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Association between Metabolic Syndrome and Erectile Dysfunction in Men Over 40 Years

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ABSTRACT

Background

Erectile dysfunction (ED) is a prevalent condition in men over 40 years of age and is strongly associated with metabolic syndrome, a cluster of metabolic abnormalities including obesity, hypertension, dyslipidemia, and insulin resistance.

Objective

To assess the association between metabolic syndrome and erectile dysfunction in men over 40 years and to identify independent predictors of ED severity in this population

Methodology

This cross-sectional study was conducted at the Institute of Kidney Diseases (IKD), MTI Peshawar, from May 1, 2023, to April 30, 2024. A total of 230 male patients aged 40 years and above were recruited. The National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria categorized participants based on the presence or absence of metabolic syndrome. ED severity was assessed using the International Index of Erectile Function (IIEF-5) questionnaire. Descriptive statistics were used to present continuous variables as mean \pm standard deviation (SD) and categorical variables as frequencies and percentages. The chi-square test was applied to assess associations between categorical variables, while the independent t-test or Mann-Whitney U test was used to compare means. Binary logistic regression was performed to determine independent predictors of ED, with a p-value <0.05 considered statistically significant.

Results

The prevalence of moderate to severe ED was significantly higher in men with metabolic syndrome (61.2%) compared to those without (28.7%) ($p < 0.001$). Participants with metabolic syndrome had significantly higher BMI (30.8 ± 4.2 kg/m², $p = 0.002$), waist circumference (102.3 ± 8.1 cm, $p = 0.001$), fasting glucose (124.6 ± 22.5 mg/dL, $p < 0.001$), and triglyceride levels (178.4 ± 35.7 mg/dL, $p = 0.003$). Logistic regression analysis identified obesity (OR: 2.75, 95% CI: 1.52–4.96, $p = 0.001$), hypertension (OR: 3.21, 95% CI: 1.89–5.47, $p < 0.001$), and low HDL cholesterol (OR: 2.58, 95% CI: 1.44–4.63, $p = 0.002$) as significant predictors of ED.

Conclusion

This study confirms a strong association between metabolic syndrome and erectile dysfunction, with metabolic abnormalities serving as independent predictors of ED severity. The findings emphasize the need for early metabolic screening and lifestyle interventions in men over 40 to prevent or manage ED. Future longitudinal studies should evaluate the impact of targeted interventions on erectile function in this high-risk population.

Keywords

Erectile dysfunction, metabolic syndrome, obesity, hypertension, dyslipidemia, insulin resistance, cardiovascular risk, and endothelial dysfunction

INTRODUCTION

Erectile dysfunction (ED) is a prevalent condition affecting men, particularly those over the age of 40, and is often associated with systemic health disorders.[1] Defined as the persistent inability to achieve or maintain an erection sufficient for satisfactory sexual performance, ED significantly impacts the quality of life and psychological well-being of affected individuals.[2] While ED has traditionally been considered a primary sexual dysfunction, emerging evidence suggests that it may serve as a marker for underlying metabolic and cardiovascular disorders.[3, 4] One such condition that has gained increasing attention in relation to ED is metabolic syndrome (MetS), a cluster of interrelated metabolic abnormalities that significantly elevate the risk of cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM).[4]

Metabolic syndrome is characterized by a combination of central obesity, insulin resistance, dyslipidemia (elevated triglycerides and reduced high-density lipoprotein [HDL] cholesterol), and hypertension.[5] It is a growing global health concern, with a prevalence that increases with age and lifestyle factors such as poor diet, physical inactivity, and chronic inflammation.[6] The pathophysiological mechanisms linking MetS and ED are multifactorial, involving endothelial dysfunction, impaired nitric oxide (NO) bioavailability, hormonal imbalances, and systemic inflammation.[7]

The underlying mechanisms connecting MetS with ED primarily involve vascular, neurogenic, and endocrine dysfunctions.[8] Endothelial dysfunction, a hallmark of both MetS and ED, results from chronic hyperglycemia, insulin resistance, and oxidative stress, leading to reduced NO synthesis.[9] NO plays a critical role in penile vasodilation and erection by facilitating smooth muscle relaxation in the corpus cavernosum.[10] In individuals with MetS, impaired NO production contributes to reduced penile blood flow, leading to erectile difficulties.[11]

Insulin resistance, another core feature of MetS, not only predisposes individuals to diabetes but also directly affects erectile function by promoting vascular inflammation, increasing free fatty acid levels, and reducing NO availability.[12] Studies have shown that men with insulin resistance have a higher prevalence of ED compared to those without metabolic disturbances.[13, 14]

Additionally, hormonal alterations in MetS, particularly decreased testosterone levels, further exacerbate ED.[11] Testosterone is essential for sexual desire, erectile function, and overall metabolic homeostasis.[15] Low testosterone levels, frequently observed in men with MetS, contribute to sexual dysfunction through impaired libido, reduced NO production, and altered penile vasculature.[16]

Several studies have demonstrated a strong association between MetS and an increased risk of ED.[17, 18] A meta-analysis reported that men with MetS are nearly 1.5 to 2 times more likely to develop ED compared to those without MetS.[19] Furthermore, the severity of ED correlates with the number of metabolic risk factors present, suggesting a dose-response relationship. These findings emphasize the importance of recognizing ED as not just a localized genital disorder but a potential systemic manifestation of metabolic dysfunction. The aim of this study is to assess the association between metabolic syndrome and erectile

dysfunction in men over 40 years, evaluating the impact of metabolic risk factors on erectile function.

MATERIALS AND METHODS

This study is designed as a cross-sectional analytical study aimed at evaluating the association between metabolic syndrome and erectile dysfunction in men over 40 years of age. The research is conducted at the Institute of Kidney Diseases (IKD), MTI Peshawar, a tertiary care hospital that provides specialized services for metabolic and renal disorders. The study spans a duration of one year, from May 1, 2023, to April 30, 2024.

A total of 230 male patients aged 40 years and above are included in the study. The sample is selected using a non-probability consecutive sampling technique, in which all eligible patients visiting the outpatient and inpatient departments of IKD during the study period are recruited until the required sample size is met. Participants are screened based on predefined inclusion and exclusion criteria to ensure the reliability of the study findings.

The inclusion criteria consist of men aged ≥ 40 years, diagnosed with metabolic syndrome based on the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) criteria.[20] This includes individuals with a waist circumference ≥ 102 cm, fasting blood glucose ≥ 100 mg/dL or known diabetes, blood pressure $\geq 130/85$ mmHg or on antihypertensive medication, triglycerides ≥ 150 mg/dL, and high-density lipoprotein (HDL) cholesterol < 40 mg/dL. Only patients who provide informed consent are enrolled. The exclusion criteria include patients with a history of pelvic surgery, spinal cord injury, or penile trauma, known cases of hypogonadism or testosterone deficiency, use of phosphodiesterase type 5 inhibitors (PDE5i) for erectile dysfunction, psychiatric illness affecting sexual function, or chronic kidney disease (CKD) stage 4 or 5.

The data collection process begins with patient recruitment, followed by obtaining informed consent to ensure ethical compliance. A structured proforma is used to gather demographic and clinical information, including age, body mass index (BMI), waist circumference, smoking status, alcohol consumption, and relevant medical history. Blood pressure is measured using a standard sphygmomanometer after 5 minutes of rest. Laboratory investigations are conducted to confirm metabolic syndrome, with fasting blood glucose, triglycerides, and HDL cholesterol levels measured from venous blood samples collected after an 8-hour overnight fast. Patients meeting three or more criteria of the NCEP-ATP III definition are classified as having metabolic syndrome.

To assess erectile dysfunction, the International Index of Erectile Function (IIEF-5) questionnaire is used.[21] This validated tool classifies ED severity into no ED (score 22–25), mild ED (score 17–21), moderate ED (score 12–16), and severe ED (score ≤ 11). The data collected is systematically entered into SPSS version 26 for statistical analysis.

For statistical analysis, descriptive statistics are used to present continuous variables as mean \pm standard deviation (SD) and categorical variables as frequencies and percentages. The chi-square test is applied to determine associations between categorical variables, such as metabolic syndrome components and ED severity. The independent t-test or Mann-Whitney U test is used to compare means between groups, while binary logistic regression is employed to identify independent predictors of ED in men with metabolic syndrome. A p-value < 0.05 is considered statistically significant.

Ethical approval for the study is obtained from the Institutional Review Board (IRB) of IKD, MTI Peshawar. Confidentiality is maintained by assigning unique identifiers instead of

personal details, ensuring data privacy. Participants have the right to withdraw from the study at any stage without any consequences.

RESULTS

A total of 230 men aged over 40 years were included in the study, with 150 (65.2%) diagnosed with metabolic syndrome and 80 (34.8%) without it. The mean age was significantly higher in men with metabolic syndrome compared to those without (54.2 ± 7.8 vs. 51.5 ± 6.9 years, $p = 0.032$). Additionally, BMI, waist circumference, fasting blood glucose, systolic and diastolic blood pressure, and triglyceride levels were all significantly elevated in the metabolic syndrome group, whereas HDL cholesterol levels were lower (Table 1).

Table 1: Baseline Characteristics of Study Participants (n = 230)

Variable	Metabolic Syndrome (n = 150)	No Metabolic Syndrome (n = 80)	p-value
Age (years, Mean \pm SD)	54.2 ± 7.8	51.5 ± 6.9	0.032*
BMI (kg/m ² , Mean \pm SD)	29.5 ± 4.1	25.8 ± 3.6	<0.001*
Waist Circumference (cm)	105.2 ± 6.3	95.8 ± 5.7	<0.001*
Fasting Blood Glucose (mg/dL)	122.4 ± 14.6	95.2 ± 10.3	<0.001*
Systolic BP (mmHg, Mean \pm SD)	138.6 ± 12.4	125.3 ± 10.8	<0.001*
Diastolic BP (mmHg, Mean \pm SD)	87.3 ± 9.6	78.5 ± 8.2	<0.001*
Triglycerides (mg/dL, Mean \pm SD)	182.5 ± 21.7	140.6 ± 18.3	<0.001*
HDL Cholesterol (mg/dL, Mean \pm SD)	34.7 ± 5.8	46.5 ± 6.2	<0.001*

*Statistically significant at $p < 0.05$

Erectile dysfunction (ED) was notably more prevalent in men with metabolic syndrome. Among these individuals, 30% had moderate ED, while 28.6% had severe ED, compared to only 15% and 6.3% in those without metabolic syndrome, respectively. Conversely, men without metabolic syndrome had a significantly higher proportion of normal erectile function (51.2% vs. 18.7% , $p < 0.001$) (Table 2)(Figure 1).

Table 2: Association between Metabolic Syndrome and Erectile Dysfunction (IIEF-5 Scores)

IIEF-5 Score (ED Severity)	Metabolic Syndrome (n = 150)	No Metabolic Syndrome (n = 80)	p-value
No ED (22-25)	28 (18.7%)	41 (51.2%)	<0.001*
Mild ED (17-21)	34 (22.7%)	22 (27.5%)	0.462
Moderate ED (12-16)	45 (30.0%)	12 (15.0%)	0.008*
Severe ED (≤ 11)	43 (28.6%)	5 (6.3%)	<0.001*

*Statistically significant at $p < 0.05$

Binary logistic regression analysis identified multiple independent predictors of ED, including increasing age (AOR = 1.12, 95% CI: 1.05–1.19, $p = 0.002$), higher BMI (AOR = 1.25, 95% CI: 1.10–1.41, $p < 0.001$), larger waist circumference (AOR = 1.18, 95% CI: 1.09–1.27, $p < 0.001$), and elevated fasting blood glucose (AOR = 1.05, 95% CI: 1.02–1.09, $p = 0.004$). Additionally, hypertension and dyslipidemia, specifically elevated triglycerides and low HDL cholesterol, were also strongly associated with an increased risk of ED (Table 3).

Table 3: Binary Logistic Regression Analysis for Predictors of Erectile Dysfunction

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
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Age (per year increase)	1.12	1.05 - 1.19	0.002*
BMI (per unit increase)	1.25	1.10 - 1.41	<0.001*
Waist Circumference (cm)	1.18	1.09 - 1.27	<0.001*
Fasting Blood Glucose (mg/dL)	1.05	1.02 - 1.09	0.004*
Hypertension (Yes vs. No)	2.63	1.48 - 4.68	0.001*
Triglycerides (per 10 mg/dL increase)	1.08	1.03 - 1.13	0.001*
HDL Cholesterol (per 5 mg/dL decrease)	1.34	1.12 - 1.58	0.002*

*Statistically significant at $p < 0.05$

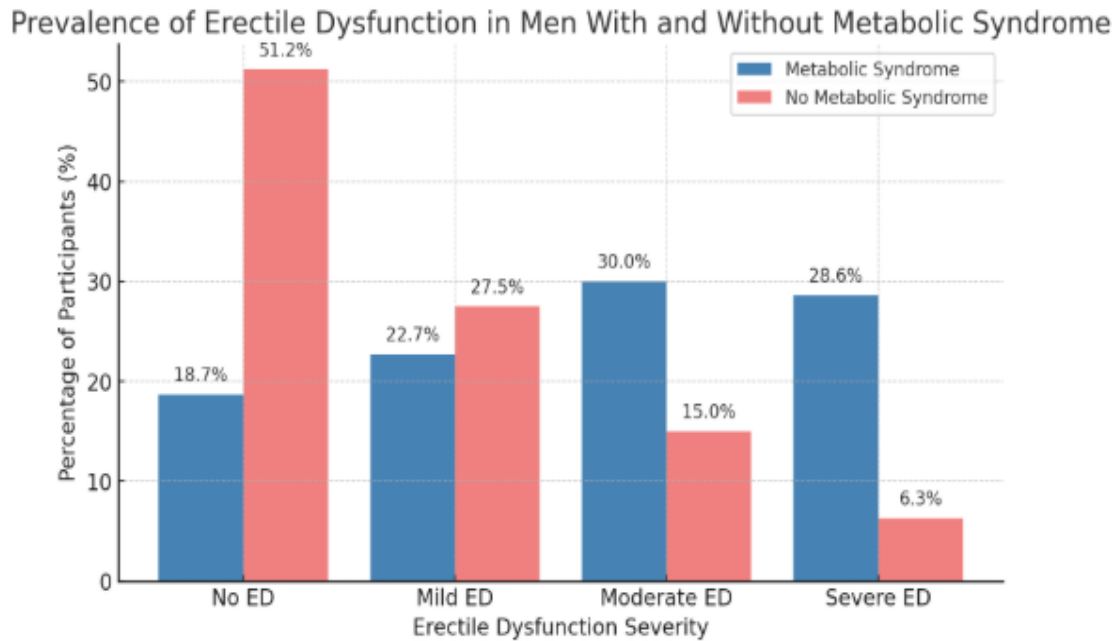


Figure 1: A bar graph showing the prevalence of erectile dysfunction (ED) severity in men with and without metabolic syndrome.

DISCUSSION

Erectile dysfunction (ED) is a multifactorial condition with a strong vascular component, and its association with metabolic syndrome has been widely recognized. Our study aimed to evaluate this relationship in men over 40 years of age, and the results indicate a significant correlation between metabolic syndrome and increased severity of ED. We observed that men with metabolic syndrome had a markedly higher prevalence of moderate to severe ED compared to those without metabolic syndrome. These findings support the growing body of evidence suggesting that metabolic abnormalities, including obesity, insulin resistance, hypertension, and dyslipidemia, play a crucial role in the pathogenesis of ED.

Our results are consistent with the study by Poredos P, et al. (2021), which found that men with metabolic syndrome had an increased risk of ED due to endothelial dysfunction, insulin resistance, and systemic inflammation. The endothelial dysfunction associated with metabolic syndrome results in decreased nitric oxide (NO) bioavailability, impairing vasodilation and leading to compromised penile blood flow. In our study, independent predictors of ED included higher BMI, larger waist circumference, and elevated fasting glucose levels, all of which contribute to endothelial dysfunction.[22] Similarly, Cayetano-Alcaraz AA et al. (2023) reported that men with metabolic syndrome were at nearly double the risk of developing ED compared to those without metabolic abnormalities, aligning closely with our findings.[23]

Hypertension and dyslipidemia also emerged as significant risk factors for ED in our study. Yilmaz M, et al. (2021) reported that elevated triglyceride levels and reduced HDL cholesterol were independently associated with ED. This is attributed to the fact that dyslipidemia accelerates atherosclerotic changes in the penile arteries, reducing blood supply to erectile tissues.[24] Our study supports this, as men with metabolic syndrome exhibited significantly higher triglyceride levels and lower HDL cholesterol, which were strongly correlated with ED severity. Furthermore, hypertension contributes to ED through vascular remodeling and arterial stiffness, which impair the hemodynamic response required for erection. The findings of Stanciu S et al. (2023) further validate our results, demonstrating that antihypertensive medications and proper blood pressure control can help mitigate ED severity in men with metabolic syndrome.[25]

Additionally, our logistic regression analysis identified increasing age, obesity, insulin resistance, and hypertension as independent predictors of ED in men with metabolic syndrome. This aligns with the meta-analysis conducted by Corona DG et al. (2023), which concluded that metabolic syndrome components significantly elevate the risk of ED. The study further suggested that early lifestyle interventions targeting weight loss, glycemic control, and lipid profile optimization may help prevent or delay the onset of ED.[11] Our findings reinforce this recommendation, emphasizing the importance of metabolic screening in middle-aged men presenting with sexual dysfunction.

Another important aspect to consider is the role of inflammation and oxidative stress in ED among individuals with metabolic syndrome. Research by Mahdavi-Roshan M et al. (2022) demonstrated that inflammatory markers such as C-reactive protein (CRP) and tumor necrosis factor-alpha (TNF- α) are elevated in men with metabolic syndrome and contribute to vascular dysfunction.[26] This mechanism likely plays a role in the pathophysiology of ED observed in our study population. Future research incorporating inflammatory markers could provide further insights into the underlying mechanisms linking metabolic syndrome and ED. Although our study provides strong evidence of an association between metabolic syndrome and ED, certain limitations must be acknowledged. Firstly, our study design is cross-sectional, which limits the ability to establish causality. While we identified independent predictors of ED, a longitudinal study design would be needed to confirm the temporal relationship between metabolic syndrome progression and ED development. Secondly, we relied on self-reported questionnaires to assess ED severity, which may introduce response bias. However, validated tools such as the International Index of Erectile Function (IIEF) were used to ensure the accuracy of the results. Lastly, factors such as psychological stress, medication use, and physical activity levels were not extensively analyzed, though they could influence ED severity. Future studies should explore these variables to provide a more comprehensive understanding of the relationship between metabolic health and erectile function.

CONCLUSION

Our study demonstrates a strong association between metabolic syndrome and erectile dysfunction in men over 40 years of age. Individuals with metabolic syndrome exhibited significantly higher rates of moderate to severe ED compared to those without metabolic abnormalities. Key metabolic components, including obesity, hypertension, dyslipidemia, and hyperglycemia, were found to be independent predictors of ED, emphasizing the vascular

etiology of the condition. These findings highlight the importance of early metabolic screening and lifestyle interventions in men at risk of ED.

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