl. 2015;87:20-24. [Crossref]
37. Crocetto F, Barone B, Manfredi C, Trama F, Romano L, Romeo M, Russo G, Sicignano E, Persico F, Aveta A, Spirito L, Napolitano L, Imbimbo C, Tarantino G. Are insulin resistance and non-alcoholic fatty liver disease associated with Peyronie's disease? A pilot study. J Physiol Pharmacol. 2022;73. [Crossref]