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The Relationship Between Metabolic Syndrome and Urogenital Health Markers: A Cross-Sectional Study

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Abstract:

Objective: Metabolic syndrome (MetS) is a cluster of metabolic abnormalities that increases cardiovascular risk and may adversely affect urogenital function, particularly erectile and prostate-related parameters. To evaluate the association between MetS and urogenital health markers, including erectile function, lower urinary tract symptoms, prostate volume, and internal iliac artery resistive index (RI).

Methods: This cross-sectional study included 110 adult men without known cardiovascular, endocrine, oncological, or urological diseases evaluated at a hospital check-up clinic. Participants were grouped according to the presence of MetS. Erectile function (International Index of Erectile Function-5 [IIEF-5]), lower urinary tract symptoms (International Prostate Symptom Score [IPSS]), prostate volume, and internal iliac artery RI were assessed. Group comparisons were performed using non-parametric tests and the chi-square test, as appropriate.

Results: Participants with MetS had significantly lower IIEF-5 scores and a higher prevalence of erectile dysfunction compared with MetS and without MetS (P=0.042). Although IPSS scores and prostate volume tended to be higher in the MetS group, these differences were not statistically significant (P>0.05). No significant differences were observed in internal iliac artery RI values between groups (P>0.05).

Conclusion: MetS is significantly associated with erectile dysfunction and may contribute to impaired urogenital health. Internal iliac artery RI alone does not appear to be a sensitive early marker of urogenital vascular impairment.

Keywords: Metabolic Syndrome, Erectile Dysfunction, Prostate Volume, Internal Iliac Artery, International Prostate Symptom Score, International Index of Erectile Function-5

Metabolic syndrome (MetS) is a multifactorial disorder characterized by chronic inflammation and insulin resistance. It is closely associated with major causes of morbidity and mortality, including cardiovascular diseases, type 2 diabetes, and various cancers [1]. The core components of MetS are abdominal obesity, insulin resistance/hyperglycemia, dyslipidemia and hypertension [2]. The effects of these metabolic disorders on male health, particularly their relationship with the urogenital system, have become a growing focus of research in recent years.

The pathophysiological connections among benign prostatic hyperplasia, lower urinary tract

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symptoms, erectile dysfunction (ED), and MetS are becoming increasingly clear. There is strong evidence that MS contributes to erectile dysfunction via endothelial dysfunction, chronic inflammation, and hormonal imbalances [3, 4]. Similarly, it has been suggested that insulin resistance and hyperinsulinemia may trigger the development of benign prostatic hyperplasia by promoting the proliferation of prostate cells [5].

This study aimed to evaluate the relationship between metabolic syndrome and urogenital health markers in healthy men using a multidimensional approach. Clinical symptom scores (International Prostate Symptom Score [IPSS] and International Index of Erectile Function-5 [IIEF-5]), prostate volume, and vascular status assessed by the internal iliac artery resistive index were evaluated in combination. The internal iliac artery resistive index was further examined to explore its potential role as a non-invasive indicator of pelvic vascular status in relation to urogenital health.

METHODS

Study Design and Population

This study was designed as a cross-sectional observational study conducted in adult male individuals presenting to a hospital check-up clinic. Data were collected at a single time point. Between January 2025 and May 2025, a total of 147 individuals were initially screened. Exclusion criteria included a history of diabetes mellitus, cardiovascular disease, chronic kidney disease, known prostate disease, oncological disease, prior pelvic surgery, or current use of medications affecting sexual or urinary function. After applying these criteria, 110 adult men were enrolled in the study. All participants provided written informed consent, and the study protocol was approved by the local Clinical Research Ethics Committee (Approval No: 137/2025) in accordance with the Declaration of Helsinki. A flowchart illustrating patient screening, exclusions, and final inclusion is presented in Figure 1.

Clinical and Laboratory Assessment

Demographic characteristics, including age, body mass index (BMI), and smoking status, were recorded for all participants. Blood samples were collected in the morning after an overnight fast to measure fasting blood glucose (FBG), glycosylated hemoglobin (HbA1c), high-density lipoprotein (HDL) cholesterol, triglycerides (TG), and total prostate-specific antigen (PSA).

Definition of Metabolic Syndrome

MetS was defined according to commonly used criteria derived from the American Diabetes Association (ADA) and the International Diabetes Federation (IDF). Participants were classified as having metabolic syndrome if at least two of the following criteria were present: low HDL cholesterol (<40 mg/dL), elevated TG (≥150 mg/dL), FBG ≥100 mg/dL, and/or HbA1c ≥5.7%.

Radiological Assessment

Prostate volume was measured by an experienced radiologist using transabdominal ultrasonography. A prostate volume greater than 25 mL was considered increased. Pelvic vascular evaluation was performed using color Doppler Ultrasound. The RI was measured bilaterally from the internal iliac arteries and calculated as RI = (Peak systolic velocity [PSV] – end diastolic velocity [EDV]) / PSV. The internal iliac artery was selected as a proximal pelvic vascular marker due to its contribution to both prostatic and penile arterial supply.

Symptom and Functional Assessment

Lower urinary tract symptoms were assessed using the IPSS, categorized as mild (0–7), moderate (8–19), or severe (20–35). Erectile function was evaluated using the five-item IIEF-5, and erectile dysfunction severity was categorized as normal, mild, mild-to-moderate, moderate, or severe according to established cut-off values.

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Continuous variables with normal distribution are presented as mean ± standard deviation, whereas non-normally distributed

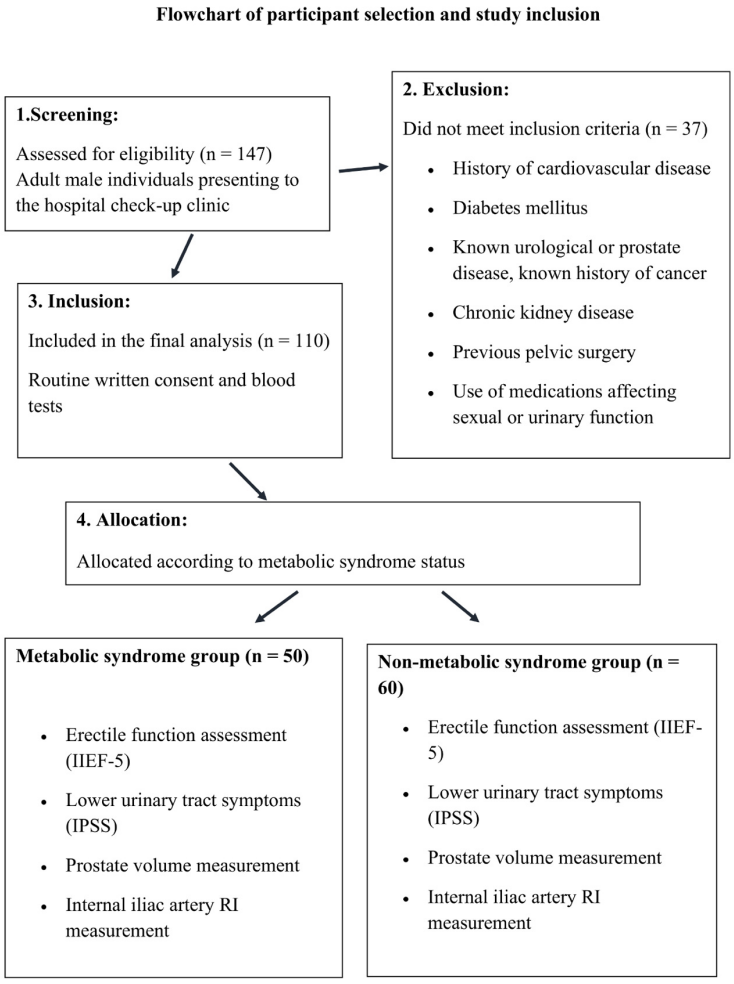

FIGURE 1. Flowchart of participant selection and study inclusion.

variables are expressed as median and interquartile range. Comparisons between the metabolic syndrome and non-metabolic syndrome groups were performed using the Student's t-test for normally distributed continuous variables and the Mann-Whitney U test for non-normally distributed continuous variables. Categorical variables were compared using the chi-square (χ^2) test. A two-sided P-value <0.05 was considered statistically significant. A post-hoc power analysis was conducted based on the observed difference in IIEF-5 scores between groups. With a total sample size of 110 participants and a two-sided alpha level of 0.05, the study achieved a statistical power of greater than 80% to detect a medium effect size, which indicates that the study was adequately powered for the primary outcome related to erectile function, while non-significant findings for other parameters should be interpreted with caution.

RESULTS

Data from a total of 110 participants were analyzed. The mean age of the study population was 45.8 years, with a median age of 44 years. MetS was identified in 50 individuals (45.5%), while 60 participants (54.5%) did not meet the diagnostic criteria. Baseline demographic and clinical characteristics are summarized in Table 1. The MetS and non-MetS groups were comparable with respect to age and smoking status, whereas significant differences were observed in metabolic parameters and BMI.

Based on IIEF-5 scores, erectile dysfunction was significantly more prevalent among individuals with MetS (P=0.042). In particular, the proportions of mild-to-moderate and moderate erectile dysfunction were higher in the MetS group, whereas the non-MetS group demonstrated a higher prevalence of normal

TABLE 1. Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Metabolic syndrome (n=50)	Non-Metabolic syndrome (n=60)	P-value
Age (years)	46.3±8.2	45.4±7.9	0.512
Body mass index (kg/m²)	29.1±3.4	25.6±2.9	**<0.001**
Smoking status, n (%)			0.684
Current smoker	18 (36.0)	20 (33.3)	
Non-smoker	32 (64.0)	40 (66.7)	
Fasting blood glucose (mg/dL)	112 (104–126)	92 (86–98)	**<0.001**
HbA1c (%)	5.9 (5.7–6.3)	5.3 (5.1–5.5)	**<0.001**
HDL cholesterol (mg/dL)	38 (34–41)	47 (44–52)	**<0.001**
Triglycerides (mg/dL)	178 (156–214)	118 (96–134)	**<0.001**
Total PSA (ng/mL)	0.86 (0.52–1.21)	0.81 (0.49–1.17)	0.614

Data are shown as mean ± standard deviation or median (interquartile range) or n (%) where appropriate. HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; PSA, prostate-specific antigen.

Statistically significant P-values are shown in bold.

erectile function (Figure 2).

Regarding IPSS categories, severe lower urinary tract symptoms were more frequently observed in the MetS group; however, this difference did not reach statistical significance (P=0.100). Similarly, increased prostate volume- including severe enlargement in five cases (n=5)- was more common in MetS group, although this finding also failed to achieve statistical significance (P=0.061) (Figure 3).

No statistically significant differences were detected in internal iliac artery resistive index (RI) values between the groups. Median RI values for both

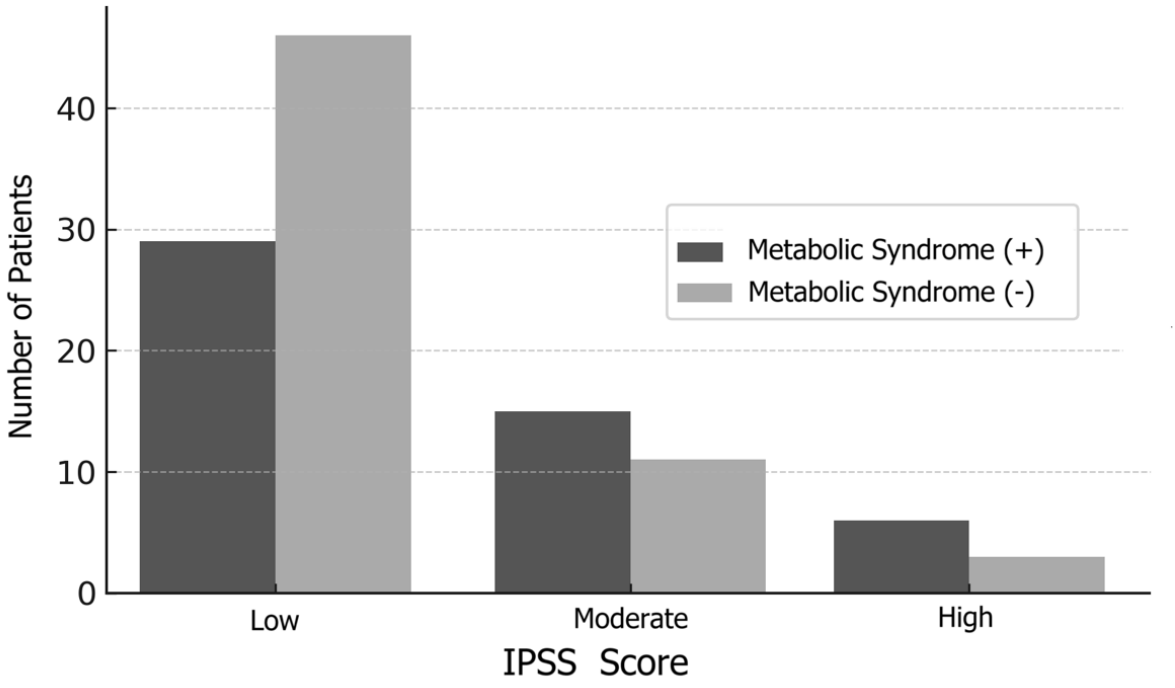

FIGURE 2. International Index of Erectile Function-5 questions (IIEF-5) scores for patients with and without metabolic syndrome.

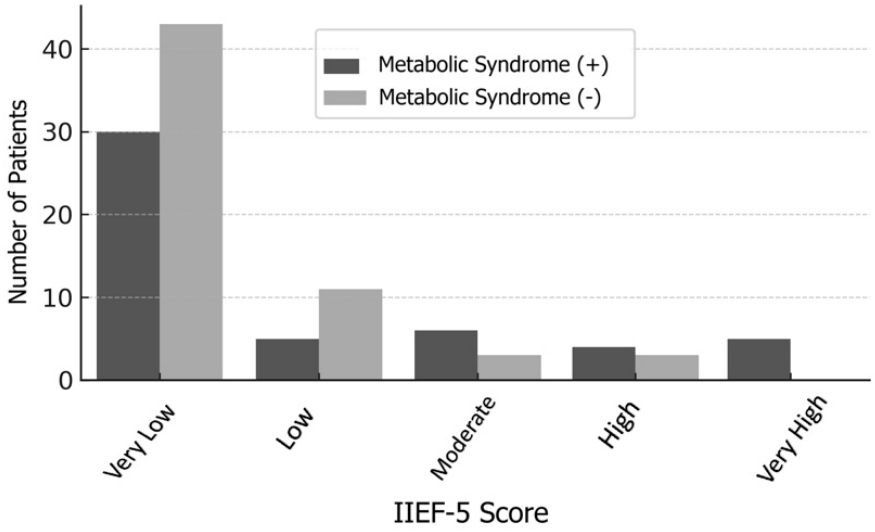

FIGURE 3. **International Prostate Symptom Score (IPSS) for patients with and without metabolic syndrome.**

the right and left internal iliac arteries were 1.00 in both groups (P=0.479 for right RI and P=0.749 for left RI) (Figures 4 and 5).

DISCUSSION

This study examined the association between MetS and several urogenital health parameters, including erectile function, lower urinary tract symptoms, prostate volume, and pelvic vascular indices. The principal finding was a significant association between MetS and erectile dysfunction, reflected by lower IIEF-5 scores among individuals with MetS. This result is consistent with previous studies demonstrating that MetS contributes to erectile dysfunction through endothelial dysfunction, chronic inflammation, and metabolic and vascular impairment [4, 6].

Endothelial dysfunction plays a central role in the pathophysiology of erectile dysfunction and is closely associated with insulin resistance and dyslipidemia [6-

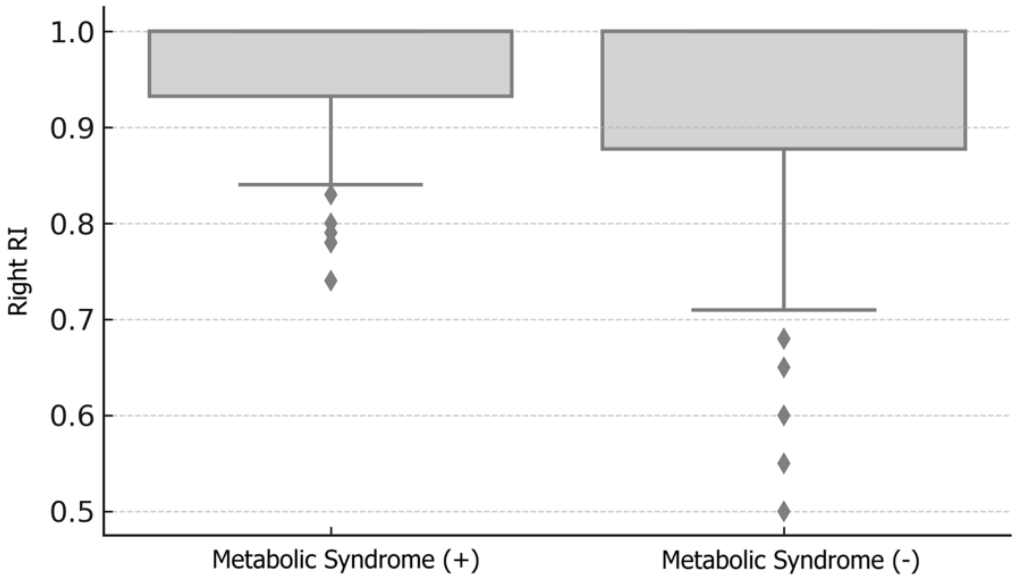

FIGURE 4. **Right internal iliac artery resistive index (RI) for patients with and without metabolic syndrome.**

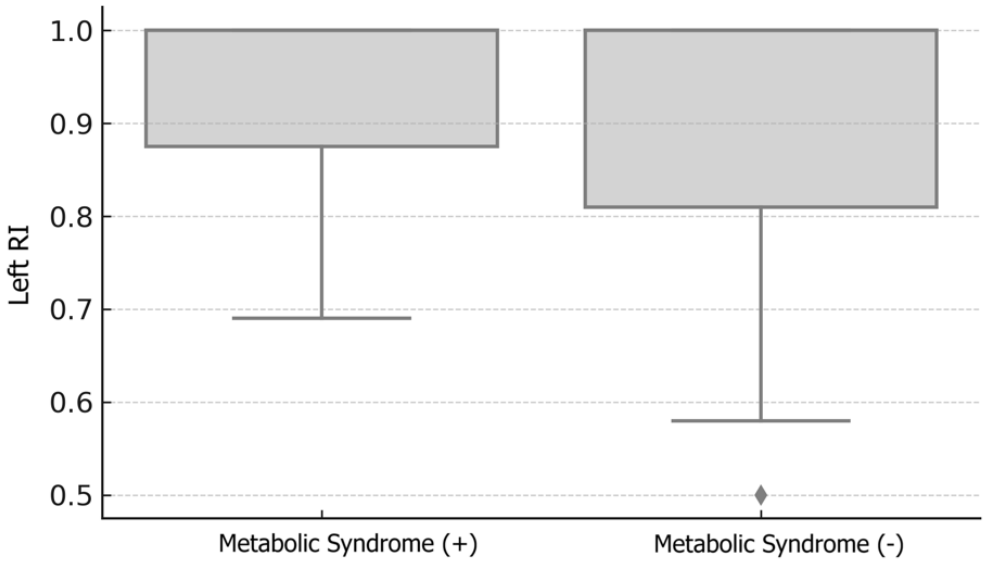

FIGURE 5. Left internal iliac artery resistive index (RI) for patients with and without metabolic syndrome.

8]. Decreased nitric oxide bioavailability, increased oxidative stress, and altered endothelial nitric oxide synthase activity have been proposed as key mechanisms contributing to erectile dysfunction in men with MetS. In addition, erectile dysfunction has been recognized as an early clinical manifestation of subclinical cardiovascular disease, reinforcing its significance as a systemic vascular marker [9, 10]. Due to the moderate sample size and the strong intercorrelation among metabolic components, multivariable regression analysis to identify independent predictors of erectile dysfunction was not performed to avoid model overfitting and unstable estimates.

In the present study, individuals with MetS demonstrated higher IPSS scores and larger prostate volumes than those without MetS; however, these differences did not reach statistical significance. These results should therefore be interpreted with caution, as no definitive conclusions can be drawn regarding a causal relationship between MetS and lower urinary tract symptoms or prostate enlargement based on the current data. Nonetheless, the observed trends are consistent with previous studies indicating an association between metabolic disturbances, insulin resistance, and benign prostatic hyperplasia [11-14]. The absence of statistical significance may partly reflect the relatively limited sample size, particularly for prostate-related outcomes.

A notable aspect of this study is the evaluation of the internal iliac artery RI as a potential pelvic vascular marker. No significant differences in internal iliac artery RI values were observed between the MetS and non-MetS groups, indicating that this parameter alone may lack sufficient sensitivity to detect early vascular alterations associated with metabolic syndrome. Previous studies have demonstrated that Doppler parameters obtained from more distal penile vessels - particularly the internal pudendal and cavernosal arteries - are more sensitive indicators of early endothelial dysfunction and erectile impairment [15]. As the internal pudendal artery directly supplies the penile vascular bed, hemodynamic changes at this level may precede detectable alterations in more proximal pelvic arteries, such as the internal iliac artery.

Accordingly, the absence of significant differences in internal iliac artery RI values may reflect an early or subclinical stage of vascular involvement in the study population. In addition, RI measurements are affected by several physiological and technical factors, including blood pressure, vascular compliance, and insonation angle, which may further limit their utility as stand-alone indicators of urogenital vascular health. These factors underscore the importance of comprehensive vascular assessment approaches that incorporate both proximal pelvic and distal penile arterial evaluations.

Strengths and Limitations

This study included a well-defined group of otherwise healthy men, reducing potential confounding effects. Urogenital health was evaluated using clinical symptom scores (IPSS and IIEF-5), prostate volume, and Doppler-based assessment of the internal iliac artery. The sample size was sufficient for the primary outcome related to erectile function.

The cross-sectional, single-center design limits causal interpretation and generalizability. The sample size may have limited the detection of significant differences in prostate-related outcomes. Hormonal parameters were not assessed, and vascular evaluation was limited to the internal iliac artery, which may be less sensitive to early vascular changes than distal penile vessels.

CONCLUSION

This study demonstrates an adverse association between MetS and erectile function. Although differences in prostate volume and lower urinary tract symptoms were not statistically significant, the observed trends suggest a potential link between metabolic disturbances and benign prostatic hyperplasia. The finding that the internal iliac artery RI alone is insufficient as a marker of urogenital vascular health underscores the need for comprehensive vascular assessment strategies. MetS criteria may therefore serve as a useful framework for identifying individuals at increased risk of urogenital health impairment. Larger, multicenter studies incorporating hormonal assessments are warranted to further clarify these associations.

Ethics Approval and Consent to Participate

This study was approved by the Istanbul Aydın University Non-Interventional Clinical Research Ethics Committee (Decision No: 2025/137; date: 26.06.2025). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all individual participants included in the study.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Authors' Contribution

Study Conception: FST, GÖ, HCD; Study Design: FST, GÖ, HCD; Supervision: FST, GÖ, HCD; Funding: N/A; Materials: FST, GÖ, HCD; Data Collection and/or Processing: FST, GÖ, HCD; Statistical Analysis and/or Data Interpretation: FST, GÖ, HCD; Literature Review: FST; Manuscript Preparation: FST; and Critical Review: FST, GÖ, HCD.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

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Generative Artificial Intelligence Statement

The authors declare that no artificial intelligence-based tools or applications were used during the preparation process of this manuscript. The all content of the study was produced by the authors in accordance with scientific research methods and academic ethical principles.

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