Association Between Metabolic Syndrome, International Prostate Symptom Score, and Prostate Volume at A Teaching Hospital in North Sumatera

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ABSTRACT

Background: Metabolic syndrome (MetS) is increasingly recognized as a risk factor for lower urinary tract symptoms (LUTS) and benign prostatic hyperplasia (BPH). Its impact on symptom severity, assessed by the International Prostate Symptom Score (IPSS), and prostate volume remains under-investigated in Southeast Asian populations.
Objectives: To evaluate the association between metabolic syndrome, IPSS, and prostate volume in patients attending a teaching hospital in North Sumatra.
Methods: This cross-sectional study enrolled male patients with and without MetS according to WHO criteria. IPSS was assessed using validated questionnaires, and prostate volume was measured by transabdominal ultrasound. Associations were analyzed using chi-square and independent eta tests, with $p < 0.05$ considered statistically significant.
Results: A total of 56 patients were included (28 with MetS, 28 controls). Patients with MetS had significantly higher mean IPSS scores (12,43 ± 1,5 vs. 7 ± 2,14, $p < 0.05$) and larger prostate volume (41,39 ± 3,19 mL vs. 27,32 ± 2,34 mL, $p < 0.01$). The prevalence of moderate-to-severe LUTS (IPSS ≥ 8) was higher in the MetS group (64,3% vs. 35,7%, $p < 0.05$).
Conclusion: Metabolic syndrome is significantly associated with higher LUTS severity and greater prostate volume. These findings highlight the importance of metabolic evaluation in men presenting with LUTS to improve integrated management strategies.

INTRODUCTION

Metabolic syndrome (MetS) has emerged as a significant global public health challenge, affecting both developed and developing nations across all age groups. It is characterized by a cluster of conditions including central obesity, hypertension, lipid disorders, and glucose intolerance, which collectively increase the risk of cardiovascular disease and diabetes mellitus. As sedentary lifestyles become more prevalent in modern society, the impact of MetS has extended beyond cardiovascular health to encompass various urological complications. One area gaining increasing clinical attention is the development of lower urinary tract symptoms (LUTS), which are frequently experienced by men, particularly those with benign prostatic hyperplasia (BPH).[1,2]

The severity of LUTS is commonly evaluated using the International Prostate Symptom Score (IPSS), where higher scores indicate a profound negative impact on a patient's quality of life. Current literature suggests that LUTS is not merely a consequence of aging but is significantly influenced by metabolic health. For instance, a study by Malde et al. highlighted that metabolic factors play an independent role in the progression of urological symptoms.[3] Furthermore, prostate volume serves as a critical clinical parameter; larger volumes often correlate with symptom severity.[4,5] However, there are diverging hypotheses regarding the

exact mechanism; while some researchers argue that MetS directly accelerates prostate growth through chronic inflammation, others suggest the relationship is primarily mediated by increased intra-abdominal pressure or autonomic nervous system dysfunction. These pro and contra results regarding the direct causal link between specific metabolic components and prostate morphology represent a continuing debate in the field.[6,7]

Despite the growing body of international research, there is a scarcity of comprehensive data regarding the interaction between metabolic profiles and urological health within the Indonesian population. This represents a significant gap in the current state of the art, as ethnic and lifestyle variations in Indonesia may influence the manifestation of both MetS and LUTS. This study provides novelty by systematically analyzing the correlation between MetS, IPSS, and prostate volume specifically within the clinical setting of the North Sumatra Education Hospital. By integrating these variables, the research offers a more holistic approach compared to traditional urological evaluations that often overlook metabolic comorbidities.

The primary objective of this research is to analyze the relationship between metabolic syndrome and both the IPSS and prostate volume among men in North Sumatra. This study is vital for the development of health and medicine in Indonesia, as it provides local evidence to support more comprehensive management strategies. By understanding these interactions, clinicians can better identify high-risk patients and design interventions that not only alleviate urological symptoms but also reduce the broader risks of cardiovascular disease. In conclusion, this research underscores that managing metabolic health is a crucial, yet often neglected, component of improving the urological quality of life for Indonesian patients.

METHODS

Study design

This observational analytic study used a cross-sectional design to analyze the relationship between metabolic syndrome (MetS), IPSS, and prostate volume. The research was conducted at the North Sumatra Education Hospitals (RS Prof. Dr. CPL and RS Haji Adam Malik Medan.

Population and sample

The population included patients with metabolic syndrome selected via purposive sampling. Inclusion criteria were males aged >40 years with MetS who provided informed consent. Exclusion criteria included prostate cancer, prior prostate surgery, renal disease, and severe comorbidities (e.g., hepatic dysfunction or uncontrolled diabetes). The sample size was determined using the formula for the difference between two proportions:

$$n = \frac{(Z\alpha\sqrt{2P(1-P)} + Z\beta\sqrt{P1(1-P1) + P2(1-P2)})^2}{(P1-P2)^2}$$

Based on Aktas et al.[10], with $P_1 = 0.311$ and $P_2 = 0.699$, the minimum sample of 25 per group was adjusted to 28 per group to account for a 10% potential drop-out rate.

Data collection

Clinical data were obtained from medical records and physical examinations. MetS was diagnosed using WHO criteria, incorporating waist-to-hip ratio, lipid profiles (mg/dL), and blood glucose levels. LUTS severity was assessed using the IPSS questionnaire, and prostate volume (cm^3) was measured via ultrasonography. All measurements followed standard metric units: weight in kilograms (kg), height in centimeters (cm), and blood pressure in millimeters

of mercury (mmHg)

Data analysis

Statistical analysis was performed using SPSS version 26. Univariate analysis described demographic characteristics, while bivariate analysis utilized Chi-square, Fisher's Exact, or Eta tests to determine the relationship between MetS and the dependent variables. All statistical values and p-values are reported to three decimal places (e.g., $p < 0.05$) with a 95% confidence interval.

Ethical statement

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara (No:78/KEPK/USU/2025). All participants provided written informed consent after receiving a detailed explanation of the study's objectives and risks. Patient confidentiality was strictly maintained.

RESULTS

Demographic and Clinical Characteristics

The study included 56 participants, divided into two groups: those with metabolic syndrome (MetS, n = 28) and those without (n = 28). Table 1 summarizes the clinical profile of the subjects. Patients with MetS were generally older (63.82 ± 2.96 years) and exhibited significantly higher Body Mass Index (BMI) (30.07 ± 2.00 kg/m^2) compared to the non-MetS group. High systolic and diastolic blood pressure, along with elevated fasting glucose levels, were also characteristic of the MetS group, where 57.1% were diagnosed with diabetes mellitus (DM).

Table 1. Baseline Characteristics of Study Subjects

Characteristics	MetS Group (n=28)	Non-MetS Group (n=28)
Age (years)	63.82 ± 2.96	60.50 ± 3.52
BMI (kg/m²)	30.07 ± 2.00	24.06 ± 2.19
Systolic BP (mmHg)	141.64 ± 7.78	117.00 ± 9.37
Diastolic BP (mmHg)	91.82 ± 4.35	75.14 ± 7.03
Fasting Glucose (mg/dL)	134.43 ± 19.20	90.21 ± 5.83
Glycemic Status, n (%)		
Diabetes Mellitus	16 (57.1%)	0 (0.0%)
Impaired Fasting Glucose	12 (42.9%)	0 (0.0%)
Normal	0 (0.0%)	28 (100.0%)
Waist-to-Hip Ratio	0.94 ± 0.04	0.84 ± 0.03

Metabolic Syndrome and IPSS

The analysis of the International Prostate Symptom Score (IPSS) revealed that subjects with MetS had a significantly higher mean score (12.43 ± 1.50) compared to those without MetS (7.00 ± 2.14). The Eta coefficient (n = 0.831) indicates a strong correlation between metabolic status and symptom severity ($p < 0.001$). Furthermore, the Eta-squared value ($n^2 = 0.691$) suggests that metabolic syndrome explains 69.1% of the variation in IPSS scores (Table 2).

Table 2. Analysis of IPSS Score between Groups

Metabolic	n	Mean IPSS	p-value	Eta (η)	Eta² (η²)

Syndrome		Score			
Yes	28	12.43 ± 1.50	< 0.001*	0.831	0.691
No	28	7.00 ± 2.14			

When categorized, 100% of the MetS group fell into the moderate IPSS category, while the majority (64.3%) of the non-MetS group reported mild symptoms. The Relative Risk (RR) was calculated at 2.800 (95% CI: 1.703–4.602), indicating that patients with MetS are 2.8 times more likely to experience moderate LUTS than those without MetS (Table 3).

Table 3. Association between MetS and IPSS Categories

Metabolic Syndrome	Mild IPSS n (%)	Moderate IPSS n (%)	p-value	Relative Risk (95% CI)
Yes	0 (0.0%)	28 (100.0%)	< 0.001*	2.80 (1.70 – 4.60)
No	18 (64.3%)	10 (35.7%)		

Metabolic Syndrome and Prostate Volume

A strong and significant relationship was observed between MetS and prostate volume. The mean prostate volume in the MetS group was significantly higher (41.39 ± 3.19 mL) than in the non-MetS group (27.32 ± 2.34 mL). The Eta coefficient ($n = 0.931, p < 0.001$) confirms a very strong association, with MetS status accounting for 86.8% of the variance in prostate volume (Table 4).

Table 4. Relationship between Metabolic Syndrome and Prostate Volume

Metabolic Syndrome	n	Prostate Volume (mL)	p-value	Eta (η)	Eta² (η²)
Yes	28	41.39 ± 3.19	< 0.001*	0.931	0.868
No	28	27.32 ± 2.34			

DISCUSSION

This study demonstrates a significant association between metabolic syndrome (MetS) and the clinical severity of benign prostatic hyperplasia (BPH) as measured by the International Prostate Symptom Score (IPSS) and prostate volume. Our findings reveal that the MetS group exhibited a substantially higher mean IPSS (12.43 ± 1.50 vs. 7.00 ± 2.14; $p < 0.001$) and a markedly larger prostate volume (41.39 ± 3.19 mL vs. 27.32 ± 2.34 mL; $p < 0.001$) compared to the non-MetS group. These results align with recent epidemiological data and meta-analyses, such as the comprehensive study by Omran et al. involving over 90,000 subjects, which confirmed that MetS is significantly associated with larger prostate volumes and worse Lower Urinary Tract Symptoms (LUTS). The strong association found in this study ($n = 0.831$ for IPSS and $n = 0.931$ for prostate volume) suggests that metabolic status is a primary determinant of urological health in aging men.[11]

The observed differences can be explained through several complex biological mechanisms. Central obesity, reflected by the higher BMI and Waist-to-Hip Ratio (WHR) in our MetS group, acts as an active endocrine organ. Visceral adipose tissue releases pro-inflammatory adipokines such as TNF-α, IL-6, and CRP, creating a chronic low-grade systemic inflammation that stimulates the proliferation of prostate stromal and epithelial cells.[12] Furthermore, the high prevalence of Diabetes Mellitus (57.1%) in our MetS group

highlights the role of hyperinsulinemia. Chronic hyperglycemia and insulin resistance activate the insulin-like growth factor (IGF-1) pathway, which exerts mitogenic and anti-apoptotic effects on prostate tissue, as corroborated by Syahputra et al. Additionally, autonomic neuropathy and oxidative stress induced by hyperglycemia impair bladder detrusor function, further exacerbating the storage and voiding symptoms characteristic of LUTS.[13,14]

Our results regarding anthropometric indicators also reinforce the superiority of visceral adiposity over simple BMI in predicting BPH severity. The significantly higher WHR in the MetS group (0.94 ± 0.04) compared to controls suggests that visceral fat distribution is more metabolically active and urologically damaging. This supports the findings of Huang et al. and Chang et al., who noted that indices reflecting visceral adiposity, such as the Cardiometabolic Index (CMI) and Visceral Adiposity Index (VAI), are better predictors of BPH than BMI alone. The increased abdominal pressure from obesity and the vascular insufficiency caused by chronic hypertension in MetS subjects likely contribute to a "metabolic microenvironment" that favors prostate enlargement and bladder dysfunction.[12,15]

The clinical implications of these findings are substantial. Patients with MetS should be viewed as a high-risk group for moderate-to-severe LUTS. Integrating metabolic management including glycemic control, lipid management, and weight reduction into standard urological care could potentially slow the progression of BPH and improve the quality of life. This holistic approach aligns with the United Nations' Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), by promoting comprehensive care for non-communicable diseases and improving aging health. By addressing metabolic risk factors, we not only reduce cardiovascular morbidity but also mitigate the burden of urological diseases in the elderly population.

Despite the strong correlations found, this study has several limitations. First, the cross-sectional design prevents the establishment of a definitive causal relationship between the onset of MetS and the progression of BPH over time. Second, the relatively small sample size (n = 56) may limit the generalizability of the findings to a broader population. Third, the study did not account for other potential confounding factors such as dietary habits or specific physical activity levels, which could influence both metabolic and urological health. Future longitudinal research with larger cohorts and more diverse anthropometric indicators is needed to further elucidate the long-term impact of metabolic interventions on prostate health.

CONCLUSION

This study concludes that there is a significant and strong association between metabolic syndrome and the clinical severity of benign prostatic hyperplasia, characterized by substantially higher IPSS scores and larger prostate volumes in affected individuals. The presence of metabolic syndrome appears to be a critical determinant in the progression of lower urinary tract symptoms, driven by the synergistic effects of central obesity, insulin resistance, and chronic inflammation. Consequently, a comprehensive management strategy that integrates urological treatment with the control of metabolic risk factors is essential to improve patient outcomes and quality of life. Future research should prioritize longitudinal cohort studies with larger, more diverse populations and the inclusion of advanced visceral adiposity markers to establish definitive causal pathways. Additionally, clinical trials investigating the direct impact of metabolic interventions, such as specific dietary protocols or insulin-sensitizing therapies, on the stabilization of prostate growth and symptom relief are warranted to refine multi-disciplinary treatment guidelines.

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