

Prevalence of Metabolic Syndrome and its Association with Lifestyle and Dietary Risk Factors Among Adults Attending an Urban Health Centre**Ramesh Nikam¹**¹Associate Professor, Community Medicine, Smt. Sakhubai Narayanrao Katkade Medical College, Kompathan, Kopergaon, Maharashtra, India

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Abstract

Background: Metabolic syndrome (MetS) is a cluster of cardiometabolic abnormalities that substantially increases the risk of type 2 diabetes mellitus and cardiovascular disease. Rapid urbanization, sedentary lifestyles, obesity, and unhealthy dietary practices have contributed to its increasing burden. This study assessed the prevalence of MetS and its association with lifestyle and dietary risk factors among adults attending an urban health centre.

Materials and Methods: This cross-sectional observational study included 110 adults attending an urban health centre. Sociodemographic characteristics, lifestyle behaviours, dietary practices, anthropometric measurements, blood pressure, fasting plasma glucose, triglycerides, and high-density lipoprotein cholesterol were assessed. MetS was diagnosed using modified NCEP ATP III/harmonized criteria with Asian-specific waist circumference cut-offs. Associations were evaluated using appropriate statistical tests and multivariable logistic regression.

Results: The mean age was 44.6 ± 13.2 years, and 52.7% were male. MetS was present in 39 (35.5%) participants. Abdominal obesity (53.6%) was the most frequent component, followed by reduced HDL-C (51.8%), elevated triglycerides (43.6%), elevated blood pressure (40.0%), and elevated fasting glucose (38.2%). MetS was significantly associated with inadequate physical activity (74.4% vs 45.1%; $p=0.003$), high sedentary behaviour (64.1% vs 39.4%; $p=0.013$), overweight/obesity (79.5% vs 49.3%; $p=0.002$), and several unhealthy dietary practices. On multivariable analysis, overweight/obesity (AOR 3.12; $p=0.022$), inadequate physical activity (AOR 2.68; $p=0.039$), and frequent fried-food consumption (AOR 2.54; $p=0.048$) were independent predictors of MetS.

Conclusion: MetS was common among urban adults and was strongly associated with modifiable lifestyle and dietary factors. Routine screening, weight management, regular physical activity, and dietary modification may help reduce future cardiometabolic risk.

Keywords: Metabolic syndrome; Urban health; Obesity; Physical activity; Dietary risk factors; Cardiovascular risk.

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Introduction

Over the past few decades, the global pattern of disease has undergone a major epidemiological transition, with non-communicable diseases (NCDs) emerging as leading causes of morbidity and mortality. This transition is particularly evident in developing countries such as India, where rapid urbanization, demographic changes and lifestyle transitions have contributed substantially to the growing burden of chronic diseases [1]. The Global Burden of Disease study estimated that NCDs accounted for approximately 62.7% of all deaths in India in 2016 [1]. Many cardiometabolic risk factors responsible for these diseases frequently occur together and are collectively recognized as

metabolic syndrome (MetS) [2]. Metabolic syndrome is a cluster of interrelated metabolic abnormalities characterized principally by central obesity, elevated blood pressure, impaired glucose metabolism, hypertriglyceridaemia and reduced high-density lipoprotein cholesterol (HDL-C) [3]. Several organizations have proposed diagnostic definitions, of which the International Diabetes Federation (IDF) and National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria are widely used [4,5]. The clinical importance of MetS lies in its ability to identify individuals at increased cardiometabolic risk. Individuals with MetS have been reported to

have approximately a five-fold greater risk of developing type 2 diabetes mellitus (T2DM) and a two-fold higher risk of cardiovascular disease (CVD) over the subsequent 5–10 years [3]. It has also been associated with increased risks of myocardial infarction, stroke and cardiovascular mortality [6]. Metabolic syndrome has become an important public health problem worldwide, although its prevalence varies considerably according to ethnicity, age, sex, socioeconomic status and diagnostic criteria. A study from the United States reported a prevalence of approximately 22.9%, [7] while Indian studies have reported prevalence estimates ranging from approximately 10% to 30% [8]. A multicity study involving 11 urban centres in India reported a prevalence of approximately 35%, highlighting the substantial burden among urban populations [9]. Rapid urbanization may increase the risk of MetS through profound changes in lifestyle and dietary behaviour. Physical inactivity, sedentary occupations, overweight and obesity, tobacco and alcohol use, psychological stress and inadequate sleep may contribute to insulin resistance and cardiometabolic abnormalities. Similarly, increased consumption of energy-dense and processed foods, refined carbohydrates, saturated fats, added sugars and salt, together with inadequate consumption of fruits, vegetables, whole grains and other fibre-rich foods, may promote central obesity, dyslipidaemia, hypertension and impaired glucose regulation [10,11]. Importantly, many of these determinants are modifiable and therefore represent potential targets for preventive interventions. Urban health centres provide an important opportunity for early detection of individuals with previously unrecognized central obesity, hypertension, dysglycaemia and dyslipidaemia. However, prevalence estimates and associated behavioural risk factors may vary substantially between populations, emphasizing the need for locally relevant evidence [11,12]. Therefore, the present study aims to determine the prevalence of metabolic syndrome and its association with lifestyle and dietary risk factors among adults attending an urban health centre.

Materials and Methods

The present study was conducted as a hospital-based cross-sectional observational study to determine the prevalence of metabolic syndrome and its association with lifestyle and dietary risk factors among adults attending an Urban Health Centre. The study was conducted at Department of Community Medicine of a tertiary care centre. Adult patients attending the Urban Health Centre during the study period were screened for eligibility and recruited according to the predefined inclusion and exclusion criteria. The study was conducted over a period of 18 months.

Study Population: The study population consisted of adult individuals attending the Urban Health Centre during the study period. Participants fulfilling the eligibility criteria and providing written informed consent were enrolled in the study. A total of 110 participants were included in the study. The final sample size for the study was therefore 110 adults.

Inclusion Criteria

Participants were included if they:

1. were aged 18 years or above;
2. attended the selected Urban Health Centre during the study period;
3. were willing to participate in the study; and
4. provided written informed consent.

Exclusion Criteria

Participants were excluded if they:

1. were pregnant;
2. were seriously ill or required immediate emergency medical care;
3. had a medical condition that prevented reliable anthropometric measurements;
4. were unable to provide the required information regarding lifestyle or dietary practices; or
5. declined to provide written informed consent.

Data Collection Procedure: After obtaining informed consent, each participant was interviewed using a pre-designed, pre-tested, structured questionnaire. Information regarding sociodemographic characteristics, relevant medical and family history, lifestyle behaviours and dietary practices was collected. The sociodemographic variables included age, sex, education, occupation, marital status and socioeconomic status. Relevant history of diabetes mellitus, hypertension, dyslipidaemia and cardiovascular disease was recorded. Family history of diabetes mellitus, hypertension and cardiovascular disease was also documented.

Assessment of Lifestyle Risk Factors: Lifestyle-related information included physical activity, sedentary behaviour, tobacco use, alcohol consumption and sleep duration. Participants were asked about the frequency, duration and type of routine physical activity and the average time spent in sedentary activities. Tobacco use was recorded according to current or previous use of smoking and/or smokeless tobacco. Alcohol consumption was documented according to the participant's reported consumption pattern. Average sleep duration per day was also recorded.

Physical activity status was categorized according to the predefined criteria used in the study questionnaire. Participants not meeting the

recommended level of physical activity were classified as having inadequate physical activity.

Assessment of Dietary Risk Factors: Dietary practices were assessed using a structured dietary questionnaire. Information was collected regarding the frequency of consumption of fruits, vegetables, whole grains, pulses, fried foods, processed or packaged foods, sweets, sugar-sweetened beverages and foods rich in saturated fats. Additional information regarding meal frequency, skipping of meals, snacking between meals and frequency of eating outside the home was recorded where applicable.

Anthropometric Measurements: Anthropometric measurements were obtained using standardized procedures.

Height: Height was measured with the participant standing erect without footwear, with the heels together and the head positioned in the Frankfurt horizontal plane. Height was recorded to the nearest 0.1 cm.

Weight: Body weight was measured using a calibrated weighing scale with the participant wearing light clothing and without footwear. Weight was recorded to the nearest 0.1 kg.

Body Mass Index: Body mass index (BMI) was calculated using the following formula:

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

Participants were subsequently categorized according to the BMI classification adopted for the study.

Waist Circumference: Waist circumference was measured using a non-stretchable measuring tape with the participant standing erect. Measurement was obtained at the midpoint between the lower margin of the last palpable rib and the top of the

iliac crest at the end of normal expiration. Waist circumference was recorded to the nearest 0.1 cm.

Measurement of Blood Pressure: Blood pressure was measured using a calibrated sphygmomanometer with the participant seated comfortably after at least 5 minutes of rest. An appropriately sized cuff was applied to the upper arm at heart level.

Two blood pressure measurements were obtained at an interval of approximately 5 minutes, and the average of the two readings was used for analysis. Systolic and diastolic blood pressures were recorded in mmHg.

Biochemical Assessment: Participants were instructed to maintain an overnight fast of approximately 8–12 hours before blood sample collection. Venous blood samples were collected under aseptic precautions.

The following biochemical parameters were assessed:

- Fasting plasma glucose (mg/dL)
- Serum triglycerides (mg/dL)
- High-density lipoprotein cholesterol (HDL-C) (mg/dL)

Biochemical investigations were performed in the designated laboratory using standardized laboratory procedures.

Definition of Metabolic Syndrome: Metabolic syndrome was diagnosed using the modified NCEP ATP III/harmonized criteria with Asian-specific waist circumference cut-offs.

A participant was considered to have metabolic syndrome when three or more of the following five criteria were present:

Component	Diagnostic criterion
Abdominal obesity	Waist circumference ≥ 90 cm in men or ≥ 80 cm in women
Elevated triglycerides	≥ 150 mg/dL or receiving treatment for elevated triglycerides
Reduced HDL-C	< 40 mg/dL in men or < 50 mg/dL in women, or receiving treatment
Elevated blood pressure	Systolic BP ≥ 130 mmHg and/or diastolic BP ≥ 85 mmHg, or receiving antihypertensive treatment
Elevated fasting glucose	Fasting plasma glucose ≥ 100 mg/dL or receiving treatment for diabetes/hyperglycaemia

Outcome Measures

Primary Outcome: The primary outcome was the prevalence of metabolic syndrome among adults attending the Urban Health Centre. Prevalence was calculated as:

$$\text{Prevalence of MetS (\%)} = (\text{Number of participants with MetS} / \text{Total number of participants studied}) \times 100$$

Secondary Outcomes: Secondary outcomes included the association of metabolic syndrome with:

- sociodemographic characteristics;
- BMI and central obesity;
- physical activity and sedentary behaviour;
- tobacco and alcohol use;
- sleep duration;
- fruit and vegetable consumption;

- consumption of fried, processed and energy-dense foods;
- sugar-sweetened beverage consumption; and
- other relevant dietary practices.

Data Management and Statistical Analysis: The collected data were entered into a Microsoft Excel spreadsheet, checked for completeness and consistency, and subsequently analysed using an SPSS. 26 statistical software package.

Categorical variables were presented as frequency (n) and percentage (%). Continuous variables were summarized as mean $\pm$ standard deviation (SD) when normally distributed and as median with interquartile range (IQR) when the distribution was non-normal.

The prevalence of metabolic syndrome was reported as a proportion with an appropriate 95% confidence interval (CI). The association between metabolic syndrome and categorical lifestyle, dietary and sociodemographic variables was assessed using the Chi-square test or Fisher's exact test, as appropriate.

Continuous variables between participants with and without metabolic syndrome were compared using the independent-samples Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables.

Variables demonstrating clinically relevant or statistically significant associations on univariate analysis were considered for binary logistic regression analysis to identify independent factors associated with metabolic syndrome. Results of regression analysis were expressed as odds ratios (ORs) and adjusted odds ratios (AORs) with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

Results

A total of 110 participants were included in the study. The mean age of the participants was 44.6 ± 13.2 years. The largest proportion belonged to the 41–50-year age group (26.4%), followed by 31–40 years (22.7%) and 51–60 years (21.8%). There were 58 (52.7%) males and 52 (47.3%) females. Regarding education, 26.4% were graduates or above, while 8.2% had no formal education. Nearly half of the participants (48.2%) had a sedentary occupation/activity pattern, and 41.8% belonged to the middle socioeconomic category. The detailed sociodemographic characteristics are presented in Table 1. The mean weight and height of the participants were 69.8 ± 11.6 kg and 163.9 ± 8.7 cm, respectively, with a mean BMI of 26.0 ± 4.1 kg/m². The mean waist circumference was 88.7 ± 10.8 cm. Mean systolic and diastolic blood pressures were 128.6 ± 15.4 mmHg and 81.9 ± 9.7 mmHg, respectively. Median fasting plasma

glucose was 101 mg/dL (IQR: 91–116), while median triglyceride level was 146 mg/dL (IQR: 112–184). Mean HDL-C was 43.8 ± 10.2 mg/dL. These anthropometric, clinical, and biochemical characteristics are summarized in Table 2. The overall prevalence of metabolic syndrome (MetS) was 35.5% (39/110), while 64.5% of participants did not have MetS. Among the individual components, abdominal obesity was the most prevalent abnormality (53.6%), followed by reduced HDL-C (51.8%), elevated triglycerides (43.6%), elevated blood pressure (40.0%), and elevated fasting plasma glucose (38.2%). The prevalence of MetS and its individual components is presented in Table 3 and Figure 1. Lifestyle characteristics showed significant associations with MetS. Inadequate physical activity was observed in 74.4% of participants with MetS compared with 45.1% without MetS ($p=0.003$). Similarly, high sedentary behaviour was more frequent among participants with MetS (64.1% vs 39.4%; $p=0.013$). Overweight/obesity was present in 79.5% of participants with MetS compared with 49.3% without MetS ($p=0.002$). Tobacco use ($p=0.229$), alcohol consumption ($p=0.196$), and sleep duration ($p=0.059$) were not significantly associated with MetS. The associations between lifestyle risk factors and MetS are detailed in Table 4 and Figure 2. Several dietary factors were also significantly associated with MetS. Inadequate fruit intake was more common among participants with MetS than those without MetS (69.2% vs 46.5%; $p=0.022$), as was inadequate vegetable intake (61.5% vs 39.4%; $p=0.026$). Frequent consumption of fried foods (64.1% vs 36.6%; $p=0.006$), processed/packaged foods (56.4% vs 32.4%; $p=0.014$), sugar-sweetened beverages (51.3% vs 29.6%; $p=0.024$), and high-fat foods (59.0% vs 38.0%; $p=0.034$) was significantly more common among participants with MetS. Frequent eating outside the home was higher in the MetS group (46.2% vs 32.4%), although the association was not statistically significant ($p=0.152$). These findings are presented in Table 5. On multivariable logistic regression analysis, overweight/obesity, inadequate physical activity, and frequent fried food consumption emerged as independent factors significantly associated with MetS. Overweight/obese participants had approximately three times greater adjusted odds of MetS (AOR 3.12; 95% CI: 1.18–8.27; $p=0.022$). Inadequate physical activity was associated with 2.68-fold higher adjusted odds (AOR 2.68; 95% CI: 1.05–6.84; $p=0.039$), while frequent fried food consumption was associated with 2.54-fold higher adjusted odds (AOR 2.54; 95% CI: 1.01–6.39; $p=0.048$). Age ≥ 45 years, high sedentary behaviour, inadequate fruit and vegetable intake, frequent processed food consumption, and frequent sugar-sweetened beverage intake did not remain statistically significant after adjustment. The crude

and adjusted associations are shown in Table 6 and Figure 3.

Table 1: Sociodemographic characteristics of study participants (N=110)

Characteristic	Category	N	%
Age (years)	18–30	18	16.4
	31–40	25	22.7
	41–50	29	26.4
	51–60	24	21.8
	>60	14	12.7
	Mean $\pm$ SD	44.6 $\pm$ 13.2 years	
Sex	Male	58	52.7
	Female	52	47.3
Education	No formal education	9	8.2
	Primary	17	15.5
	Secondary	30	27.3
	Higher secondary	25	22.7
	Graduate and above	29	26.4
Occupation/activity type	Sedentary	53	48.2
	Moderate activity	43	39.1
	Heavy activity	14	12.7
Socioeconomic status	Upper/Upper-middle	31	28.2
	Middle	46	41.8
	Lower-middle/Lower	33	30.0

Table 2: Anthropometric, clinical and biochemical characteristics

Parameter	Mean $\pm$ SD / Median (IQR)
Weight (kg)	69.8 $\pm$ 11.6
Height (cm)	163.9 $\pm$ 8.7
BMI (kg/m ²)	26.0 $\pm$ 4.1
Waist circumference (cm)	88.7 $\pm$ 10.8
Systolic BP (mmHg)	128.6 $\pm$ 15.4
Diastolic BP (mmHg)	81.9 $\pm$ 9.7
Fasting plasma glucose (mg/dL)	101 (91–116)
Triglycerides (mg/dL)	146 (112–184)
HDL-C (mg/dL)	43.8 $\pm$ 10.2

Table 3: Prevalence of metabolic syndrome and its individual components

Metabolic abnormality	n	%
Abdominal obesity	59	53.6
Elevated triglycerides	48	43.6
Reduced HDL-C	57	51.8
Elevated blood pressure	44	40.0
Elevated fasting plasma glucose	42	38.2
Metabolic syndrome present	39	35.5
Metabolic syndrome absent	71	64.5

Table 4: Association of lifestyle risk factors with metabolic syndrome

Risk factor	Category	MetS present (n=39)	MetS absent (n=71)	p-value
Physical activity	Adequate	10 (25.6%)	39 (54.9%)	0.003
	Inadequate	29 (74.4%)	32 (45.1%)	
Sedentary behaviour	Low	14 (35.9%)	43 (60.6%)	0.013
	High	25 (64.1%)	28 (39.4%)	
Tobacco use	No	28 (71.8%)	58 (81.7%)	0.229
	Yes	11 (28.2%)	13 (18.3%)	
Alcohol consumption	No	29 (74.4%)	60 (84.5%)	0.196
	Yes	10 (25.6%)	11 (15.5%)	
Sleep duration	≥ 7 h/day	18 (46.2%)	46 (64.8%)	0.059
	<7 h/day	21 (53.8%)	25 (35.2%)	
BMI category	Normal	8 (20.5%)	36 (50.7%)	0.002
	Overweight/obese	31 (79.5%)	35 (49.3%)	

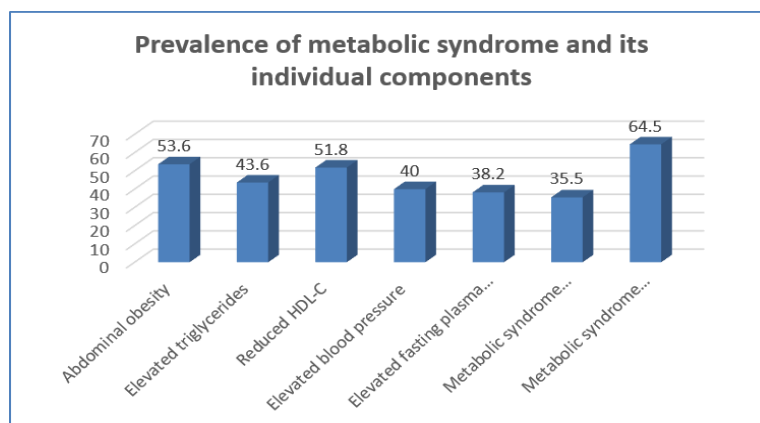


Figure 1: Prevalence of metabolic syndrome and its individual components

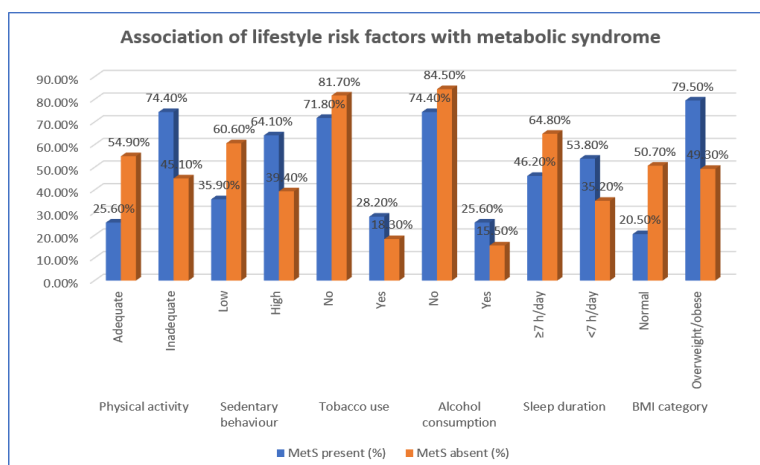


Figure 2: Association of lifestyle risk factors with metabolic syndrome

Table 5: Association of dietary risk factors with metabolic syndrome

Dietary factor	Category	MetS present (n=39)	MetS absent (n=71)	p-value
Fruit intake	Adequate	12 (30.8%)	38 (53.5%)	0.022
	Inadequate	27 (69.2%)	33 (46.5%)	
Vegetable intake	Adequate	15 (38.5%)	43 (60.6%)	0.026
	Inadequate	24 (61.5%)	28 (39.4%)	
Fried foods	Low	14 (35.9%)	45 (63.4%)	0.006
	Frequent	25 (64.1%)	26 (36.6%)	
Processed/packaged foods	Low	17 (43.6%)	48 (67.6%)	0.014
	Frequent	22 (56.4%)	23 (32.4%)	
Sugar-sweetened beverages	Low/None	19 (48.7%)	50 (70.4%)	0.024
	Frequent	20 (51.3%)	21 (29.6%)	
High-fat food intake	Low	16 (41.0%)	44 (62.0%)	0.034
	Frequent	23 (59.0%)	27 (38.0%)	
Eating outside home	Infrequent	21 (53.8%)	48 (67.6%)	0.152
	Frequent	18 (46.2%)	23 (32.4%)	

Table 6: Logistic regression analysis of factors associated with metabolic syndrome

Risk factor	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Age ≥45 years	2.31 (1.03–5.17)	1.86 (0.75–4.61)	0.181
Overweight/obesity	3.99 (1.62–9.82)	3.12 (1.18–8.27)	0.022
Inadequate physical activity	3.53 (1.48–8.41)	2.68 (1.05–6.84)	0.039
High sedentary behaviour	2.74 (1.22–6.15)	1.91 (0.76–4.80)	0.169
Inadequate fruit intake	2.59 (1.14–5.88)	1.73 (0.68–4.40)	0.250
Inadequate vegetable intake	2.46 (1.10–5.51)	1.59 (0.64–3.95)	0.319
Frequent fried food consumption	3.09 (1.37–6.96)	2.54 (1.01–6.39)	0.048
Frequent processed food consumption	2.70 (1.20–6.06)	1.88 (0.75–4.72)	0.179
Frequent sugar-sweetened beverages	2.51 (1.11–5.68)	1.72 (0.69–4.31)	0.246

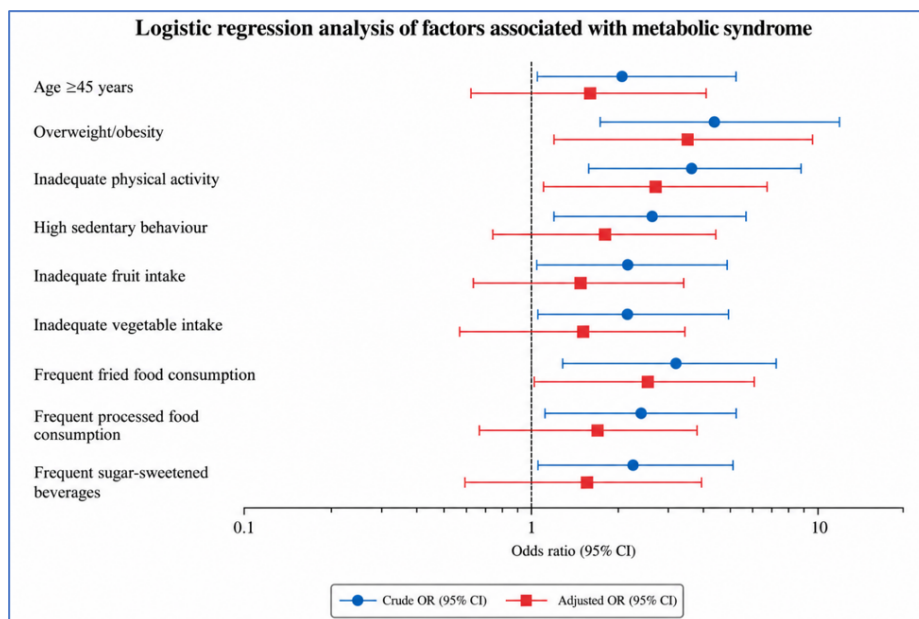


Figure 3: Logistic regression analysis of factors associated with metabolic syndrome

Discussion

The present study assessed the prevalence of metabolic syndrome (MetS) and its association with lifestyle and dietary risk factors among 110 adults attending an urban health centre. The mean age was 44.6 ± 13.2 years, with 52.7% males and 47.3% females. The mean BMI was 26.0 ± 4.1 kg/m² and mean waist circumference was 88.7 ± 10.8 cm, indicating a substantial burden of excess adiposity. MetS was present in 39 participants, giving a prevalence of 35.5%. This was comparable to Krishnamoorthy et al.[13], whose systematic review and meta-analysis of 111 Indian studies involving 133,926 participants reported a pooled MetS prevalence of 30% (95% CI: 28–33%), increasing to 32% among urban populations and 38% in facility-based studies. Similarly, Deedwania et al.[14], in a study of 6,198 adults from 11 Indian cities, reported an age-adjusted prevalence of 33.3% among men and 40.4% among women, supporting the high burden of MetS in urban India. Among MetS components, abdominal obesity was most prevalent (53.6%), followed by reduced HDL-C (51.8%), elevated triglycerides (43.6%), elevated blood pressure (40.0%), and elevated fasting plasma glucose (38.2%). Deedwania et al.[14] similarly documented abdominal obesity in 35.7% of men and 57.5% of women, and low HDL-C in 34.1% and 52.8%, respectively, highlighting central obesity and dyslipidaemia as major contributors to MetS. Lifestyle factors were significantly associated with MetS. Inadequate physical activity was more frequent among participants with MetS than those without MetS (74.4% vs 45.1%; $p=0.003$), as was high sedentary behaviour (64.1% vs 39.4%;

$p=0.013$). Inadequate physical activity remained independently associated with MetS (AOR 2.68; 95% CI: 1.05–6.84; $p=0.039$), consistent with Indian evidence showing increased odds of MetS among physically inactive individuals. Overweight/obesity showed the strongest association, being present in 79.5% of participants with MetS versus 49.3% without MetS ($p=0.002$).

It remained an independent predictor after adjustment (AOR 3.12; 95% CI: 1.18–8.27; $p=0.022$), emphasizing the central role of excess adiposity in MetS. Unhealthy dietary practices were also more frequent among MetS cases, including inadequate fruit (69.2% vs 46.5%; $p=0.022$) and vegetable intake (61.5% vs 39.4%; $p=0.026$), frequent fried-food consumption (64.1% vs 36.6%; $p=0.006$), processed/packaged foods (56.4% vs 32.4%; $p=0.014$), sugar-sweetened beverages (51.3% vs 29.6%; $p=0.024$), and high-fat foods (59.0% vs 38.0%; $p=0.034$). Frequent fried-food intake remained independently associated with MetS (AOR 2.54; 95% CI: 1.01–6.39; $p=0.048$). In contrast, tobacco ($p=0.229$) and alcohol consumption ($p=0.196$) were not significantly associated with MetS. Overall, the 35.5% prevalence of MetS and the independent associations with overweight/obesity, inadequate physical activity, and frequent fried-food consumption are consistent with Indian evidence.[13,14] These findings emphasize weight management, regular physical activity, reduced sedentary behaviour, and healthier dietary practices as important targets for MetS prevention in urban populations.

Conclusion

The present study demonstrated a high prevalence of metabolic syndrome (35.5%) among adults attending an urban health centre, with abdominal obesity (53.6%) and reduced HDL-C (51.8%) being the most frequent components. Metabolic syndrome was significantly associated with several modifiable lifestyle and dietary factors. Overweight/obesity (AOR 3.12), inadequate physical activity (AOR 2.68), and frequent fried-food consumption (AOR 2.54) emerged as independent predictors of MetS. These findings emphasize the need for routine screening, weight management, promotion of regular physical activity, and healthy dietary practices at the primary healthcare level. Early identification and modification of these risk factors may help reduce the subsequent burden of type 2 diabetes and cardiovascular disease.

Limitations

The study was limited by its cross-sectional design, which prevented establishment of causal relationships between lifestyle or dietary factors and metabolic syndrome. The relatively small sample size (N=110) and single-centre setting may limit the generalizability of the findings. Lifestyle and dietary information was largely self-reported and was therefore susceptible to recall and reporting bias. Additionally, residual confounding from unmeasured genetic, socioeconomic, and behavioural factors could not be completely excluded.

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