fortune Journals

Research Article

ARCHIVES OF INTERNAL MEDICINE RESEARCH

ISSN: 2688-5654



Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study

Hanu Kamal Hossain[1], Naima Jannat Shabrina Haque[2], Mst Mahfuza Akter[3], Samia Hossain[4], Afia Tabassum Raisa[4], Ummey Maimuna[5], Esmat Ara[6], Momtaj Maksuda[7*]

Abstract

Background: Metabolic syndrome (MetS) is a cluster of interrelated cardiometabolic abnormalities, including central adiposity, dysglycemia, dyslipidemia, and elevated blood pressure, that increases the risk of cardiovascular disease and type 2 diabetes mellitus. Identifying patterns of cardiometabolic risk is important for early detection and prevention. This study assessed cardiometabolic characteristics and their associations with MetS among adults attending a hospital-based setting in Bangladesh.

Objective: To assess cardiometabolic risk profiles and factors associated with metabolic syndrome among adults using anthropometric, glycemic, lipid, blood pressure, and sociodemographic characteristics.

Methods: A hospital-based cross-sectional study was conducted among 500 participants in a tertiary-care hospital in Savar, Dhaka, Bangladesh. Sociodemographic, anthropometric, glycemic, lipid, and blood pressure data were analyzed, including age, sex, BMI, waist circumference, random blood sugar, total cholesterol, triglycerides, LDL-C, HDL-C, systolic and diastolic blood pressure, marital status, education, and work status. MetS was the primary outcome. Categorical and continuous variables were compared using the chi-square test and independent-samples t-test, respectively. Associations with MetS were assessed using multivariable logistic regression, reporting adjusted odds ratios (aORs) with 95% confidence intervals (CIs). A two-sided $p<0.05$ was considered statistically significant.

Results: Among 500 participants, 75 (15.0%) had metabolic syndrome (MetS). Participants with MetS had significantly higher waist circumference (99.78 ± 14.01 vs. 86.11 ± 12.40 cm), BMI (27.87 ± 4.44 vs. 24.37 ± 6.57 kg/m²), random blood glucose (6.05 ± 3.62 vs. 4.74 ± 1.37 mmol/L), triglycerides (3.05 ± 1.74 vs. 1.52 ± 0.97 mmol/L), systolic BP (129.19 ± 15.98 vs. 116.55 ± 13.90 mmHg), and diastolic BP (86.76 ± 10.87 vs. 73.65 ± 10.08 mmHg), while HDL-C was lower (1.08 ± 0.52 vs. 1.30 ± 0.47 mmol/L); all differences were statistically significant. MetS prevalence increased from 6.9% in normal-weight participants to 26.1% in overweight and 30.6% in obese participants ($p<0.001$), and from 10.7% among those aged 20–35 years to 42.9% among those aged 51–65 years ($p<0.001$). Triglycerides showed the strongest correlation with MetS ($r=0.440$), followed by diastolic blood pressure ($r=0.418$) and waist circumference ($r=0.358$), all $p<0.001$. Gender was also significantly associated with MetS, with a higher proportion of males among MetS participants ($p<0.001$).

Conclusion: Metabolic syndrome was associated with an adverse cardiometabolic profile, particularly higher adiposity, triglycerides, blood pressure, and glucose, together with lower HDL-C. The findings emphasize the importance of early cardiometabolic screening and timely risk-factor management in clinical settings.

Affiliation:

[1]Faculty of Medical Studies, Bangladesh University of Professionals, Dhaka, Bangladesh

[2]Department of Stroke Unit, National Institute of Neuroscience & Hospital, Dhaka, Bangladesh

[3]Faculty of Nursing, Dhaka Central International Nursing College and Institute, Dhaka, Bangladesh

[4]Faculty of Nursing, Dynamic Nursing College, Dhaka, Bangladesh

[5]Department of Medicine, Cox's Bazar Sadar Hospital, Cox's Bazar, Bangladesh

[6]Department of Cardiology, Delta Hospital Limited, Dhaka, Bangladesh

[7]Faculty of Nursing, CARE Nursing College, Dhaka, Bangladesh

***Corresponding author:**
Momtaj Maksuda, Vice Principal, Faculty of Nursing, CARE Nursing College, Dhaka, Bangladesh.

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.

Received: September 21, 2026
Accepted: October 05, 2026
Published: November 02, 2026

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

Keywords: Metabolic syndrome; Cardiometabolic risk; Central adiposity; Dyslipidemia; Cardiovascular risk

Introduction

Metabolic syndrome (MetS) is a complex cardiometabolic condition characterized by the coexistence of multiple interrelated metabolic abnormalities, including central adiposity, impaired glucose regulation, elevated blood pressure, hypertriglyceridemia, and reduced high-density lipoprotein cholesterol (HDL-C) [1,2]. Rather than representing a single disease entity, MetS reflects the clustering of metabolic disturbances that arise from overlapping biological and lifestyle-related mechanisms. This clustering has important clinical implications because individuals with MetS are at substantially increased risk of cardiovascular disease, type 2 diabetes mellitus, and other chronic health complications [3]. A large systematic review and meta-analysis involving more than 950,000 individuals found that MetS was associated with approximately a two-fold higher risk of cardiovascular disease and cardiovascular mortality [4]. The global burden of MetS has increased considerably over recent decades, paralleling the worldwide rise in obesity, physical inactivity, hypertension, dysglycemia, and lipid abnormalities. A recent systematic review and modelling analysis of more than 45 million adults estimated that approximately 1.54 billion adults worldwide had MetS in 2023, with prevalence increasing substantially between 2000 and 2023 across both sexes [4-6]. The burden also varied according to age, geographic region, and degree of urbanization. More recent global evidence suggests that prevalence estimates generally range between approximately 19% and 31%, with South Asian populations reporting particularly high levels of MetS. These trends highlight the growing importance of systematic identification of cardiometabolic risk profiles before progression to established cardiovascular and metabolic diseases [7,8]. The development of MetS is multifactorial and involves the interaction of anthropometric, metabolic, hemodynamic, behavioral, and sociodemographic determinants. Central adiposity is particularly important because visceral fat accumulation is closely related to insulin resistance, abnormal lipid metabolism, systemic inflammation, and elevated blood pressure [9]. Similarly, hypertriglyceridemia, low HDL-C, elevated glucose concentrations, and increased blood pressure frequently occur together and contribute to an adverse cardiometabolic phenotype [10]. The World Health Organization identifies raised blood pressure, overweight/obesity, elevated blood glucose, and abnormal blood lipids as major metabolic risk factors underlying the global burden of noncommunicable diseases [11]. This issue is particularly relevant in South Asian populations, who may develop cardiometabolic abnormalities at comparatively lower levels of adiposity and are experiencing rapid transitions in dietary patterns, physical activity, urbanization, and socioeconomic conditions [12]. Bangladesh is undergoing a substantial epidemiological transition, with noncommunicable diseases increasingly contributing to morbidity and mortality. Previous evidence from Bangladesh has demonstrated a considerable burden of cardiovascular risk factors, including hypertension, diabetes, and dyslipidemia, with important differences according to urbanization and population characteristics [13]. A systematic review and meta-analysis of Bangladeshi studies reported an overall pooled prevalence of MetS of approximately 30%, although substantial heterogeneity was observed according to diagnostic criteria, geographic setting, and participant characteristics [14]. Despite this growing burden, cardiometabolic risk factors are often evaluated individually rather than as an interconnected risk profile. Assessment of waist circumference and BMI alongside glycemic status, lipid parameters, and blood pressure may provide a more comprehensive understanding of the metabolic phenotype associated with MetS. Furthermore, age, sex, educational attainment, marital status, and employment status may influence the distribution of cardiometabolic risk and should be considered when characterizing population-level risk patterns. A multidimensional assessment may therefore help identify subgroups with a greater concentration of metabolic abnormalities and inform opportunities for earlier risk stratification and preventive intervention. Therefore, this study aimed to assess cardiometabolic risk profiles and identify factors associated with metabolic syndrome among adults in a hospital-based setting.

Methods

A hospital-based cross-sectional study was conducted at a tertiary care hospital in Savar, Dhaka, Bangladesh, from June 2023 to June 2025. A total of 500 participants were included in the analysis based on the availability of complete information on the study variables. Sociodemographic characteristics included age, gender, marital status, education level, and work status. For analysis, age was categorized into 20–35, 36–50, 51–65, and 66–80 years. Gender was classified as male or female. Marital status was categorized as married, unmarried/never married, and widowed/separated/divorced, while educational attainment was classified as primary (Classes 1–9), secondary (Classes 10–12), and tertiary (>Class 12). Employment status was categorized as unemployed, self-employed, and formally employed [10]. Anthropometric assessment included body mass index (BMI) and waist circumference. BMI was calculated from recorded height and weight and categorized as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²). Cardiometabolic parameters included random blood sugar (RBS), total cholesterol, triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), systolic blood pressure (SBP), and diastolic blood pressure (DBP). These

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

parameters were evaluated to characterize the participants' overall cardiometabolic profile [12]. Metabolic syndrome (MetS) was the primary outcome, defined according to the predefined diagnostic criteria applied in the study. The associations of sociodemographic, anthropometric, glycemic, lipid, and blood pressure characteristics with MetS were subsequently evaluated [13]. Continuous variables were presented as mean ± standard deviation (SD) and categorical variables as frequency and percentage. Differences between MetS groups were assessed using the independent samples t-test for continuous variables and chi-square test for categorical variables. Multivariable logistic regression was used to identify factors independently associated with MetS, with results expressed as adjusted odds ratios (aORs) and 95% confidence intervals (CIs). A two-sided $p<0.05$ was considered statistically significant. Statistical analysis was performed using SPSS.

Results

As presented in Table 1, a total of 500 participants were included in the analysis. The mean waist circumference was 88.13 ± 13.54 cm, while the mean BMI was 24.90 ± 6.42 kg/m². The mean RBS concentration was 4.94 ± 1.93 mmol/L. Among the lipid parameters, the mean total cholesterol, TG, LDL-C, and HDL-C concentrations were 4.47 ± 1.90, 1.75 ± 1.24, 2.94 ± 0.89, and 1.26 ± 0.48 mmol/L, respectively. The mean systolic and diastolic blood pressures were 118.45 ± 14.92 mmHg and 75.62 ± 11.22 mmHg, respectively. Overall, 75 (15.0%) participants were identified as having MetS, whereas 425 (85.0%) did not.

Table 1: Overall Sociodemographic and Cardiometabolic Characteristics of the Study Participants (n=500).

Variable	Number (N)	Mean ± SD
Waist circumference (cm)	495	88.13 ± 13.54
RBS (mmol/L)	499	4.94 ± 1.93
Total cholesterol (mmol/L)	500	4.47 ± 1.90
TG (mmol/L)	498	1.75 ± 1.24
LDL-C (mmol/L)	500	2.94 ± 0.89
HDL-C (mmol/L)	500	1.26 ± 0.48
Systolic BP (mmHg)	500	118.45 ± 14.92
Diastolic BP (mmHg)	500	75.62 ± 11.22
BMI (kg/m²)	496	24.90 ± 6.42

As shown in Table 2, participants with MetS demonstrated significantly less favorable cardiometabolic profiles than those without MetS. Mean waist circumference was substantially higher among participants with MetS (99.78 ± 14.01 vs. 86.11 ± 12.40 cm; $p<0.001$). Similarly, BMI was significantly higher in the MetS group (27.87 ± 4.44 vs. 24.37 ± 6.57 kg/m²; $p<0.001$). The mean RBS concentration was also significantly higher among participants with MetS (6.05 ± 3.62 vs. 4.74 ± 1.37 mmol/L; $p=0.003$). Significant differences were observed across lipid parameters. Total cholesterol was higher in the MetS group (4.87 ± 1.13 vs. 4.40 ± 2.00 mmol/L; $p=0.005$), as were TG (3.05 ± 1.74 vs. 1.52 ± 0.97 mmol/L; $p<0.001$) and LDL-C (3.25 ± 1.00 vs. 2.88 ± 0.86 mmol/L; $p=0.004$). In contrast, HDL-C was significantly lower among participants with MetS (1.08 ± 0.52 vs. 1.30 ± 0.47 mmol/L; $p=0.001$). Blood pressure also differed significantly between the two groups. Participants with MetS had higher mean systolic blood pressure (129.19 ± 15.98 vs. 116.55 ± 13.90 mmHg; $p<0.001$) and diastolic blood pressure (86.76 ± 10.87 vs. 73.65 ± 10.08 mmHg; $p<0.001$).

Table 2: Comparison of Cardiometabolic Parameters According to Metabolic Syndrome Status.

Variable	No MetS (n=425), Mean ± SD	MetS (n=75), Mean ± SD	p
Waist circumference (cm)	86.11 ± 12.40	99.78 ± 14.01	<0.001
RBS (mmol/L)	4.74 ± 1.37	6.05 ± 3.62	0.003
Total cholesterol (mmol/L)	4.40 ± 2.00	4.87 ± 1.13	0.005
TG (mmol/L)	1.52 ± 0.97	3.05 ± 1.74	<0.001
LDL-C (mmol/L)	2.88 ± 0.86	3.25 ± 1.00	0.004
HDL-C (mmol/L)	1.30 ± 0.47	1.08 ± 0.52	0.001
Systolic BP (mmHg)	116.55 ± 13.90	129.19 ± 15.98	<0.001
Diastolic BP (mmHg)	73.65 ± 10.08	86.76 ± 10.87	<0.001
BMI (kg/m²)	24.37 ± 6.57	27.87 ± 4.44	<0.001

The distribution of sociodemographic characteristics according to MetS status is presented in Table 3. A significant association was observed between gender and MetS ($p<0.001$). Males accounted for 60.0% (45/75) of participants with MetS compared with 35.3% (150/425) of those without MetS. Age was also significantly associated with MetS ($p<0.001$). Among participants with MetS, 42.7% (32/75) were aged 20–35 years, 33.3% (25/75) were aged 36–50 years, and 24.0% (18/75) were aged 51–65 years. In comparison, these proportions among participants without MetS were 62.6%, 31.3%, and 5.6%, respectively. Marital status showed a significant association with MetS ($p<0.001$), with married participants comprising 65.3% (49/75) of the MetS group compared with 39.5% (168/425) of the non-MetS group. Educational attainment was also significantly associated with MetS ($p=0.047$), while work status showed a significant association ($p=0.023$). A particularly strong association was observed between BMI category and MetS ($p<0.001$). Among participants with MetS, 46.7% were overweight and 29.3% were obese, compared with 23.3% and 11.8%, respectively, among those without MetS.

As demonstrated in Table 4, the prevalence of MetS increased progressively with increasing BMI category. No MetS cases were observed among the 28 underweight

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

participants. MetS was present in 18 of 259 normal-weight participants (6.9%), increasing to 35 of 134 overweight participants (26.1%) and 22 of 72 obese participants (30.6%). The association between BMI category and MetS was highly significant (χ^2 test, $p<0.001$).

According to Table 5, MetS prevalence increased substantially across the younger and middle-aged groups. MetS was identified in 32 of 298 participants (10.7%) aged 20–35 years, compared with 25 of 158 (15.8%) among those aged 36–50 years. The prevalence increased markedly to 18 of 42 participants (42.9%) among those aged 51–65 years. No MetS cases were observed among the two participants aged 66–80 years. The overall association between age group and MetS was statistically significant ($p<0.001$).

Figure 1 demonstrates the increasing prevalence of MetS with higher BMI categories, from 6.9% among normal-weight participants to 26.1% among overweight and 30.6% among obese participants.

The Pearson correlation matrix is presented in Table 6. BMI demonstrated a strong positive correlation with waist circumference (r=0.590). Systolic and diastolic blood pressure were also strongly correlated (r=0.598). Total cholesterol showed a moderate positive correlation with LDL-C (r=0.457). Waist circumference was positively correlated with diastolic blood pressure (r=0.347) and TG (r=0.196). TG demonstrated a negative correlation with HDL-C (r=0.287), indicating that higher triglyceride concentrations tended to occur alongside lower HDL-C concentrations. BMI also showed positive correlations with diastolic blood pressure (r=0.297) and LDL-C (r=0.212).

Table 3: Sociodemographic and BMI Characteristics According to Metabolic Syndrome Status.

Variable	Category	No MetS, n (%)	MetS, n (%)	*p*
Gender	Male	150 (35.3)	45 (60.0)	<0.001
	Female	275 (64.7)	30 (40.0)	
Age	20–35 years	266 (62.6)	32 (42.7)	<0.001
	36–50 years	133 (31.3)	25 (33.3)	
	51–65 years	24 (5.6)	18 (24.0)	
	66–80 years	2 (0.5)	0 (0.0)	
Marital status	Married	168 (39.5)	49 (65.3)	<0.001
	Unmarried/Never married	186 (43.8)	18 (24.0)	
	Widow/Separated/Divorced	70 (16.5)	8 (10.7)	
Education	Primary	93 (21.9)	24 (32.0)	0.047
	Secondary	125 (29.4)	20 (26.7)	
	Tertiary	186 (43.8)	22 (29.3)	
Work status	Unemployed	171 (40.2)	20 (26.7)	0.023
	Self-employed	124 (29.2)	33 (44.0)	
	Formal	130 (30.6)	22 (29.3)	
BMI status	Underweight	28 (6.6)	0 (0.0)	<0.001
	Normal	241 (56.7)	18 (24.0)	
	Overweight	99 (23.3)	35 (46.7)	
	Obese	50 (11.8)	22 (29.3)	

Table 4: Prevalence of Metabolic Syndrome Across BMI Categories.

BMI category	Total, n	MetS, n	MetS prevalence (%)
Underweight	28	0	0
Normal	259	18	6.9
Overweight	134	35	26.1
Obese	72	22	30.6

• $p<0.001$

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

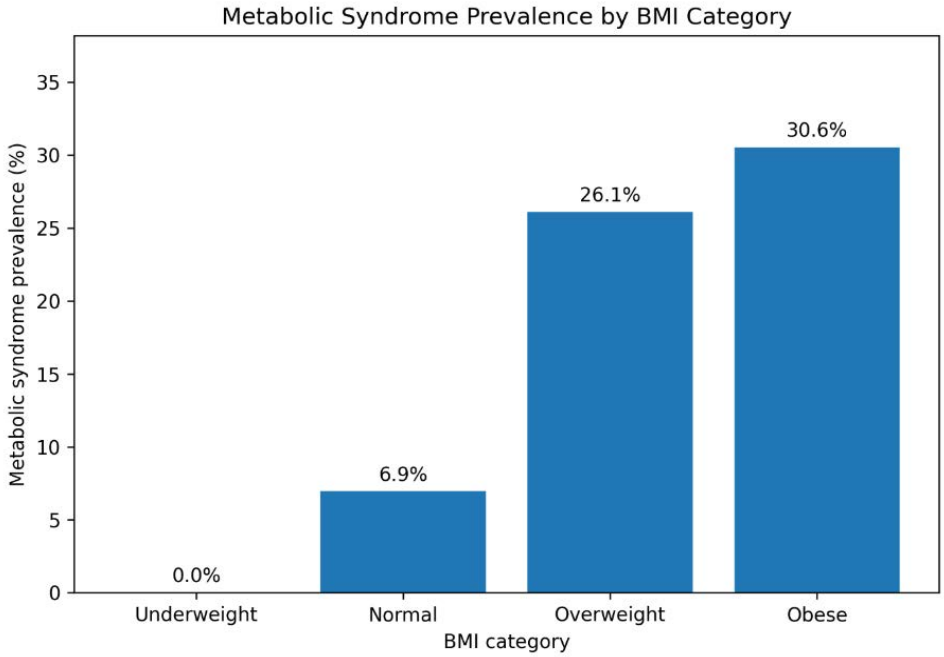


Figure 1: Metabolic Syndrome Prevalence Across BMI Categories.

Table 5: Age-Specific Prevalence of Metabolic Syndrome.

Age group	Total, n	MetS, n	MetS prevalence (%)
20–35 years	298	32	10.7
36–50 years	158	25	15.8
51–65 years	42	18	42.9
66–80 years	2	0	0

• $p<0.001$

Table 6: Pearson Correlation Matrix of Cardiometabolic Parameters.

Variable	Waist	RBS	Chol	TG	LDL	HDL	SBP	DBP	BMI
Waist	1	0.14	0.082	0.196	0.172	-0.088	0.187	0.347	0.59
RBS	0.14	1	0.047	0.121	0.19	0.003	0.132	0.113	0.102
Cholesterol	0.082	0.047	1	0.134	0.457	0.11	0.039	0.052	0.096
TG	0.196	0.121	0.134	1	0.053	-0.287	0.128	0.247	0.114
LDL	0.172	0.19	0.457	0.053	1	0.119	0.112	0.142	0.212
HDL	-0.088	0.003	0.11	-0.287	0.119	1	0.001	-0.05	-0.029
SBP	0.187	0.132	0.039	0.128	0.112	0.001	1	0.598	0.073
DBP	0.347	0.113	0.052	0.247	0.142	-0.05	0.598	1	0.297
BMI	0.59	0.102	0.096	0.114	0.212	-0.029	0.073	0.297	1

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

As shown in Table 7, several cardiometabolic parameters demonstrated significant associations with MetS. The strongest positive correlation was observed for TG (r=0.440; p<0.001), followed by diastolic blood pressure (r=0.418; p<0.001) and waist circumference (r=0.358; p<0.001). Systolic blood pressure was also positively correlated with MetS (r=0.303; p<0.001). RBS demonstrated a positive association with MetS (r=0.240; p<0.001), while BMI showed a weaker but significant positive correlation (r=0.196; p<0.001). LDL-C was positively correlated with MetS (r=0.147; p=0.001), whereas HDL-C showed a significant inverse correlation (r=−0.160; p<0.001). The correlation between total cholesterol and MetS was weak and borderline significant (r=0.088; p=0.050).

Table 7: Correlation of Cardiometabolic Variables with Metabolic Syndrome.

Variable	Point-biserial *r*	*p*
Waist circumference	0.358	<0.001
RBS	0.24	<0.001
Total cholesterol	0.088	0.05
TG	0.44	<0.001
LDL-C	0.147	0.001
HDL-C	−0.160	<0.001
Systolic BP	0.303	<0.001
Diastolic BP	0.418	<0.001
BMI	0.196	<0.001

Figure 2 presents the relationship between waist circumference and TG concentration. A positive correlation was observed, indicating that greater central adiposity was associated with higher triglyceride concentrations.

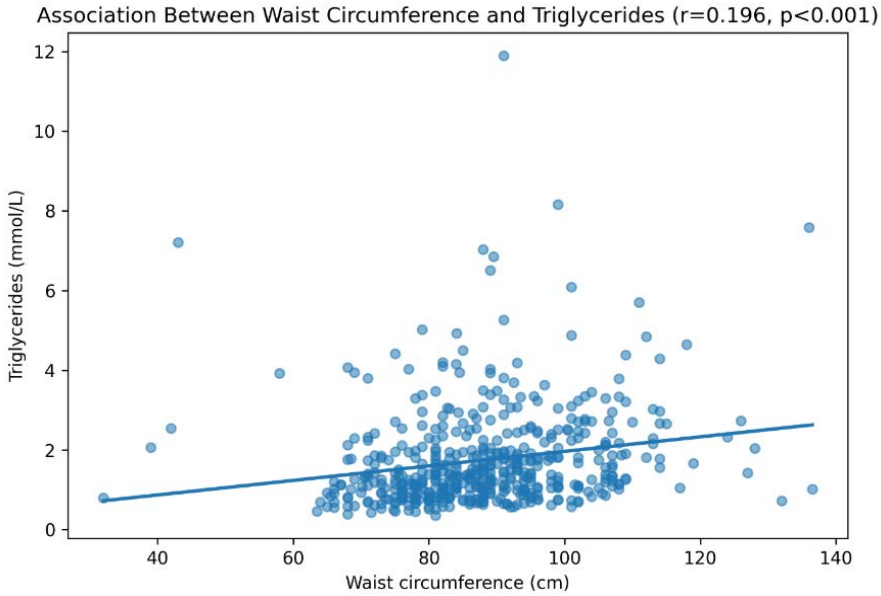


Figure 2: Relationship Between Waist Circumference and Triglycerides.

Figure 3 illustrates the relationship between diastolic blood pressure and TG concentration, showing a positive association between these two cardiometabolic parameters.

Discussion

The observed prevalence of MetS (15.0%) is lower than the approximately 30% pooled prevalence reported in a systematic review and meta-analysis of studies conducted in Bangladesh. However, direct comparison should be made cautiously because the previous review incorporated studies with substantial heterogeneity in age distribution, geographic setting, participant characteristics, sampling methods, and diagnostic criteria. The pooled prevalence also varied considerably according to the definition used, ranging from approximately 20% with WHO criteria to 37% with modified NCEP-ATP III criteria. The lower prevalence observed in the present study may therefore partly reflect differences in the study population and diagnostic framework rather than indicating a lower underlying cardiometabolic burden in the Bangladeshi population. Previous Bangladeshi studies have likewise demonstrated considerable variation in MetS prevalence. For example, a community-based study of Bangladeshi adults reported an overall prevalence of 45.5%, while a recent rural Bangladeshi study reported a prevalence of 30.7% using modified NCEP-ATP III criteria. These findings reinforce the importance of interpreting MetS prevalence in relation to the characteristics and diagnostic

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

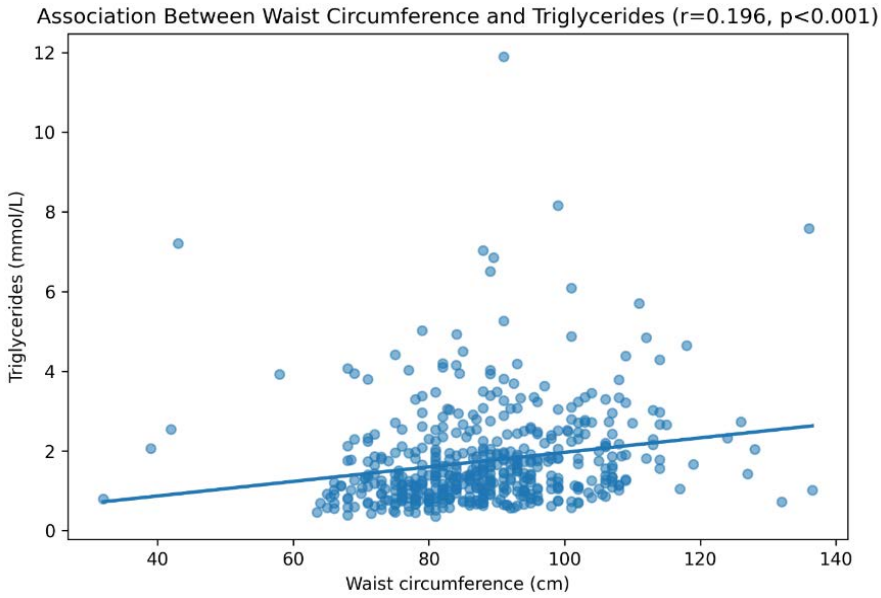


Figure 3: Relationship Between Diastolic Blood Pressure and Triglycerides.

criteria of the population studied [15]. A particularly important finding was the markedly unfavorable anthropometric profile among participants with MetS. Mean waist circumference was 99.78 ± 14.01 cm in the MetS group compared with 86.11 ± 12.40 cm among participants without MetS, while mean BMI was 27.87 ± 4.44 versus 24.37 ± 6.57 kg/m², respectively. The correlation analysis further demonstrated a positive association between waist circumference and MetS (r=0.358, p<0.001), while BMI showed a weaker but statistically significant association (r=0.196, p<0.001). Importantly, MetS prevalence increased progressively across BMI categories, from 6.9% among normal-weight participants to 26.1% among overweight and 30.6% among obese participants. This pattern supports the central role of excess adiposity in the clustering of metabolic abnormalities. The strong correlation between BMI and waist circumference (r=0.590) also suggests that overall adiposity and central adiposity were closely related in this population, although waist circumference appeared more strongly associated with MetS than BMI [16]. The importance of central adiposity is particularly relevant in South Asian populations. Recent evidence from rural Bangladesh identified optimal waist circumference thresholds of approximately 90 cm for men and 80 cm for women for identifying MetS, with substantial associations between elevated waist circumference and MetS. Earlier Bangladeshi research has also shown that the prevalence of MetS can change substantially depending on the waist circumference threshold applied, emphasizing the importance of population-specific definitions [17]. Thus, the strong relationship between waist circumference and MetS observed in the present study is biologically and epidemiologically plausible and highlights the potential value of routine central-adiposity assessment during cardiometabolic screening. The lipid profile demonstrated another important component of the MetS phenotype. Participants with MetS had substantially higher triglyceride concentrations than those without MetS (3.05 ± 1.74 vs. 1.52 ± 0.97 mmol/L; p<0.001), while HDL-C was significantly lower (1.08 ± 0.52 vs. 1.30 ± 0.47 mmol/L; p=0.001). Triglycerides showed the strongest point-biserial correlation with MetS in the present analysis (r=0.440, p<0.001), whereas HDL-C showed an inverse relationship (r=−0.160, p<0.001). The scatter-plot analysis also demonstrated a positive relationship between waist circumference and triglyceride concentration (r=0.196, p<0.001), suggesting that increasing central adiposity tended to accompany a more adverse triglyceride profile. This pattern is consistent with the established metabolic clustering of abdominal adiposity, hypertriglyceridemia, and reduced HDL-C. Similar findings have been documented in Bangladesh, where low HDL-C and elevated triglycerides have repeatedly emerged as prominent components of MetS. A systematic review reported low HDL-C as one of the most frequently observed MetS components in Bangladeshi populations, while a rural Bangladeshi study reported high triglycerides in 30.4% and low HDL-C in 92.2% of participants [18].

The observed relationship between triglycerides and MetS may also reflect broader metabolic disturbances associated with insulin resistance. Central adiposity can promote increased release of free fatty acids and alter hepatic lipid metabolism, favoring hepatic triglyceride synthesis and the development of atherogenic dyslipidemia. The inverse correlation between triglycerides and HDL-C in the present study (r=−0.287) provides additional evidence of this interconnected lipid pattern. Nevertheless, because

Hossain HK, et al., Arch Intern Med Res 2026
DOI:10.26502/aimr.0261

the study is cross-sectional, these associations should be interpreted as clustering or relationships rather than evidence that increased waist circumference or triglycerides independently caused MetS [19].

Blood pressure was another major feature distinguishing participants with and without MetS. Mean systolic blood pressure was 129.19 ± 15.98 mmHg among participants with MetS compared with 116.55 ± 13.90 mmHg among those without MetS, while mean diastolic blood pressure was 86.76 ± 10.87 versus 73.65 ± 10.08 mmHg, respectively. Diastolic blood pressure showed a particularly strong positive correlation with MetS ($r=0.418$, $p<0.001$), second only to triglycerides, while systolic blood pressure also demonstrated a significant association ($r=0.303$, $p<0.001$). Furthermore, diastolic blood pressure was positively correlated with triglycerides ($r=0.247$, $p<0.001$), and the scatter-plot analysis demonstrated a positive relationship between these two parameters. These findings indicate that elevated blood pressure and dyslipidemia were not isolated abnormalities in this population but tended to occur within a broader cardiometabolic risk pattern. Previous Bangladeshi studies have similarly identified elevated blood pressure as a common component of MetS [20,21]. The association between age and MetS was also pronounced. The prevalence increased from 10.7% among participants aged 20–35 years to 15.8% among those aged 36–50 years and 42.9% among those aged 51–65 years. Although only 42 participants were in the 51–65-year group, the marked increase in MetS prevalence in this age category is consistent with the broader epidemiological observation that cardiometabolic risk accumulates with advancing age. A systematic review of Bangladeshi studies found that MetS prevalence generally increased with increasing mean age, with substantially higher pooled prevalence among studies involving older populations [21]. A recent Bangladeshi cross-sectional study similarly reported a progressive increase in MetS and its components across age groups. The age gradient observed in the present study therefore supports the importance of earlier identification of cardiometabolic risk before multiple abnormalities become established. However, the very small number of participants aged 66–80 years in the present dataset means that the absence of MetS in this group should not be interpreted as evidence of lower risk [22]. Sex differences were also evident. Males represented 60.0% of the MetS group compared with 35.3% of the non-MetS group, and gender was significantly associated with MetS ($p<0.001$). This finding differs from several earlier Bangladeshi population-based studies in which MetS prevalence was higher among women. The Bangladesh systematic review reported a pooled prevalence of 32% among females compared with 25% among males, although the difference was not statistically significant at the meta-regression level. Similarly, several studies included in that review reported higher MetS prevalence among women, particularly in rural populations. In contrast, a recent rural Bangladeshi study found similar overall prevalence between men and women, although individual components differed by sex. The higher representation of men among MetS cases in the present study may therefore reflect differences in the study population, healthcare-seeking behavior, occupational or lifestyle characteristics, age distribution, and the hospital-based nature of the sample [18,22]. Importantly, the present findings demonstrate an association with sex within this particular sample and should not be generalized to the wider Bangladeshi population without population-based confirmation.

Marital status, educational attainment, and employment status were also statistically associated with MetS in the present analysis. Married participants constituted 65.3% of the MetS group compared with 39.5% of the non-MetS group, while self-employed participants represented 44.0% of the MetS group compared with 29.2% of the non-MetS group. Education and work status also showed statistically significant differences. These associations may reflect differences in age, household structure, occupational activity, socioeconomic circumstances, dietary behavior, or healthcare utilization. However, because the current analysis is cross-sectional and these variables were not evaluated within a fully adjusted causal framework, the observed associations should be interpreted cautiously. Statistical significance alone does not establish that marital status, education, or employment independently determines MetS [23]. The correlation analysis further demonstrates that the cardiometabolic variables formed an interconnected network rather than acting independently. Waist circumference correlated positively with diastolic blood pressure ($r=0.347$) and triglycerides ($r=0.196$), while BMI correlated with diastolic blood pressure ($r=0.297$) and LDL-C ($r=0.212$). Total cholesterol and LDL-C showed a moderate positive correlation ($r=0.457$), and systolic and diastolic blood pressure were strongly correlated ($r=0.598$). The inverse relationship between triglycerides and HDL-C ($r=-0.287$) is particularly consistent with the dyslipidemic pattern typically accompanying cardiometabolic risk. These interrelationships support the concept that MetS represents a clustering of mutually related metabolic and hemodynamic abnormalities rather than a collection of unrelated risk factors [24]. An important observation from the present study is that random blood glucose was significantly higher among participants with MetS (6.05 ± 3.62 vs. 4.74 ± 1.37 mmol/L; $p=0.003$) and demonstrated a positive correlation with MetS ($r=0.240$, $p<0.001$). Although the strength of this relationship was lower than that observed for triglycerides, diastolic blood pressure, and waist circumference, the finding is consistent with the role of abnormal glucose regulation within the MetS phenotype. Previous Bangladeshi studies have also identified elevated glucose as an important component of MetS. The relatively modest association in the present study

may partly reflect the use of random blood glucose rather than fasting glucose, which can introduce greater biological and measurement variability. Therefore, the present findings should not be interpreted as an estimate of impaired fasting glucose or diabetes prevalence.

Conclusion

This hospital-based cross-sectional study demonstrated a substantial clustering of cardiometabolic risk factors among adults, with metabolic syndrome identified in 15.0% of participants. MetS was characterized by greater central adiposity and BMI, higher random blood glucose, triglycerides, total cholesterol, LDL-C, and blood pressure, together with lower HDL-C. Triglycerides, diastolic blood pressure, and waist circumference showed the strongest associations with MetS, while its prevalence increased markedly across higher BMI and older age groups. These findings highlight the importance of early identification of clustered cardiometabolic abnormalities through routine assessment of waist circumference, BMI, blood pressure, glucose, and lipid parameters. Strengthening preventive screening and timely lifestyle and risk-factor management may help reduce the future burden of cardiometabolic disease in similar clinical populations.

Limitations

This study has several limitations. First, cross-sectional design prevents establishing temporal relationships or causal associations between the identified cardiometabolic factors and metabolic syndrome. Second, the study was conducted in a hospital-based population, which may differ from the general community and therefore limits the generalizability of the findings to the wider Bangladeshi population. Third, the distribution of participants across age groups was uneven, with relatively few participants aged 51–65 years and only two participants aged 66–80 years; consequently, age-specific estimates, particularly for the oldest group, should be interpreted cautiously. Fourth, some variables had missing observations, resulting in slightly different sample sizes for individual analyses. Fifth, the study relied on routinely available cardiometabolic measurements and did not comprehensively assess potentially important lifestyle and behavioral factors such as dietary intake, physical activity, smoking, sleep patterns, and socioeconomic determinants. Finally, several variables examined in relation to MetS are themselves components of the metabolic syndrome diagnostic construct; therefore, their observed associations with MetS should be interpreted as reflecting metabolic clustering rather than independent causal effects. Future multicenter, population-based longitudinal studies with larger and more representative samples are warranted to validate these findings and identify independent predictors of MetS in Bangladesh.

Author Contribution

Conceptualization and Methodology: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter

Data Collection and Investigation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna

Formal Analysis and Data Interpretation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Esmat Ara

Writing – Original Draft Preparation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain

Writing – Review and Editing: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda

Supervision and Project Administration: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Momtaj Maksuda

Final Approval

All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

References

1. Chowdhury MZ, Anik AM, Farhana Z, et al. Prevalence of metabolic syndrome in Bangladesh: a systematic review and meta-analysis of the studies. BMC public health 18 (2018): 308.
2. Krishnamoorthy Y, Rajaa S, Murali S, et al. Prevalence of metabolic syndrome among adult population in India: A systematic review and meta-analysis. PLoS One 15 (10): e0240971.
3. Ali N, Taher A, Trisha AD, et al. Prevalence of Metabolic Syndrome and its Related Factors in Bangladeshi Adults: A Cross-Sectional Study. Endocrinology, Diabetes & Metabolism 7 (2024): e00491.
4. Khanam MA, Qiu C, Lindeboom W, et al. The metabolic syndrome: prevalence, associated factors, and impact on survival among older persons in rural Bangladesh. PLoS One 6 (2011): e20259.
5. Siddiquee T, Bhowmik B, Munir SB, et al. Optimal cut-off points for waist circumference in the definition of metabolic syndrome: a cross-sectional study in rural Bangladesh. BMJ open. 15 (2025): e093159.
6. Alberti KG, Zimmet P, Shaw J. The metabolic syndrome—a new worldwide definition. The Lancet 366 (2005): 1059-1062.

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.

7. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome—a new world-wide definition. A consensus statement from the international diabetes federation. Diabetic medicine 23 (2006): 469-480.

8. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, lung, and blood institute; American heart association; world heart federation; international atherosclerosis society; and international association for the study of obesity. Circulation 120 (2009): 1640-1645.

9. National Cholesterol Education Program (US). Second Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (adult Treatment Panel II): Executive Summary. National Cholesterol Education Program, US National Institutes of Health, National Heart, Lung, and Blood Institute (1993).

10. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. Jama 287 (2002): 356-359.

11. Ford ES, Li C, Sattar N. Metabolic syndrome and incident diabetes: current state of the evidence. Diabetes care 31 (2008): 1898-1904.

12. Sarker PK, Sultana N, Islam H, et al. Thyroid dysfunction and metabolic dysregulation: a cross-sectional study of hormonal and glycemic parameters. Mol Mech Res 3 (2025): 10227.

13. Galassi A, Reynolds K, He J. Metabolic syndrome and risk of cardiovascular disease: a meta-analysis. The American journal of medicine. 119 (2006): 812-819. Wu SH, Liu Z, Ho SC. Metabolic syndrome and all-cause mortality: a meta-analysis of prospective cohort studies. Eur J Epidemiol 25 (2010): 375-384.

14. Gupta RD, Tamanna RJ, Akonde M, et al. Prevalence and associated factors of metabolic syndrome among Bangladeshi adults: evidence from a nation-wide survey. Diabetes Epidemiology and Management 5 (2022): 100037.

15. Misra A, Khurana L. The metabolic syndrome in South Asians: epidemiology, determinants, and prevention. Metabolic syndrome and related disorders 7 (2009): 497-514.

16. Misra A, Vikram NK. Insulin resistance syndrome (metabolic syndrome) and Asian Indians. Current Science (2002): 1483-1496.

17. Chanda M, Biswas T, Amiruzzaman M, et al. Association of serum uric acid and liver enzymes in adults at Tertiary Level Hospital in Bangladesh. Bangladesh Medical Journal 51 (2022): 18-27.

18. Misra A, Chowbey P, Makkar BM, et al. Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. Japi 57 (2009): 163-170.

19. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: definitions and controversies. BMC medicine 9 (2011): 48.

20. Cornier MA, Dabelea D, Hernandez TL, et al. The metabolic syndrome. Endocrine reviews 29 (2008): 777-822.Grundy SM. Metabolic syndrome: a multiplex cardiovascular risk factor. J Clin Endocrinol Metab.

21. Grundy SM, Brewer Jr HB, Cleeman JI, et al. Definition of metabolic syndrome: report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. Circulation 109 (2004): 433-438.

22. Abdi HI, Mohamed MN, Rahman MA. Impact of urbanization and dietary transitions on metabolic syndrome and insulin resistance in Bangladesh: A cross-sectional study. Viral Infections and Cancer Research 1 (2024): 8141.

23. Jornayvaz FR, Samuel VT, Shulman GI. The role of muscle insulin resistance in the pathogenesis of atherogenic dyslipidemia and nonalcoholic fatty liver disease associated with the metabolic syndrome. Annual review of nutrition 30 (2010): 273-290.

24. Krishnamoorthy Y, Rajaa S, Murali S, et al. Prevalence of metabolic syndrome among adult population in India: A systematic review and meta-analysis. PLoS One 15 (2020): e0240971.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license 4.0

Citation: Hanu Kamal Hossain, Naima Jannat Shabrina Haque, Mst Mahfuza Akter, Samia Hossain, Afia Tabassum Raisa, Ummey Maimuna, Esmat Ara, Momtaj Maksuda. Cardiometabolic Risk Profiling and Determinants of Metabolic Syndrome Among Middle-Aged Adults: A Hospital-Based Cross-Sectional Study. Archives of Internal Medicine Research. 9 (2026): 341-350.