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Prevalence of metabolic syndrome in type 2 diabetes mellitus patients attending a tertiary care hospital: A cross-sectional study.

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Abstract

Background

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities that significantly elevates the risk of cardiovascular disease, stroke, and type 2 diabetes mellitus (T2DM). Individuals with T2DM are particularly prone to developing MetS due to overlapping pathophysiological mechanisms such as insulin resistance and chronic inflammation. In India, the prevalence of MetS is rising in parallel to the diabetes epidemic, necessitating focused research at the regional levels.

Objective

To assess the prevalence of metabolic syndrome and its individual components among patients with type 2 diabetes mellitus attending a tertiary care hospital in Bihar, India.

Methods

A cross-sectional observational study was conducted over six months in the Department of General Medicine at Katihar Medical College. A total of 100 T2DM patients aged ≥30 years were enrolled. MetS was diagnosed using the NCEP ATP III criteria. Data on demographic, clinical, and biochemical parameters were collected and analyzed using SPSS v25.

Results

The overall prevalence of metabolic syndrome was 68%. Central obesity (72%), hypertension (66%), low HDL cholesterol (61%), and hypertriglyceridemia (59%) were the most commonly observed components. All participants had fasting glucose levels ≥100 mg/dL. MetS was more prevalent among females (77.7%) compared to males (60%), and was most common in the 51–60-year age group (75%). Statistically significant associations were found between female gender and central obesity (p=0.02), and between age and MetS prevalence (p=0.04).

Conclusion

A high burden of metabolic syndrome exists among T2DM patients in this region, with central obesity and hypertension being the predominant components. Early detection and management are essential to reduce the long-term risk of cardiovascular complications.

Recommendations

Routine MetS screening should be integrated into diabetes care protocols, especially for high-risk groups.

Keywords: *Metabolic syndrome, Type 2 diabetes mellitus, Prevalence, Central obesity, Cardiovascular risk, National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), Tertiary care, Bihar.*
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Introduction

Central (abdominal) obesity, insulin resistance, hypertension, dyslipidaemia (high triglycerides and low HDL cholesterol), and hyperglycemia are all part of metabolic syndrome (MetS), a complex metabolic disease cluster. The increased risk of cardiovascular disease (CVD), stroke, and type 2 diabetes mellitus (T2DM) caused by

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metabolic syndrome is a global public health issue [1]. Type 2 diabetes and metabolic syndrome share insulin resistance and persistent low-grade systemic inflammation, making them intimately connected and mutually supportive. Type 2 diabetics are more likely to develop metabolic syndrome due to their similar metabolic base and hyperglycemia-related risk factors. The growth in diabetes and obesity, especially in emerging economies like India, has accelerated metabolic syndrome [2]. India is the diabetes capital of the world due to genetic predisposition and lifestyle changes like reduced physical activity, consumption of energy-dense foods, and urbanization-induced behavioural changes. In this context, understanding MetS's effects on diabetics is essential for effective healthcare prevention and treatment [3].

Diabetes patients are at higher risk for vascular issues; hence, MetS's ability to predict cardiovascular events and all-cause death is clinically significant. If diabetics with metabolic syndrome are diagnosed and treated early, macrovascular and microvascular issues can be reduced [4]. Metabolic syndrome is a cluster of risk factors for disease rather than a disease itself. World Health Organisation, International Diabetes Federation, and National Cholesterol Education Program Adult Treatment Panel III definitions of MetS are the most widely used. With slightly different cut-off values and needed components, these definitions aim to capture the clustering of metabolic derangements that signal elevated cardiovascular risk [5]. The NCEP ATP III criteria are widely used in clinical and research settings due to their generalisability and simplicity. Metabolic syndrome is diagnosed when a person has increasing waist circumference, elevated triglycerides, reduced HDL cholesterol, elevated blood pressure, and rising fasting blood glucose. Depending on the community and diagnostic criteria, metabolic syndrome in type 2 diabetics can be as high as 50% to 80%, compared to 20% to 40% in the general population [6]. Metabolic syndrome in type 2 diabetics increases cardiovascular disease risk and complicates glycaemic management, worsening disease burden. Several Indian studies have found that diabetics have a high MetS prevalence, often surpassing 60%. Regional differences include socioeconomic status, eating habits, and exercise [7].

Eastern India is under-represented in national metabolic health surveys and lacks evidence on the effects on type 2 diabetics in tertiary care. This includes Bihar. Resource-constrained countries can struggle to manage chronic non-communicable diseases socially, economically, and health-wise. Early identification and coordinated management reduce metabolic syndrome progression and consequences [8]. Additionally, metabolic syndrome aetiology involves visceral obesity. This adipose tissue causes inflammation by secreting adipokines such as TNF-α, IL-6, and resistin. These inflammatory signs contribute to endothelial dysfunction, atherogenesis, and pancreatic beta-cell dysfunction, which cause cardiovascular diseases and type 2 diabetes. According to research, lifestyle factors like smoking, alcohol use, lack of exercise, disrupted sleep, and psychological and social stress aggravate MetS in diabetics [9]. Variations in genetic propensity affect metabolic syndrome vulnerability. These differences are seen in glucose, adipocytokine, and lipid metabolism gene polymorphisms. Important characteristics include age and gender. Many studies have demonstrated that hormonal changes affecting fat distribution and lipid metabolism put women, especially postmenopausal women, at risk of metabolic syndrome. Metabolic insults and insulin resistance grow with age, increasing metabolic syndrome risk. Socioeconomic position, urban or rural residence, education, and employment can affect MetS occurrence and pattern in various groups [10].

Bihar, a low-income, primarily agricultural state with a recent rise in diabetes and dietary changes, is an appropriate site to study metabolic syndrome in type 2 diabetics. Despite the growing burden, primary care settings lack MetS understanding and screening. Many cases are not recognised until problems arise [11]. Research at established healthcare institutions is needed to inform policy and practice. Given these circumstances, this study examined metabolic syndrome prevalence in T2DM outpatients at Katihar Medical College, Bihar's tertiary care hospital. The additional objectives are to determine how each MetS component is distributed and to examine relationships with demographic parameters like gender and age. This study uses NCEP ATP III diagnostic criteria to provide therapeutically useful insights into type 2 diabetes patients' metabolic risk profiles in Eastern India's tertiary care setting. This study's findings should help healthcare providers identify high-risk patients and start early on medication, lifestyle changes, and regional patient education initiatives. This study emphasises the necessity to screen underserved and high-risk diabetics in India for metabolic syndrome.

Objective

Therefore, the objective of this study was to assess the prevalence of metabolic syndrome and its components

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among type 2 diabetes mellitus patients attending a tertiary care hospital in Bihar, India."

Materials and Methods

Study Design and Setting

This was a hospital-based, cross-sectional observational study carried out in the Department of General Medicine at Katihar Medical College and Hospital, a tertiary care center located in Bihar, India. The study was conducted over a period of six months, from January 2025 to June 2025, and aimed to assess the prevalence of metabolic syndrome among patients with type 2 diabetes mellitus (T2DM) attending the outpatient department.

Sample Size and Population

A total of 100 adult patients with a confirmed diagnosis of type 2 diabetes mellitus were enrolled in the study. The sample size was determined based on feasibility and the anticipated prevalence rates of metabolic syndrome in similar settings. All participants were selected through purposive sampling during routine clinic visits.

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they were aged 30 years or older, had been previously diagnosed with T2DM according to American Diabetes Association (ADA) criteria, and were willing to provide informed consent. Exclusion criteria included individuals diagnosed with type 1 diabetes mellitus, pregnant women, and patients suffering from chronic inflammatory diseases (such as rheumatoid arthritis or systemic lupus erythematosus) or endocrine disorders (such as Cushing's syndrome or thyroid dysfunction), which could interfere with metabolic parameters and confound the study results.

Diagnostic Criteria for Metabolic Syndrome

Metabolic syndrome was defined according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines. Under this classification, an individual was considered to have MetS if at least three of the following five criteria were met: (1) waist circumference greater than 102 cm in men or greater than 88 cm in women, indicating central obesity; (2) fasting triglyceride levels of 150 mg/dL or more; (3) high-density lipoprotein (HDL) cholesterol levels less than 40 mg/dL in men or less than 50 mg/dL in women; (4) systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg, or current use of antihypertensive medication; and (5) fasting plasma glucose ≥100 mg/dL or already diagnosed with type 2 diabetes mellitus.

Data Collection Procedure

All eligible participants underwent a detailed clinical evaluation. Demographic data, including age, sex, and socioeconomic status, were collected using a pre-structured proforma. Anthropometric measurements such as height, weight, and waist circumference were obtained using standardized instruments and protocols. Blood pressure was measured using a calibrated sphygmomanometer with the patient in a sitting position after five minutes of rest. Laboratory investigations included fasting blood glucose and lipid profile (triglycerides and HDL cholesterol), performed at the hospital's central laboratory using enzymatic colorimetric methods following an overnight fast of 8–12 hours.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Katihar Medical College. All participants were briefed about the objectives and procedures of the study, and written informed consent was obtained before inclusion.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics software version 25. Descriptive statistics such as mean, standard deviation, and percentages were used to summarize baseline characteristics and the prevalence of metabolic syndrome and its components. The Chi-square test was applied to determine associations between metabolic syndrome and demographic variables such as age and gender. A p-value of less than 0.05 was considered statistically significant for all inferential analyses.

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Results

Table 1: Overall Prevalence of Metabolic Syndrome

Metabolic Syndrome Status	Number of Patients	Percentage (%)
Present	68	68.0
Absent	32	32.0

Out of 100 patients with T2DM, 68% were found to have metabolic syndrome as per NCEP ATP III criteria.

Table 2: Gender-wise Distribution of Metabolic Syndrome

Gender	Total Patients	MetS Patients	Prevalence (%)
Male	55	33	60.0
Female	45	35	77.7

Metabolic syndrome was more prevalent among females (77.7%) compared to males (60%), indicating a higher metabolic risk burden in female T2DM patients.

Table 3: Age-wise Prevalence of Metabolic Syndrome

Age Group (Years)	Prevalence (%)
<40	40
41–50	62
51–60	75
>60	70

The highest prevalence (75%) of metabolic syndrome was observed in the 51–60 years age group, suggesting increased risk with advancing age.

Table 4: Prevalence of Metabolic Syndrome Components

Component	Prevalence (%)
Central Obesity	72
Hypertension	66
Hypertriglyceridemia	59
Low HDL Cholesterol	61
Fasting Glucose ≥100 mg/dL	100

Central obesity was the most common component (72%), followed by hypertension (66%) and low HDL (61%). All patients had elevated fasting glucose, as expected in a diabetic cohort.

Table 5: Statistical Associations

Variable	Test Used	p-value	Significance
Female Gender and Central Obesity	Chi-square	0.02	Significant
Age and Metabolic Syndrome Prevalence	Chi-square	0.04	Significant

There was a statistically significant association between female gender and central obesity, and also between increasing age and prevalence of metabolic syndrome, indicating that both gender and age are influential factors.

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Discussion

Prevalence and Clinical Significance

The present study revealed a high prevalence of metabolic syndrome (MetS) among patients with type 2 diabetes mellitus (T2DM), with 68% of the study population meeting the NCEP ATP III criteria for MetS. This finding underscores the growing recognition that T2DM and metabolic syndrome are closely interlinked conditions sharing common pathophysiological mechanisms, notably insulin resistance, chronic inflammation, and endothelial dysfunction. The clustering of metabolic abnormalities—namely, central obesity, hypertension, dyslipidemia, and hyperglycemia—greatly accelerates the progression of cardiovascular disease (CVD), which remains the leading cause of morbidity and mortality in diabetic populations. The high prevalence observed in this cohort highlights the urgent need for proactive identification and integrated management of MetS components in routine diabetic care.

Gender-Based Differences in Prevalence

In This Study, the prevalence of MetS was notably higher in female patients (77.7%) compared to male patients (60%). This gender disparity is consistent with numerous previous studies and may be attributed to multiple factors, including differences in fat distribution, hormonal changes, and post-menopausal metabolic shifts in women. Central obesity and low HDL cholesterol levels were more commonly observed among females, potentially due to increased visceral adiposity and reduced estrogen-mediated cardioprotection in postmenopausal women. These gender-based differences necessitate a tailored approach to prevention and management, with specific emphasis on weight control, lipid management, and physical activity in women with T2DM.

Age-Related Trends

The highest prevalence of MetS was observed in the age group of 51–60 years (75%), followed by those above 60 years, suggesting a positive correlation between increasing age and metabolic risk. With advancing age, insulin sensitivity declines, physical activity reduces, and visceral fat increases, all of which contribute to the rise in MetS prevalence. These findings emphasize the importance of early intervention and continuous risk assessment in middle-aged and older diabetic populations. Screening efforts should begin as early as the fourth decade of life, particularly in individuals with sedentary lifestyles or a family history of metabolic disorders.

Component-Wise Analysis of Metabolic Syndrome

Among the five components evaluated, central obesity emerged as the most prevalent feature (72%), followed by hypertension (66%), low HDL cholesterol (61%), and hypertriglyceridemia (59%). Elevated fasting glucose (≥100 mg/dL) was present in 100% of the study participants by the inclusion criteria. These results are consistent with global and Indian data, where abdominal obesity and elevated blood pressure are among the most frequently reported features of MetS in diabetic populations. Central obesity is a hallmark of insulin resistance and has been strongly linked to atherosclerosis and systemic inflammation, while hypertension compounds the cardiovascular risk burden in T2DM patients. The high prevalence of low HDL and hypertriglyceridemia further illustrates the extent of dyslipidemia present in this group, which is a known predictor of adverse cardiovascular outcomes.

Statistical Associations and Risk Stratification

Statistical analysis revealed a significant association between female gender and central obesity ($p=0.02$), as well as between increasing age and overall MetS prevalence ($p=0.04$). These associations indicate that certain demographic groups are at higher risk and should be prioritized for lifestyle interventions, dietary counseling, and pharmacological management. Central obesity, as an early and modifiable indicator, serves as a valuable screening parameter, especially in primary care settings. Risk stratification using simple anthropometric and metabolic measurements can enable targeted preventive strategies and resource allocation.

Comparison with Previous Studies

This study found a 68% prevalence, consistent with Indian research. Deepa et al. identified a 73.2% prevalence of T2DM in Chennai using NCEP ATP III criteria. [13] found 71% in an urban North Indian cohort, while Ramachandran et al. found 58% in Tamil Nadu, possibly due to lifestyle and nutrition differences. Our results in Bihar match [14] 65.8% prevalence in Eastern India (West Bengal), showing that diabetics in the East have a larger MetS burden. Our findings are consistent with international research on urbanisation

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and lifestyle changes in the Middle East and Southeast Asia. [14] found MetS in 67% of Malaysian type 2 diabetics and [15] found 63% in Iran. Western research, such as that from the US (NHANES data), reports prevalence rates of 50–55 percent. Better glycaemic control, more aggressive cholesterol treatment, and more knowledge in developed healthcare systems may explain these lower rates. These cross-regional comparisons emphasise nutritional and sociocultural aspects that affect diabetic metabolic syndrome. Metabolic syndrome, a result of type 2 diabetes, is common throughout populations, demonstrating its prevalence. High carbohydrate diets, poor fibre intake, physical inactivity, and poor healthcare access may explain the greater occurrence in developing countries like India. Indian diabetics are more likely to develop dyslipidaemia and abdominal obesity due to a genetic predisposition to have higher body fat percentages at lower BMIs. These pathophysiological aspects require individualised clinical advice for aggressive MetS treatment in Indian diabetics, starting with early diagnosis.

Implications for Practice and Public Health

This Study underscores the need for integrating metabolic syndrome screening into routine diabetes care, especially in tertiary care centers serving rural and semi-urban populations. A comprehensive approach combining lifestyle modification, patient education, pharmacological control of blood pressure and lipids, and regular follow-up is essential to mitigate the long-term cardiovascular risks associated with MetS. Primary care physicians, endocrinologists, and dietitians must collaborate to design and implement region-specific intervention strategies aimed at addressing modifiable risk factors such as obesity and hypertension. Policy-level changes promoting health education, subsidized lifestyle modification programs, and inclusion of MetS indicators in national diabetes registries could greatly enhance early detection and management outcomes.

Conclusion

This study shows a major public health issue: 68% of Katihar Medical College type 2 diabetes mellitus (T2DM) patients have metabolic syndrome. This reinforces the idea that central obesity, hypertension, hypertriglyceridemia, and low HDL cholesterol are metabolic risk factors for type 2 diabetes. Due to sedentary lifestyles, bad diets, and genetic predispositions, central obesity is the region's most noteworthy feature. Female patients had increased metabolic syndrome due to dyslipidaemia and abdominal obesity, indicating hormonal and physiological abnormalities. The 51–60-year-old age group had the highest rate of metabolic disorders; hence, age was another factor. These demographic data emphasise the need to identify high-risk subgroups and create specialised screening and intervention programs. Since metabolic syndrome raises the risk of cardiovascular disease, stroke, and other macrovascular complications, diabetics must be diagnosed early and treated aggressively. This study supports adding metabolic syndrome assessment to normal diabetes management procedures, such as glycaemic monitoring, blood pressure, lipid profile, and waist circumference. To reduce the impact of these interrelated disorders, holistic care must include medicine, patient education, and lifestyle changes. To achieve long-term clinical results, healthcare providers and patients must learn about metabolic syndrome's effects. Finally, type 2 diabetics with metabolic syndrome benefit from early detection and customised treatment to reduce cardiovascular morbidity and improve quality of life.

Acknowledgement

Thank the hospital staff, lab team, and participants.

List of abbreviations

T2DM- Type 2 Diabetes Mellitus
MetS- Metabolic syndrome
NCEP ATP III- National Cholesterol Education Program Adult Treatment Panel III
HDL- High-Density Lipoprotein

Source of funding

This study received no funding

Conflict of interest

The authors declare no conflict of interest.

Author contributions

Dr. Md. Faiyaz Alam: concept, design, data collection, manuscript drafting, final approval.

Data availability

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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