Original Article

Metabolic Syndrome and Co-occurrence of Its Components Among Female Medical Students in A Private Medical College in Bangladesh: A Cross-Sectional Study

Tohura Sharmin[1], Richmond Ronald Gomes[2], Evan Akhter Adrita[3], Nahid Yasmin[4]

Abstract

Background: Medical students often face intense academic pressure; moreover, they adopt sedentary lifestyles, which can significantly elevate their cardiometabolic risk. As future healthcare providers, their own health status is a critical indicator of public health trends.

Objective: This study aimed to determine the prevalence of metabolic syndrome and its components among female medical students in a private medical college in Bangladesh.

Methods: A cross-sectional study was conducted at Ad-din Women's Medical College, Dhaka. Data were collected from female students following NCEP ATP III criteria. Clinical and biochemical assessments included waist circumference, blood pressure, fasting blood glucose, fasting triglycerides, and HDL cholesterol.

Result: The overall prevalence of metabolic syndrome was 78 (42.2%). The most pervasive metabolic abnormality was low HDL cholesterol 101 (54.6%), followed by elevated blood pressure 70 (37.8%) and triglycerides 69 (37.3%). Notably, a high proportion of students who did not meet the full criteria for MetS (Metabolic Syndrome) were found to have one or two risk factors, placing them on the threshold of the syndrome.

Conclusion: The prevalence of metabolic syndrome in this cohort is alarmingly high compared to international data for medical students. These findings highlight an urgent need for institutional health interventions, regular screenings, and lifestyle modifications to safeguard the health of future physicians.

Keywords: Metabolic Syndrome; Medical Students; Cardiometabolic Risk; HDL Cholesterol; NCEP ATP III.

1. Assistant Professor, Department of Community Medicine and Public Health, Ad-din Women's Medical College, Dhaka, Bangladesh
2. Professor and Head, Department of Internal Medicine, Ad-din Women's Medical College, Dhaka, Bangladesh
3. Lecturer, Department of Community Medicine and Public Health, Ad-din Women's Medical College, Dhaka, Bangladesh
4. Professor and Head, Department of Community Medicine and Public Health, Ad-din Women's Medical College, Dhaka, Bangladesh

Correspondence: Dr. Tohura Sharmin, Assistant Professor, Department of Community Medicine and Public Health, Ad-din Women's Medical College, Dhaka, Bangladesh. Email: tohurasharminmercy@gmail.com, Mobile: 01731537870

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Introduction

Non-communicable diseases are a rising concern across South Asia specially South East Asia, with evidence indicating that medical practitioners are increasingly vulnerable to premature cardiovascular complications due to the demanding nature of their academic and clinical environments.[1,2] Medical students, in particular, face a confluence of chronic stress, sedentary routines, and suboptimal dietary practices that exacerbate their susceptibility to metabolic syndrome.[3,5] This condition, characterized by central obesity, dyslipidemia, hypertension, and impaired glucose homeostasis, serves as a critical harbinger of long-term cardiovascular disease and type 2 diabetes.[3,6,7] While the pathophysiology of metabolic

syndrome is well- established in older populations, the subtle emergence of these risk factors among seemingly healthy young adults warrants careful clinical attention.[8,9] Moreover, professional and academic stressors correlate with deleterious lifestyle behaviors, including disrupted sleep and physical inactivity.[10,11] Despite the potential for long-term health consequences, systematic assessments of metabolic health in this demographic remain scarce.[12,13] Furthermore, in female populations, specific physiological responses to chronic stress and shifts in visceral fat accumulation during early adulthood may uniquely modulate susceptibility to metabolic syndrome.[14,15] This study, therefore, aims to quantify the prevalence of metabolic syndrome among female medical students in Bangladesh, examining the interplay between physiological indicators and modifiable lifestyle variables.

Materials and Methods

The objective of the study was to determine the prevalence of metabolic syndrome and its individual components among medical students in a private medical college in Bangladesh.

Study Design and Setting:

This cross-sectional study was conducted among female medical students of Ad-din Women's Medical College, Moghbazar, Dhaka, Bangladesh, from August 2025 to January 2026. The study aimed to determine the prevalence of metabolic syndrome and assess the distribution of its individual components among future healthcare professionals. Ad-din Women's Medical College is a tertiary-level academic institution that accommodates both Bangladeshi and international female medical students, providing a diverse population for assessing metabolic health status in young adults.

Study Population:

The study population consisted of undergraduate female medical students enrolled in the 3rd, 4th, and 5th academic years of the MBBS program at Ad-din Women's Medical College. These students represented a relatively homogeneous educational group but belonged to different nationalities & socio-demographic backgrounds.

Inclusion Criteria:

Participants were included in the study if they:

- Were female medical students enrolled in the 3rd, 4th, or 5th year of the MBBS program.
- Were present during the data collection period.
- Provided written informed consent to participate in the study.
- Agreed to undergo physical examination and biochemical investigations.

Exclusion Criteria:

Participants were excluded if they:

- Were pregnant at the time of data collection.
- Were unwilling to participate in the study.
- Could not be contacted after repeated attempts.

Sample Size Determination:

The sample size was calculated using the standard formula for estimation of a population proportion:

$n = Z^2pq/d^2$

Where:

- n = required sample size
- Z = standard normal deviate at 95% confidence level (1.96)
- p = anticipated prevalence of metabolic syndrome (14%)[8]
- q = 1 – p
- d = allowable error (5%)

n = (1,96)2 0.14 x (1-0.14)/ (0.05)2 = 185

Based on the prevalence reported in a previous study among medical students, the calculated minimum sample size was 185 participants. Although a larger sample was initially planned to compensate for possible non-response, complete data were ultimately available for 185 participants, and these participants constituted the final study sample.[8]

Sampling Technique:

The study institution and participants were selected purposively. Eligible participants fulfilling the inclusion criteria were recruited from the 3rd, 4th, and 5th academic years. Students were approached during academic sessions and invited to participate voluntarily. Those providing written informed consent underwent clinical assessment and laboratory investigations.

Data Collection Instrument:

Data were collected using a pretested semi-structured questionnaire and a structured clinical assessment form. The questionnaire was developed after an extensive review of relevant literature and modified according to the objectives of the study.

The questionnaire was pretested among a group of students with similar characteristics who were not included in the final study. Necessary modifications were made before commencement of the actual survey.

Data Collection Procedure:

Eligible students were informed about the purpose, objectives, benefits, and procedures of the study. Written informed consent was obtained from each participant before enrollment.

Data collection was performed through face-to-face interviews, physical examination, anthropometric measurements, and laboratory investigations. Privacy and confidentiality were maintained throughout the data collection process.

All measurements were conducted by trained investigators following standardized procedures to minimize measurement bias and ensure consistency.

Anthropometric Assessment:

Waist Circumference Measurement

Waist circumference was measured using a non-stretchable measuring tape while the participant was standing erect with feet placed close together and arms relaxed at the sides.

The measurement was taken midway between the lower margin of the last palpable rib and the iliac crest at the end of normal expiration. Measurements were recorded to the nearest 0.1 cm.

Blood Pressure Measurement:

Blood pressure was measured using a calibrated sphygmomanometer following standard recommendations.

Participants were allowed to rest in a seated position for at least five minutes before measurement. Blood pressure was measured from the right arm with the arm supported at heart level and both feet placed flat on the floor.

Two readings were obtained at one-minute intervals, and the average of the two measurements was recorded for analysis. Both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were documented.

Biochemical Assessment:

Participants were instructed to undergo overnight fasting for at least 8 hours before blood sample collection.

Venous blood samples were collected aseptically from the antecubital vein by trained personnel in the morning. Samples were transported immediately to the designated laboratory for analysis.

The following biochemical parameters were measured:

- Fasting Blood Glucose (FBG)
- Fasting Serum Triglycerides (TG)
- Fasting High-Density Lipoprotein Cholesterol (HDL-C)

Laboratory investigations were performed according to standard laboratory procedures with appropriate quality-control measures.

Diagnosis of Metabolic Syndrome:

Metabolic syndrome was diagnosed according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria.[16]

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

1. Waist Circumference (WC) ≥88 cm.
2. Serum Triglycerides (TAG) ≥150 mg/dL.
3. HDL Cholesterol (HDL-C) <50 mg/dL.
4. Systolic Blood Pressure (SBP) ≥130 mmHg and/or diastolic blood pressure (DBP) ≥85 mmHg.
5. Fasting Blood Glucose (FBG) ≥100 mg/dL17

Participants with fewer than three positive components were classified as not having metabolic syndrome.[18]

Quality Control:

Several measures were undertaken to ensure the quality and reliability of data:

- The questionnaire was pretested before the main survey.
- Investigators received training regarding interview techniques and measurement procedures.
- Standardized protocols were followed for anthropometric and blood pressure measurements.
- Measuring instruments were calibrated before use.
- Laboratory analyses were performed in a certified laboratory using standardized methods.
- Completed questionnaires were reviewed daily for completeness and consistency.
- Data entry was cross-checked to minimize transcription errors.

Data Management and Statistical Analysis:

Collected data were checked for completeness, coded, entered, cleaned, and analyzed using Statistical Package for Social Sciences (SPSS) version 26 (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.).

Descriptive statistical methods were employed to summarize the study findings. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

The prevalence of metabolic syndrome was calculated as the proportion of participants fulfilling the diagnostic criteria. The frequency distribution of individual metabolic syndrome components was also determined.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board (IRB) of Ad-din Women's Medical College, ensuring compliance with the Declaration of Helsinki before initiation of data collection.

Participation was entirely voluntary. Written informed consent was obtained from all participants after explaining the objectives, procedures, potential benefits, and possible discomforts associated with blood sampling.

Participants were assured that all information would remain confidential and would be used solely for research purposes. Personal identifiers were removed during data analysis to maintain anonymity. Participants retained the right to withdraw from the study at any stage without any academic or personal consequences.

Result

Table 1 presents the socio-demographic characteristics of the study participants. The mean age of the respondents was 22.95 ± 1.06 years, with the majority 131 (70.8%), belonging to the 23–25 years age group. Most participants were unmarried 172 (93.0%), and Muslim 182 (98.4%). More than half of the respondents were Bangladeshi nationals 108 (58.4%), while 76 (41.1%) were Indian and 1 (0.5%) was Nepali. Co-morbid conditions were reported by 19 (10.3%) of participants, whereas the majority 166 (89.7%) had no known co-morbidities.

Table 1: Socio-Demographic Characteristics of the Study Participants (n = 185)

Variable	Frequency (%)
Age Group (years)	
20–22	54 (29.2)
23–25	131 (70.8)
Mean Age ± SD	22.95 ± 1.06
Marital Status	
Unmarried	172 (93)
Married	13 (7)
Religion	
Islam	182 (98.4)
Hinduism	3 (1.6)
Nationality	
Bangladeshi	108 (58.4)
Indian	76 (41.1)
Nepali	1 (0.5)
Co-morbidity Status	
Absent	166 (89.7)
Present	19 (10.3%)

Table 2 shows the prevalence of metabolic syndrome among the study participants. Metabolic syndrome was identified in 78 participants, resulting in a prevalence of 42.2%, while 107 (57.8%) participants did not meet the diagnostic criteria for metabolic syndrome.

Table 2: Prevalence of Metabolic Syndrome Among the Study Participants (n = 185)

Metabolic Syndrome Status	Number (%)
Present	78 (42.2)
Absent	107 (57.8)

Table 3 demonstrates the overall prevalence of individual components of metabolic syndrome among the study participants. Low HDL cholesterol was the most prevalent metabolic abnormality, affecting 101 (54.6%) of participants. High blood pressure and elevated triglyceride levels were observed in 70 (37.8%) and 69 (37.3%) of participants, respectively. Increased waist circumference was present in 57 (30.8%) of participants, whereas impaired fasting blood glucose was the least common component, affecting 38 (20.5%) of the study population. These findings indicate that dyslipidemia, particularly reduced HDL cholesterol, was the predominant metabolic abnormality among the female medical students.

Table 3: Overall Prevalence of Individual Components of Metabolic Syndrome Among the Study Participants (n = 185)

Metabolic Syndrome Component	Number (%)
Low HDL Cholesterol	101 (54.6)
High Blood Pressure	70 (37.8)
Elevated Triglycerides	69 (37.3)
Increased Waist Circumference	57 (30.8)
Impaired Fasting Blood Glucose	38 (20.5)

Table 4 illustrates the clustering of metabolic syndrome components according to the number of positive risk factors present among participants. 36 (19.5%) participants did not exhibit any metabolic syndrome component, while 41 (22.2%) and 30 (16.2%) participants had one and two positive risk factors, respectively. A total of 78 (42.2%) participants exhibited three or more positive risk factors and were therefore classified as having metabolic syndrome.

Table 4: Distribution of Individual Metabolic Syndrome Components According to Number of Positive Risk Factors (n = 185)

Number of Positive Risk Factors	Total n (%)	Impaired Fasting Blood Glucose n (%)	High Blood Pressure n (%)	Low HDL Cholesterol n (%)	Elevated Triglycerides n (%)	Increased Waist Circumference n (%)
0	36 (19.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
1	41 (22.2)	3 (7.3)	6 (14.6)	22 (53.7)	7 (17.1)	3 (7.3)
2	30 (16.2)	5 (16.7)	10 (33.3)	18 (60.0)	12 (40.0)	9 (30.0)
3	37 (20)	8 (21.6)	20 (54.1)	25 (67.6)	18 (48.6)	15 (40.5)
4	29 (15.6)	10 (34.5)	22 (75.9)	24 (82.8)	20 (69.0)	18 (62.1)
5	12 (6.5)	12 (100.0)	12 (100.0)	12 (100.0)	12 (100.0)	12 (100.0)

Low HDL cholesterol was the most common abnormality across all risk-factor categories, affecting 22 (53.7%) of participants with one risk factor, 18 (60.0%) with two risk factors, 25 (67.6%) with three risk factors, and 4 (82.8%) with four risk factors. The prevalence of elevated blood pressure, elevated triglycerides, impaired fasting blood glucose, and increased waist circumference progressively increased with increasing numbers of positive risk factors. All participants with five positive risk factors demonstrated abnormalities in fasting blood glucose, blood pressure, HDL cholesterol, triglycerides, and waist circumference.

Discussion

This study reveals a high prevalence of metabolic syndrome among female medical students, primarily driven by dyslipidemia.[19,20] The high incidence of low HDL cholesterol aligns with previous studies, indicating that lifestyle and ethnic factors contribute to early-onset metabolic disturbances.[21,22] The observed clustering of risk factors confirms that individuals with multiple markers are more susceptible to concurrent lipid and glucose irregularities.[23,24] Furthermore, female students often exhibit greater vulnerability to these metabolic issues than their male counterparts.[25] Early detection of such clusters is crucial to prevent progression to severe cardiovascular disease.[26,27]

The observed 42.2% prevalence of metabolic syndrome is notably high, exceeding the 37.0% reported for the general Bangladeshi population.[1] This suggests that the sedentary nature of medical training may exacerbate metabolic risks [10]. Our findings are significantly higher than those reported in international cohorts, such as in Saudi Arabia (21.5%), India (7.6%), and Iran (up to 13.0%).[8,11,25] Although low HDL-C is common among young adults, our data indicates greater severity than other female-specific studies, such as those in Kolkata where low HDL affected 28.7% of students.[9, 22] This disparity underscores the urgent need for targeted interventions, as these future physicians face a higher cardiometabolic burden than their global counterparts.[4,14]

The high proportion of students with two metabolic risk factors is clinically significant, as these individuals approach the threshold for a metabolic syndrome diagnosis. This "pre-metabolic" state is consistent with other Bangladeshi cohorts; for example, while overall metabolic syndrome prevalence in one university study was 27.7%, low HDL-C affected 78% of the student population.[1] International data aligns with these concerns, such as a study of Iranian medical students where nearly 15% possessed two risk factors despite a 3.2% overall syndrome prevalence. These subclinical clusters represent a critical window for intervention before chronic disease manifests.[8] Female students appear particularly susceptible, with studies in India identifying low HDL and elevated blood pressure as primary drivers.[28] Early identification is essential, as the sedentary and high-stress demands of medical education can trigger the progression of these two-factor profiles into established disease.[8,28]

The high prevalence of metabolic syndrome likely results from the interplay between rigorous medical training and inadequate institutional support for wellness. Bangladeshi medical students face intense academic pressure, irregular sleep, and prolonged sedentary periods due to demanding curricula.[4,13] These stressors often correlate with unhealthy dietary habits, including frequent consumption of calorie-dense foods.[4,12] Additionally, the urban environment in Dhaka limits opportunities for physical activity; research on female professionals in Bangladesh identifies a "triad of risks" where sedentary behavior and stress are significantly associated with impaired fasting glucose and central obesity.[10] This compounded by long online sessions and

restricted movement post-pandemic, creates a "perfect storm" for early-onset metabolic disturbances.[11]

Given the study's focus on female students, sex-specific physiological factors warrant consideration. Visceral fat accumulation in women during early adulthood increases susceptibility to insulin resistance and atherogenic lipid profiles.[15] Female medical students frequently exhibit higher rates of abnormal waist-to-hip ratios and fat mass than their male peers, even when body mass index is within normal limits.[14] This aligns with Saudi Arabian findings, where female medical students showed higher metabolic syndrome prevalence than males.[25] These gender differences suggest that "apparently healthy" young women may be accumulating silent metabolic damage, predisposing them to premature cardiovascular disease and type 2 diabetes.[6,9]

These findings highlight the necessity of incorporating sex-specific screening protocols into academic health initiatives, rather than relying solely on generalized BMI metrics.[29] Current screening often fails to detect sub-clinical lipid and glucose abnormalities, which are key determinants of metabolic syndrome in sedentary university populations.[30] Consequently, longitudinal monitoring of body composition and metabolic biomarkers is essential to track health risks throughout undergraduate training.[31] Implementing structured wellness programs that integrate physical activity and nutritional education may mitigate these risks by addressing environmental and behavioral determinants.[32] By moving beyond conventional BMI-based screening, institutions can design targeted interventions that address the specific stressors identified in this study. Such comprehensive wellness frameworks can mitigate immediate cardiometabolic risks and better equip future physicians to maintain their health during their transition into professional practice.

Limitations

- **Cross-sectional design:** This study provides a snapshot of metabolic health but precludes establishing causality between lifestyle factors and metabolic disturbances.
- **Sample generalizability:** Conducted at a single institution, findings may not be generalizable to male students or diverse geographical regions within Bangladesh.
- **Self-reporting bias**: While clinical and biochemical markers were measured objectively, data regarding lifestyle habits and dietary patterns relied on participant recall, introducing potential reporting bias.
- **Diagnostic criteria:** While NCEP ATP III criteria are standard, results may differ when using other guidelines, such as the International Diabetes Federation's (IDF), which apply lower waist circumference thresholds for South Asian populations.
- **Biological variables:** The analysis excluded potential confounders, such as the phase of the menstrual cycle during blood sampling or potential ethnic variations.

Conclusion

This study identifies a high prevalence of metabolic syndrome among female medical students in Dhaka. Low HDL-C emerged as the primary metabolic abnormality, followed by elevated blood pressure and hypertriglyceridemia. A notable proportion of students, while not meeting full diagnostic criteria, present with one or two metabolic risk factors. This pre-clinical status indicates that a substantial segment of the future medical workforce faces elevated risks of premature cardiovascular disease and type 2 diabetes. The discrepancy between their future roles as health educators and their current cardiometabolic profiles underscores an urgent need for institutional health reform.

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