



Burden of Metabolic Syndrome among Urban Slum Population Attending a Tertiary Care Hospital in North India: A Cross-sectional Study

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ABSTRACT

Background: Metabolic syndrome is a clustering of cardiovascular and metabolic risk factors that significantly increases the risk of type 2 diabetes mellitus and cardiovascular diseases. Urban slum populations represent a vulnerable subgroup due to socioeconomic deprivation and unhealthy lifestyle patterns.

Objectives: To assess the burden of metabolic syndrome and associated risk factors among urban slum population attending a tertiary care hospital in North India.

Methods: A hospital-based cross-sectional study was conducted from March 2025 to November 2025 among 212 adults residing in urban slum areas attending a tertiary care hospital outpatient department. Participants aged ≥ 18 years were included using systematic random sampling. Data were collected using a structured questionnaire, anthropometric measurements, and biochemical investigations including fasting blood glucose and lipid profile. Metabolic syndrome was defined using harmonized criteria requiring central obesity plus any two metabolic abnormalities. Data were analyzed using appropriate statistical methods, and $p < 0.05$ was considered significant.

Results: The mean age of participants was predominantly between 31–60 years, with a slight male predominance. A high proportion belonged to lower socioeconomic status and exhibited sedentary lifestyle patterns. Central obesity was observed in 59.4% of participants, reduced HDL cholesterol in 52.8%, elevated blood pressure in 49.1%, and raised fasting glucose in 41.5%. Overall prevalence of metabolic syndrome was found to be 38.7% among the study population. Sedentary lifestyle, high intake of refined carbohydrates, and tobacco use were common risk factors.

Conclusion: Metabolic syndrome is highly prevalent among urban slum population attending tertiary care services in North India. The study highlights the urgent need for early screening, lifestyle modification, and targeted public health interventions in this vulnerable group to prevent long-term cardiovascular and metabolic complications.

Keyword: Metabolic syndrome; Urban slum; Central obesity; Cardiovascular risk; Cross-sectional study; India

Introduction

Non-communicable diseases (NCDs) have emerged as the leading cause of global morbidity and mortality, accounting for a substantial proportion of premature deaths worldwide. Among these, cardiovascular diseases, type 2 diabetes mellitus, and associated metabolic abnormalities constitute a major public health burden, particularly in low- and middle-income countries undergoing rapid urbanization and lifestyle transition [1]. The clustering of metabolic risk factors such as central obesity, dyslipidemia, hypertension, and impaired glucose metabolism is collectively defined as metabolic syndrome, a condition strongly associated with increased cardiovascular risk and all-cause mortality [2].

The concept of metabolic syndrome has evolved over time, with multiple definitions proposed by different organizations. A harmonized definition proposed by leading international bodies including the International Diabetes Federation (IDF), American Heart Association (AHA), and National Heart, Lung, and Blood Institute (NHLBI) emphasizes central obesity as a key component along with two or more metabolic abnormalities [3]. This standardized definition has facilitated more consistent epidemiological assessments across populations.

Globally, the prevalence of metabolic syndrome varies widely depending on diagnostic criteria,

ethnicity, age distribution, and lifestyle patterns, ranging from approximately 10% to over 40% in adult populations [4]. Rapid urbanization, sedentary behavior, and dietary transitions characterized by increased consumption of processed foods and refined carbohydrates have contributed significantly to this rising burden.

In the South Asian region, particularly India, the prevalence of metabolic syndrome is notably high, with studies reporting rates between 20% and 35% in urban adult populations [5]. South Asians are known to have a higher predisposition to central obesity and insulin resistance even at lower body mass index (BMI) levels, which further increases their susceptibility to metabolic complications. India, undergoing rapid epidemiological transition, faces a dual burden of undernutrition and overnutrition, especially in urban settings.

Urban slum populations represent a unique and vulnerable subgroup within cities. Despite residing in urban environments, individuals in slum areas often experience overcrowding, poor sanitation, limited access to healthcare, and high levels of psychosocial stress, all of which contribute to adverse metabolic health outcomes [6]. Additionally, dietary insecurity often leads to consumption of inexpensive, calorie-dense, nutrient-poor foods, further exacerbating metabolic risk.

Studies from India have demonstrated that urban slum dwellers may paradoxically exhibit a high prevalence of metabolic syndrome due to a combination of sedentary occupations, tobacco use, alcohol consumption, and lack of preventive healthcare awareness [7]. However, data specifically focusing on slum populations attending tertiary care hospitals in North India remain limited and fragmented.

In North India, available hospital-based and community-based studies suggest a rising trend of metabolic syndrome, particularly among individuals from lower socioeconomic strata who present late with established complications [8]. Nevertheless, most existing studies have focused on general urban populations, with limited emphasis on slum residents who may have distinct risk profiles and healthcare-seeking behaviors.

Furthermore, there is a significant research gap in understanding the true burden of metabolic syndrome among urban slum populations accessing tertiary care facilities, where selection bias, delayed diagnosis, and comorbidity clustering may influence observed prevalence patterns [9]. Identifying the burden in this subgroup is crucial for designing targeted preventive strategies and early intervention programs.

Given this background, the present study was undertaken to assess the burden of metabolic

syndrome among urban slum population attending a tertiary care hospital in North India. The study also aims to evaluate associated sociodemographic and lifestyle factors contributing to metabolic risk in this vulnerable population.

Methodology

Study Design: This was a hospital-based cross-sectional observational study designed to assess the burden of metabolic syndrome and its associated factors among urban slum population attending a tertiary care hospital in North India.

Study Setting: The study was conducted in a tertiary care teaching hospital in North India, which caters to a large urban and peri-urban population, including individuals residing in nearby slum areas who attend outpatient and general medicine services.

Study Duration: March 2025 to November 2025.

Study Population: The study population comprised adults aged ≥ 18 years residing in urban slum areas and attending the outpatient department (OPD) of the tertiary care hospital during the study period.

Inclusion Criteria

- Individuals aged 18 years and above
- Residents of urban slum areas (as per local municipal classification)

- Willing to participate and provide written informed consent
- Attending OPD services during the study period

Exclusion Criteria

- Pregnant women
- Critically ill patients requiring emergency care
- Known cases of chronic systemic diseases with established advanced complications (e.g., end-stage renal disease, advanced malignancy)
- Patients unwilling to participate

Sample Size: The sample size was calculated using the formula for cross-sectional studies:

$$n = Z^2 \times p \times q / d^2$$

Where:

- $Z_{\alpha} = 1.96$ at 95% confidence interval
- p = anticipated prevalence of metabolic syndrome in urban population (assumed 30% based on previous studies)
- $q = 1 - p$
- d = absolute precision of 6%

Using these assumptions, the calculated sample size was approximately 224. Considering feasibility and non-response, a final sample size of 212 participants was included in the study.

Sampling Technique: A systematic random sampling technique was used among eligible patients attending the OPD. Every k th eligible patient meeting inclusion criteria was selected until the desired sample size was achieved.

Data Collection Tools & Procedure: Data were collected using a pre-tested structured questionnaire administered through face-to-face interviews. The questionnaire included sociodemographic details (age, gender, occupation, education, socioeconomic status), lifestyle factors (dietary habits, physical activity, tobacco use, alcohol consumption), and medical history.

Anthropometric measurements including weight, height, and waist circumference were recorded using standardized techniques. Body mass index (BMI) was calculated using standard formula. Blood pressure was measured using a calibrated sphygmomanometer after 5 minutes of rest, following standard guidelines.

Biochemical parameters such as fasting blood glucose and lipid profile were obtained from hospital laboratory records after overnight fasting of at least 8–12 hours. Metabolic syndrome was defined using harmonized criteria requiring central obesity plus any two of the following: raised triglycerides, reduced HDL cholesterol, elevated blood pressure, or raised fasting glucose.

Study Variables: The dependent variable was the presence of metabolic syndrome. Independent variables included age, gender, socioeconomic status, dietary pattern, physical activity, tobacco use, alcohol consumption, BMI, waist circumference, blood pressure, fasting blood glucose, and lipid profile parameters.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software (e.g., SPSS version 20.0). Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean $\pm$ standard deviation. Associations between categorical variables were assessed using the Chi-square test. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants prior to enrolment. Confidentiality of patient data was strictly maintained. The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments, ensuring respect for autonomy, beneficence, non-maleficence, and justice.

Results

A total of 212 participants from urban slum areas attending a tertiary care hospital were included in the study. The majority of participants were in the age group of 31–60 years, with a slight male predominance. Most participants belonged to lower socioeconomic strata and had low educational status (Table 1).

Table 1: Sociodemographic profile of study participants (n = 212)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	38	17.9
	31–45	74	34.9
	46–60	66	31.1
	>60	34	16.0
Gender	Male	118	55.7
	Female	94	44.3
Socioeconomic status	Lower	142	67.0
	Middle	70	33.0
Education level	Illiterate	76	35.8

	Primary	82	38.7
	Secondary & above	54	25.5

Lifestyle assessment revealed a high prevalence of sedentary behavior (60.4%), tobacco use (45.3%), and consumption of a diet rich in refined carbohydrates (70.8%) (Table 2)

Table 2: Lifestyle characteristics of participants (n = 212)

Variable	Category	Frequency (n)	Percentage (%)
Physical activity	Sedentary	128	60.4
	Moderate/Active	84	39.6
Tobacco use	Yes	96	45.3
	No	116	54.7
Alcohol consumption	Yes	58	27.4
	No	154	72.6
Dietary pattern	High refined carbohydrate diet	150	70.8
	Balanced diet	62	29.2

Alcohol consumption was reported in approximately one-fourth of participants.

Anthropometric and clinical evaluation showed an elevated mean BMI (26.4 ± 4.2 kg/m²) and increased waist circumference (92.6 ± 10.8 cm), indicating a tendency toward central obesity. Mean blood pressure and fasting glucose levels were also in the higher range of normal (Table 3)

Table 3: Anthropometric and clinical parameters

Parameter	Mean $\pm$ SD
BMI (kg/m ²)	26.4 ± 4.2
Waist circumference (cm)	92.6 ± 10.8
Systolic BP (mmHg)	132.8 ± 18.5
Diastolic BP (mmHg)	84.6 ± 10.2
Fasting blood glucose (mg/dL)	108.5 ± 22.3

Among metabolic syndrome components, central obesity was the most prevalent (59.4%), followed by reduced HDL cholesterol (52.8%) and elevated blood pressure (49.1%) (Table 4)

Table 4: Prevalence of metabolic syndrome components (n = 212)

Component	Frequency (n)	Percentage (%)
Central obesity	126	59.4
Elevated triglycerides	98	46.2
Reduced HDL cholesterol	112	52.8
Elevated blood pressure	104	49.1
Raised fasting glucose	88	41.5

prevalence of metabolic syndrome in the study population was 38.7% (Table 5)

Table 5: Prevalence of metabolic syndrome

Condition	Frequency (n)	Percentage (%)
Metabolic syndrome present	82	38.7
Metabolic syndrome absent	130	61.3

Discussion

The present study found that the burden of metabolic syndrome among urban slum population attending a tertiary care hospital in North India was 38.7%. Central obesity emerged as the most frequent component, followed by reduced HDL cholesterol and elevated blood pressure. A high proportion of participants demonstrated sedentary lifestyle, poor dietary habits dominated by refined carbohydrates, and significant tobacco use, indicating a clustering of modifiable risk factors contributing to metabolic dysregulation.

The observed prevalence in this study is consistent with several urban Indian studies reporting metabolic syndrome prevalence ranging from 30% to 40% in adult populations, particularly in urban and semi-urban settings [10]. The relatively high burden in the present study may be attributed to the inclusion of slum dwellers who are exposed to a unique combination of socioeconomic deprivation and unhealthy lifestyle transitions.

Studies from metropolitan cities in India have also demonstrated similar findings, where central

obesity and dyslipidemia were predominant abnormalities among lower socioeconomic urban populations [11]. This may be explained by the nutritional transition characterized by increased intake of inexpensive calorie-dense foods high in trans fats and refined sugars, coupled with reduced physical activity due to occupational and environmental constraints.

International evidence also supports these findings, as urbanization and socioeconomic disadvantage have been strongly associated with metabolic syndrome globally. A systematic review has highlighted that urban poor populations often exhibit paradoxically higher metabolic risk due to lifestyle constraints despite limited access to healthcare and preventive services [12]. The present study reinforces this concept in the Indian slum context.

The high prevalence of central obesity observed aligns with the well-established “Asian phenotype,” where individuals develop metabolic complications at lower BMI thresholds compared to Western populations. This phenotype is particularly relevant in South Asian populations, where visceral adiposity plays a critical role in insulin resistance and cardiovascular risk [13].

From a public health perspective, the findings are concerning as metabolic syndrome is a strong predictor of future cardiovascular morbidity and

type 2 diabetes mellitus. The slum population, already vulnerable due to socioeconomic deprivation, is at increased risk of delayed diagnosis and poor disease outcomes due to limited healthcare access and low awareness.

The study highlights the urgent need for targeted community-based interventions focusing on lifestyle modification, early screening, and health education in urban slum areas. Integration of metabolic screening into primary healthcare services catering to slum populations may help in early identification and prevention of long-term complications.

Conclusion

The present study demonstrates a high burden of metabolic syndrome (38.7%) among urban slum population attending a tertiary care hospital in North India. Central obesity was the most prevalent metabolic abnormality, followed by dyslipidemia and elevated blood pressure, indicating a strong clustering of cardiometabolic risk factors in this vulnerable group. The findings highlight the coexistence of sedentary lifestyle, unhealthy dietary patterns, and tobacco use, which collectively contribute to metabolic derangements. The study underscores that urban slum populations, despite living in close proximity to healthcare facilities, remain at significant risk of undiagnosed metabolic syndrome and its complications. Early

identification through routine screening and targeted intervention strategies at the primary healthcare level is essential. Strengthening community-based health education programs focusing on lifestyle modification, dietary awareness, and physical activity promotion may significantly reduce future cardiovascular and metabolic disease burden in this high-risk population.

Declarations

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Conflict of Interest: None declared.

Ethical Approval: The study was approved by the Institutional Ethics Committee of the tertiary care hospital.

Informed Consent: Written informed consent was obtained from all participants prior to inclusion in the study.

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