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Original Article

Prevalence And Predictors of Metabolic Syndrome Among Adults at A Tertiary Care Centre

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ABSTRACT

Background: Metabolic syndrome (MetS) is an important predictor of cardiovascular disease and type 2 diabetes. Its prevalence is rising in India due to rapid lifestyle transitions.
Aim: To estimate the prevalence and identify predictors of MetS among adults attending a tertiary care centre, and to compare metabolic parameters with expected normal values.
Materials and Methods: A cross-sectional study was conducted among 400 adults aged ≥18 years. Data on sociodemographic factors, anthropometry, blood pressure, and fasting biochemical parameters were collected. MetS was diagnosed using NCEP-ATP III criteria. Expected normal values included waist circumference <90 cm (men) / <80 cm (women), BP <130/85 mmHg, fasting glucose <100 mg/dL, triglycerides <150 mg/dL, and HDL >40 mg/dL (men) / >50 mg/dL (women). Logistic regression identified independent predictors.
Results: The prevalence of MetS was 31.8%. Abnormal component frequencies were: increased waist circumference (44%), low HDL (41%), elevated BP (36%), high triglycerides (32%), and elevated fasting glucose (28%). Significant predictors of MetS included age >45 years (AOR 2.6), BMI ≥25 kg/m² (AOR 3.2), physical inactivity (AOR 2.1), and family history of diabetes (AOR 1.8).
Conclusion: Metabolic syndrome is common among adults at a tertiary care centre. Obesity, advancing age, sedentary lifestyle, and family history of diabetes are key predictors. Early screening and targeted lifestyle interventions are essential to mitigate cardiometabolic risk.

Keywords: *Metabolic syndrome, prevalence, predictors, tertiary care, NCEP-ATP III, obesity, Indian adults.*

INTRODUCTION:

Metabolic syndrome (MetS) is defined as a constellation of interrelated metabolic abnormalities, including central obesity, dyslipidemia, hypertension, and hyperglycemia, which collectively increase the risk for type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD)[1]. The global burden of MetS is rising rapidly, paralleling changes in diet, sedentary lifestyle, and increasing overweight and obesity. International estimates suggest that MetS affects approximately 20–25% of the adult population, with considerable regional variations[2].

In India, the prevalence of MetS has surged in recent decades, attributed to urbanization, nutritional transition, decreased physical activity, and genetic susceptibility[3],[4]. Community-based Indian studies report a prevalence ranging from 24–41%, with higher rates among older adults, urban populations, and women[5]–[7]. Metabolic syndrome significantly increases the risk of cardiovascular diseases by three-fold and diabetes by five-fold, underscoring its public health importance[8].

Several diagnostic definitions exist, including NCEP-ATP III, IDF, and WHO criteria. The NCEP-ATP III criteria are widely used due to clinical practicality and consistency[9]. Expected normal values for each component include waist

circumference <90 cm in men and <80 cm in women, triglycerides <150 mg/dL, HDL >40 mg/dL (men) or >50 mg/dL (women), fasting glucose <100 mg/dL, and blood pressure <130/85 mmHg[10].

Multiple predictors of MetS have been identified in literature, such as increasing age, high BMI, physical inactivity, tobacco and alcohol use, family history of diabetes, and dietary patterns emphasizing refined carbohydrates[11–13]. Indian population-specific characteristics—including higher visceral adiposity and lower lean mass—further exacerbate metabolic risk at lower BMI levels[14].

Despite substantial research, gaps remain in understanding the burden of MetS in hospital-based Indian populations, particularly at tertiary care centres where patients present with diverse risk factors. Identifying predictors is crucial for early screening, targeted intervention, and resource allocation.

This study aims to estimate the prevalence and identify significant predictors of metabolic syndrome among adults attending a tertiary care centre

MATERIALS AND METHODS:

Study Design and Setting

A cross-sectional observational study was conducted in the Department of Community medicine in association with the department of General Medicine at a tertiary care teaching hospital in India over a period of 12 months after obtaining Ethical approval from the Institutional Ethics Committee. Written informed consent was obtained from all the participants prior to enrolment.
Study Population

Inclusion Criteria

- Adults aged ≥18 years
- Attending outpatient clinics
- Fasting for ≥8 hours
- Provided informed written consent

Exclusion Criteria

- Pregnancy
- Chronic steroid/hormone use
- Endocrine disorders (Cushing's, hypothyroidism)
- Severe hepatic or renal disease
- Acute infection or inflammatory conditions

Sample Size and Sampling

Using an expected MetS prevalence of 30%, 5% precision, and 95% confidence, the sample size was calculated as 323. To improve precision, 400 adults were enrolled using systematic random sampling (every 5th eligible patient).

Data Collection

Data collection was carried out by trained investigators from the Departments of Community Medicine (SPM) and General Medicine. A **structured, pre-tested questionnaire** was administered to collect information on sociodemographic variables (age, sex, education, occupation), lifestyle factors (physical activity, smoking, alcohol intake), and relevant medical and family history (diabetes, hypertension, dyslipidemia). The questionnaire ensured uniformity and minimized interviewer bias.
All anthropometric measurements were obtained following **standard WHO guidelines**:

1. Height

Measured using a stadiometer with the participant standing erect, barefoot, heels together, and head in the Frankfurt plane. Values were recorded to the nearest **0.1 cm**.

2. Weight

Measured using a calibrated digital weighing scale with the participant wearing light clothing and no footwear. Values were recorded to the nearest **0.1 kg**.

3. Body Mass Index (BMI)

BMI was calculated using the formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

4. Waist Circumference (WC)
WC was measured using a non-stretchable tape placed horizontally at the midpoint between the **lower margin of the last rib** and the **iliac crest**, in full expiration. Values were recorded to the nearest **0.1 cm**.

Expected normal WC:
- Men: **<90 cm**
- Women: **<80 cm**

These measurements were taken twice, and the average was used for analysis to reduce measurement error.

Blood Pressure Measurement
Blood pressure (BP) was measured using a calibrated mercury sphygmomanometer. Participants were seated comfortably for at least **5 minutes** before measurement. Three BP readings were taken at 2-minute intervals on the right arm, and the mean of the three was used for analysis.

Laboratory Investigations
Fasting (8–12 hours) blood samples were analyzed for:
- Fasting plasma glucose (FPG) (<100 mg/dL expected)
- Triglycerides (TG) (<150 mg/dL expected)
- HDL cholesterol (>40 mg/dL men; >50 mg/dL women expected)

Automated analyzers with internal/external quality control were used.

Definition of Metabolic Syndrome
MetS was diagnosed using NCEP-ATP III criteria (any three of the following)[15]:
1. WC >90 cm (men), >80 cm (women)
2. BP ≥130/85 mmHg
3. FPG ≥100 mg/dL
4. TG ≥150 mg/dL
5. HDL <40 mg/dL (men), <50 mg/dL (women)

Operational Definitions
- Physical inactivity: <150 minutes/week of moderate activity
- Current smoker: tobacco use in past 30 days
- Alcohol use: ≥1 drink/week
- Family history: first-degree diabetic/hypertensive

Statistical Analysis:
Data were entered into Microsoft Excel and analyzed using **IBM SPSS Statistics version 20.0** Continuous variables were expressed as **mean ± standard deviation (SD)**. Categorical variables were presented as **frequencies and percentages**. Comparisons between groups (MetS vs. non-MetS) were performed using the **Independent t-test** for continuous variables and the **Chi-square test** for categorical variables.

To identify independent predictors of metabolic syndrome, **binary logistic regression analysis** was performed. Variables found significant in univariate analysis ($p < 0.05$) were entered into the multivariable model. Results were expressed as **Adjusted Odds Ratios (AOR)** with **95% CI**.
A **p-value < 0.05** was considered statistically significant for all analyses.

RESULTS:
A total of 400 adults participated in the study. All participants completed anthropometric evaluation, blood pressure measurement, and fasting biochemical assessment. The findings are presented below under demographic characteristics, prevalence of MetS, distribution of individual components, and predictors of MetS

The mean age of participants was 44.2 ± 12.7 years, with slightly more males (52%) than females (48%). The mean BMI was 26.8 ± 4.2 kg/m², indicating that overweight and obesity were common. Approximately 38% of participants reported physical inactivity, and 33% had a family history of diabetes as shown in Table 1.

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

Parameter	Value
Mean age (years)	44.2 ± 12.7
Gender: Male	208 (52%)
Gender: Female	192 (48%)

Parameter	Value
Mean BMI (kg/m²)	26.8 ± 4.2
Physical inactivity	152 (38%)
Smokers	91 (22.8%)
Alcohol users	118 (29.5%)
Family history of diabetes	132 (33%)
Family history of hypertension	121 (30.3%)

The prevalence of metabolic syndrome based on NCEP-ATP III criteria was 31.8% (95% CI: 27.1–36.9). Among males, prevalence was 29.8%, whereas among females it was slightly higher at 33.9%, though not statistically significant as shown in Table 2.

TABLE 2: PREVALENCE OF METABOLIC SYNDROME (N=400)

Category	Frequency (%)
Individuals with MetS	127 (31.8%)
Prevalence in males	62 (29.8%)
Prevalence in females	65 (33.9%)
95% Confidence Interval	27.1–36.9%

Abdominal obesity and low HDL were the most frequent abnormalities, followed by dyslipidemia and elevated blood pressure. Table 3 details parameter-wise deviations from expected values as shown in Table 3.

TABLE 3: DISTRIBUTION OF INDIVIDUAL COMPONENTS OF METABOLIC SYNDROME

Component	Expected Normal Value	Abnormal (%)
Waist circumference	<90 cm (M), <80 cm (F)	176 (44%)
Blood pressure	<130/85 mmHg	144 (36%)
Fasting glucose	<100 mg/dL	112 (28%)
Triglycerides	<150 mg/dL	128 (32%)
HDL cholesterol	>40 mg/dL (M), >50 mg/dL (F)	164 (41%)

Logistic regression identified four significant predictors: age >45 years, BMI ≥25 kg/m², physical inactivity, and family history of diabetes. Alcohol and smoking showed no significant association as shown in Table 4.

TABLE 4: LOGISTIC REGRESSION ANALYSIS OF PREDICTORS OF METABOLIC SYNDROME

Predictor	Adjusted Odds Ratio (AOR)	95% CI	p-value
Age >45 years	2.6	1.7–4.1	<0.001
BMI ≥25 kg/m²	3.2	2.1–5.0	<0.001
Physical inactivity	2.1	1.4–3.3	0.002
Family history of diabetes	1.8	1.1–2.7	0.01
Alcohol use	1.4	0.9–2.1	0.07
Smoking	1.3	0.8–2.0	0.11

Patients with MetS had significantly higher BMI, waist circumference, BP, glucose, and triglycerides compared to those without MetS. As shown in Table 5

TABLE 5: COMPARISON OF MEAN VALUES BETWEEN METS AND NON-METS GROUPS

Parameter	MetS (n = 127)	Non-MetS (n = 273)	p-value
BMI (kg/m²)	28.9 ± 4.6	25.7 ± 3.8	<0.001
Waist circumference (cm)	96.4 ± 9.8	84.2 ± 7.3	<0.001
SBP (mmHg)	138.6 ± 14.7	124.4 ± 11.2	<0.001
DBP (mmHg)	89.1 ± 9.8	79.5 ± 7.5	<0.001

Parameter	MetS (n = 127)	Non-MetS (n = 273)	p-value
Fasting glucose (mg/dL)	113.4 ± 21.6	92.8 ± 14.2	<0.001
Triglycerides (mg/dL)	188.5 ± 58.1	132.7 ± 45.3	<0.001
HDL (mg/dL)	38.4 ± 9.6	47.3 ± 11.4	<0.001

DISCUSISON:

In the present study, the prevalence of metabolic syndrome (MetS) among adults attending a tertiary care centre was 31.8%, indicating a substantial metabolic health burden. This prevalence is comparable to recent Indian studies showing MetS rates between 28–41%, particularly in urban and semi-urban populations where lifestyle transitions are prominent[15–17]. Internationally, MetS prevalence ranges from 20–25%, suggesting that South Asian populations—including Indians—may be at a comparatively higher metabolic risk[25].

The most common abnormal components observed were low HDL cholesterol (41%) and central obesity (44%). These findings are consistent with the well-documented "South Asian phenotype," characterized by increased visceral fat, dyslipidemia, and metabolic susceptibility at lower BMI levels[18],[19]. Studies from Chennai and Delhi have similarly highlighted the predominance of abdominal obesity and low HDL as major contributors to metabolic risk in India[20],[21].

Advanced age emerged as a strong predictor of MetS (AOR: 2.6). Age-related changes in body composition, increased insulin resistance, and endothelial dysfunction are known contributors to the rise in MetS prevalence with age[15],[22]. Obesity (BMI ≥25 kg/m^2) was the most powerful predictor in this study (AOR: 3.2), similar to findings from the CURES and ICMR-INDIAB studies, which emphasize the central role of adiposity in metabolic clustering[23],[24].

Physical inactivity was also significantly associated with MetS (AOR: 2.1). Sedentary behaviour reduces glucose uptake by muscle tissue, increases adiposity, and promotes insulin resistance. These associations are well supported by Indian and global evidence indicating that insufficient physical activity doubles the risk of MetS[16],[25].

A positive family history of diabetes was another significant predictor (AOR: 1.8). Genetic predisposition, shared dietary patterns, and early-life metabolic programming are recognized contributors to the familial aggregation of MetS[26]. Similar associations were reported in studies from Kerala and Maharashtra, underscoring the importance of family history as a risk marker in the Indian context[17],[27].

Although alcohol and smoking were more common among individuals with MetS, their associations were not statistically significant. This may be due to variations in consumption patterns, underreporting, or confounding by lifestyle and dietary habits, which has been noted in previous Indian analyses[28].

The clustering of elevated blood pressure, hyperglycemia, hypertriglyceridemia, and low HDL among MetS subjects in this study reinforces the syndrome's role as a precursor to cardiovascular disease and diabetes. Numerous prospective studies have demonstrated that MetS increases the incidence of type 2 diabetes by five-fold and cardiovascular events by two- to three-fold[29],[30], underscoring the importance of early identification and intervention.

Overall, our findings highlight the need for targeted screening strategies in tertiary care settings, especially for older adults, obese individuals, physically inactive patients, and those with a family history of diabetes. Lifestyle modification—focused on weight reduction, increased physical activity, and dietary adjustments—remains the cornerstone of MetS prevention and management. Public health strategies should also prioritize awareness programs and early metabolic screening, especially in high-risk groups.

CONCLUSION:

Metabolic syndrome was found to be highly prevalent in the study population, with central obesity and low HDL as the most frequent abnormalities. Older age, higher BMI, physical inactivity, and family history of diabetes were significant predictors. These findings highlight the need for routine screening and targeted lifestyle interventions to reduce cardiometabolic risk and prevent future diabetes and cardiovascular disease.

Declaration:

Conflicts of interests: The authors declare no conflicts of interest.

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