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Original Research Article

Prevalence and Associated Factors of Cardio-Metabolic Risk among Undergraduate Medical Students in Bangladesh: A Cross-Sectional Study

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Abstract: ***Background*:** Young adults, including medical students, are increasingly exposed to unhealthy lifestyle behaviors and early metabolic abnormalities that may predispose them to long-term cardiovascular disease. This constitutes a major public health challenge in South East Asia now-a days. ***Methods*:** A cross-sectional study was conducted among undergraduate medical students at Noakhali Medical College, Bangladesh, between October 2024 and June 2025. Behavioral, anthropometric, clinical, and biochemical data were collected using standardized protocols. Lifestyle factors included diet, physical activity, sedentary behavior, sleep duration, and stress. Anthropometric measurements comprised body mass index (BMI) and waist circumference, while biochemical assessments included 75-gm oral glucose tolerance test (OGTT), glycated hemoglobin (HbA1c) and lipid profile. Descriptive statistics and bivariate analyses using Chi-square tests were performed. ***Results*:** A total of 135 students (age: 21.0±1.9 years; 69.6% female) were included. The prevalence of overweight/obesity (BMI ≥25 kg/m^2) was 28.9%, and similar numbers had central obesity. More than half of participants exhibited prediabetes (51.9%), while 64.4% had dyslipidemia and 13.3% met criteria for metabolic syndrome. Hypertension was present in 4.4% of students. Overweight/obesity was significantly associated with hypertension ($p = 0.002$) and dyslipidemia ($p = 0.033$), but not with sex, physical inactivity, sedentary behavior, dietary intake, glucose intolerance, or short sleep duration. ***Conclusion*:** Undergraduate medical students in Bangladesh demonstrate a high burden of cardiometabolic risk factors, including excess body weight, early dysglycemia, and dyslipidemia. These findings underscore the need for early, targeted preventive and health promotion strategies within medical education to mitigate future cardiometabolic disease risk in this critical population.

Keywords: Cardiometabolic Risk, Medical Students, Undergraduate Medical Students, Prediabetes, Dyslipidemia, Obesity.

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INTRODUCTION

Cardio-metabolic diseases represent a major and rapidly expanding public health challenge in South Asia, with earlier onset and more aggressive progression compared with many other regions of the world [1]. The region experiences a disproportionately high burden of type 2 diabetes, hypertension, central obesity, and atherogenic dyslipidemia, all of which contribute substantially to premature cardiovascular morbidity and mortality [1–3]. Young adults are increasingly exhibiting clustered metabolic risk factors—including inadequate diet, physical inactivity, excessive sedentary time, obesity, impaired glucose regulation, and lipid abnormalities—reflecting both behavioral transitions and inherent South Asian susceptibility to metabolic dysfunction [4,5]. These early-life risk accumulations heighten lifetime cardiometabolic risk, underscoring the need for targeted surveillance in young populations.

Medical students, despite their training in health sciences, are not exempt from these evolving risk patterns. Several studies from India, Sri Lanka, and Nepal have documented considerable prevalence of overweight and obesity, dyslipidemia, inadequate physical activity, high fast-food consumption, and other behavioral risks in medical student populations [6,7]. Evidence suggests that the high academic workload, stress, irregular sleep, and restricted access to healthy food options contribute to unhealthy lifestyle patterns among medical trainees. Moreover, metabolic abnormalities—including insulin resistance, elevated triglycerides, and borderline hypertension—have been reported at concerning rates in this demographic [8, 9]. The health behaviors and metabolic profiles of medical students hold broader implications: future physicians who themselves engage in unhealthy behaviors may be less effective in counselling patients about preventive strategies, lifestyle modification, and long-term cardiometabolic risk reduction [10, 11]. Thus, early identification of risk in this group is essential not only for their personal health but also for shaping future public health practice.

Despite the growing recognition of early cardiometabolic risk among young adults globally and regionally, data from Bangladesh—particularly among medical students—remain sparse. Existing national surveys predominantly focus on the general adult population and do not address the unique environment, behavioral patterns, and metabolic vulnerabilities of undergraduate medical students. Consequently, there is limited understanding of the burden, clustering, and associated factors of cardiometabolic risk factors within this critical population. This study seeks to address this gap by quantifying the prevalence of major cardiometabolic risk factors and identifying their key associated factors among undergraduate medical students in Bangladesh. By integrating behavioral, anthropometric, clinical, and biochemical parameters, the study aims to provide a comprehensive profile that can inform targeted preventive strategies within medical education settings.

MATERIAL AND METHODS

Design and Setting

This cross-sectional study was conducted at Noakhali Medical College (NMC), Bangladesh, over a nine-month period from October 2024 to June 2025. Data collection included structured interviews, anthropometric assessments, blood pressure measurements, and biochemical testing conducted under standardized conditions.

Participants

Eligible participants were undergraduate medical students aged 18 years or older enrolled in preclinical or clinical academic years. Students were excluded if they had chronic comorbid conditions (including hepatic, renal, thyroid, autoimmune, or chronic infectious diseases) or were receiving long-term glucocorticoid or antipsychotic therapy. Participation was voluntary, and all eligible students were invited to take part.

Sample Size and Sampling

A minimum sample size of 140 was calculated using a previously reported prevalence of inadequate fruit intake among medical students, applying a 5% significance level and 10% relative precision. Participants were recruited through consecutive sampling from volunteers who responded to an open invitation circulated via institutional notice boards and student communication channels.

Variables and Measurements

Behavioral variables included daily fruit and vegetable intake, frequency of fast-food consumption, physical activity, sedentary time, smoking status, alcohol use, sleep duration, and perceived stress. Anthropometric measurements comprised weight, height, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), waist-height ratio (WHtR), and assessment for acanthosis nigricans. Weight was recorded with a calibrated digital scale, and height was measured using a stadiometer. BMI was calculated in kilograms per square meter (kg/m^2). Waist circumference (WC) and hip circumference (HC) were measured with a non-stretchable tape using standard anatomical landmarks.

Sedentary behavior was defined as an average sitting time of ≥8 hours per day, while adequate physical activity was defined as engaging in ≥30 minutes of physical activity per day. Central obesity was defined based on waist circumference cut-offs of greater than 90 cm for males and greater than 80 cm for females, in accordance with established regional and international guidelines.

Clinical assessment included measuring blood pressure with a validated upper-arm electronic device, following national guideline procedures. Participants rested for at least five minutes before the measurement, and repeated readings were taken when necessary. Biochemical variables included fasting plasma glucose, 2-hour glucose following a 75-g oral glucose tolerance test (OGTT), glycated hemoglobin (HbA1c), total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG), analyzed using standardized enzymatic methods.

Cardiovascular Risk Factor Clustering

Cardiovascular risk was assessed based on the presence of established ASCVD risk factors, including overweight/obesity, hypertension, dyslipidemia, impaired glucose regulation (prediabetes or diabetes), and smoking. Because the 10-year ASCVD risk calculator is validated for individuals aged 40 years or older, cardiovascular risk in this young cohort was evaluated based on the presence and clustering of major ASCVD risk factors rather than formal risk score estimation.

Statistical Analysis

Data were analyzed using descriptive statistics. Continuous variables are presented as mean ± standard deviation or as median with interquartile range, as appropriate. Categorical variables are summarized as frequencies and percentages. Group comparisons were performed using the Chi-square test for categorical variables and either the independent t-test or Mann–Whitney U test for continuous variables, depending on the data distribution. All tests were two-sided, and a p-value of <0.05 was considered statistically significant. Statistical analyses were conducted using STATA version 17.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Review Board of NMC, Noakhali, Bangladesh. Participation was voluntary, and written informed consent was obtained from all participants before enrolment. Participants were informed about the study objectives, procedures, potential risks, and benefits, as well as their right to withdraw at any stage without any academic or personal consequences. Confidentiality and anonymity of participant data were strictly maintained, with all data used solely for research purposes. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Baseline Characteristics

A total of 135 undergraduate medical students were included in the analysis, with a mean age of 21.0 ± 1.9 years. The study population consisted of 69.6% female students (n = 94). Dietary assessment revealed a low prevalence of healthy eating behaviors, with only 8.2% (n = 11) of participants reporting adequate fruit intake (≥5 servings/day) and 4.4% (n = 6) reporting adequate vegetable intake. In contrast, 75.6% of students (n = 102) reported consuming fast food frequently, defined as more than three times per week.

Lifestyle assessment demonstrated a high burden of unhealthy behaviors. Only 13.3% (n = 18) of participants met recommended levels of physical activity (≥30 minutes/day), while 62.2% (n = 84) reported prolonged sedentary behavior (≥8 hours/day). Additionally, 58.5% (n = 79) of students reported short sleep duration (<7 hours per night), and 57.8% (n = 78) experienced stress during the past year. The prevalence of current smoking was low, reported by 1.5% (n = 2) of participants (Table 1).

Table 1: Baseline Characteristics of the Study Participants

Variable	Mean (SD)/ n (%)
N (total)	135
Age mean ± SD	21.0 ± 1.9
Female n (%)	94 (69.6%)
Fruit adequate (≥5/day) n (%)	11 (8.2%)
Adequate vegetable intake (≥5 servings/day), n (%)	6 (4.4%)
Fast food intake >3 times/week	102 (75.6%)
Physical activity (30 m/day) n (%)	18 (13.3%)
Sedentary ≥8h/day n (%)	84 (62.2%)
Short sleep (<7h) n (%)	79 (58.5%)

Variable	Mean (SD)/ n (%)
Stress past year n (%)	78 (57.8%)
Current smoker n (%)	2 (1.5%)

Values are presented as mean ± standard deviation (SD) for continuous variables and number (percentage) for categorical variables. Adequate fruit and vegetable intake was defined as ≥5 servings per day; adequate physical activity as ≥30 minutes per day; sedentary behavior as ≥8 hours sitting per day; and short sleep as <7 hours per night.

Anthropometric and Clinical Characteristics

The mean body mass index (BMI) of the study participants was 23.28 ± 4.08 kg/m^2. Based on BMI classification, 71.1% (n = 96) of students had normal body weight, while 23.7% (n = 32) were overweight and 5.2% (n = 7) were obese, corresponding to an overall prevalence of overweight/obesity of 28.9%. The mean waist circumference was 79.80 ± 10.71 cm, and 28.9% (n = 39) of participants met the criteria for central obesity.

Regarding blood pressure, the mean systolic and diastolic blood pressures were 107.64 ± 12.51 mmHg and 72.79 ± 8.07 mmHg, respectively. Most participants were normotensive (88.9%, n = 120), while 6.7% (n = 9) were classified as having pre-hypertension and 4.4% (n = 6) met the criteria for hypertension (Table 2).

Table 2: Anthropometric and Clinical Parameters

Parameter	Mean ± SD / n (%)
Body mass index (kg/m^2)	23.28 ± 4.08
Normal	96 (71.1%)
Overweight	32 (23.7%)
Obese	7 (5.2%)
Waist circumference (cm)	79.80 ± 10.71
Central obesity	39 (28.9%)
Systolic blood pressure (mmHg)	107.64 ± 12.51
Diastolic blood pressure (mmHg)	72.79 ± 8.07
Blood pressure (BP) Category	
Normal	120 (88.9%)
Pre-hypertension	9 (6.7%)
Hypertension	6 (4.4%)

Values are presented as mean ± standard deviation (SD) for continuous variables and number (percentage) for categorical variables. Body mass index (BMI) categories were defined as normal (<25 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥30 kg/m^2). Blood pressure categories were defined as normal (SBP <130 mmHg and DBP <85 mmHg), pre-hypertension (SBP 130–139 mmHg and/or DBP 85–89 mmHg), and hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg).

Metabolic Laboratory Parameters

The mean fasting plasma glucose level among participants was 5.55 ± 0.45 mmol/L, and the mean 2-hour oral glucose tolerance test (OGTT) value was 7.03 ± 1.23 mmol/L. Based on glucose classification, 45.9% (n = 61) of students had normal glucose levels, while more than half were classified as having prediabetes (51.9%, n = 69). A small proportion of participants met the criteria for diabetes mellitus, accounting for 2.3% (n = 3). The mean glycated hemoglobin (HbA1c) level was 5.60 ± 0.29%.

The lipid profile assessment indicated a mean total cholesterol level of 176.10 ± 32.17 mg/dL. The mean high-density lipoprotein (HDL) cholesterol was 49.56 ± 25.11 mg/dL, while the low-density lipoprotein (LDL) cholesterol averaged 103.41 ± 26.99 mg/dL. Triglyceride levels were reported at 108.43 ± 53.03 mg/dL. Overall, 64.4% (n = 87) of participants met the criteria for dyslipidemia. Additionally, 13.3% (n = 18) of students were identified as having metabolic syndrome according to the International Diabetes Federation (IDF) criteria (Table 3).

Table 3: Metabolic Laboratory Parameters

Parameter	Mean ± SD / n (%)
Fasting plasma glucose (mmol/L)	5.55 ± 0.45
2-hour OGTT glucose (mmol/L)	7.03 ± 1.23
Glucose status	
Normal	61 (45.9%)
Prediabetes (IFG and/or IGT)	69 (51.9%)
Diabetes mellitus	3 (2.3%)
HbA1c (%)	5.60 ± 0.29
Total cholesterol (mg/dL)	176.10 ± 32.17
HDL-cholesterol (mg/dL)	49.56 ± 25.11
LDL-cholesterol (mg/dL)	103.41 ± 26.99
Triglycerides (mg/dL)	108.43 ± 53.03
Dyslipidemia	87 (64.4%)
Metabolic syndrome (IDF)	18 (13.3%)

Values are reported as mean ± standard deviation for continuous variables and as numbers (percentages) for categorical variables. Glucose status was classified as normal, prediabetes, or diabetes mellitus according to standard criteria, while dyslipidemia and metabolic syndrome were defined per accepted guidelines.

Lifestyle Factors Associated with Overweight/Obesity

The prevalence of overweight and obesity (BMI ≥ 25 kg/m^2) among study participants was 28.9%. In bivariate analysis, female sex was not significantly associated with overweight/obesity (29.8% vs. 26.8% in males; p = 0.887). Similarly, no significant associations were observed between overweight/obesity and physical inactivity, sedentary behavior, inadequate fruit intake, glucose intolerance, or short sleep duration (all p > 0.05).

In contrast, overweight/obesity was strongly and significantly associated with hypertension (66.7% vs. 33.3%; χ^2 = 9.75, p = 0.002) and dyslipidemia (35.6% vs. 64.4%; χ^2 = 4.53, p = 0.033). These findings suggest that excessive body weight among undergraduate medical students is closely associated with adverse cardiometabolic profiles, particularly elevated blood pressure and abnormal lipid levels (Table 4).

Table 4: Lifestyle and Clinical Factors Associated with Overweight/Obesity (BMI ≥25 kg/m^2)

Variable	Outcome Present n (%)	Outcome Absent n (%)	χ^2	p-value
Female sex	28 (29.8%)	66 (70.2%)	0.02	0.887
Physical inactivity	34 (29.1%)	83 (70.9%)	0.00	1.000
Sedentary behavior	36 (27.5%)	95 (72.5%)	2.27	0.132
Inadequate fruit intake	39 (28.9%)	96 (71.1%)	0.00	1.000
Hypertension	10 (66.7%)	5 (33.3%)	9.75	0.002
Dyslipidemia	31 (35.6%)	56 (64.4%)	4.53	0.033
Glucose intolerance	23 (31.9%)	49 (68.1%)	0.42	0.518
Short sleep (<7 h)	22 (27.8%)	57 (72.2%)	0.02	0.901

Associations were assessed using the Chi-square test. Values are presented as n (%). A p-value <0.05 was considered statistically significant.

Distribution and Clustering of Major ASCVD Risk Factors

A high burden of ASCVD risk factors was observed in the cohort. Dyslipidemia was present in 64.4% of participants, while 53.3% had impaired glucose regulation and 28.9% were overweight or obese. Overall, 82.2% of participants had at least one major ASCVD risk factor, 50.4% had two or more risk factors, and 15.6% had three or more risk factors, indicating substantial early cardiovascular risk burden despite the young age of the population (Table 5).

Table 5: Distribution and Clustering of Major ASCVD Risk Factors

ASCVD risk factor	n (%)
Dyslipidemia	87 (64.4%)
Prediabetes or diabetes	72 (53.3%)
Overweight/obesity (BMI ≥25 kg/m^2)	39 (28.9%)
Hypertension	6 (4.4%)
Current smoking	2 (1.5%)
≥1 ASCVD risk factor	111 (82.2%)
≥2 ASCVD risk factors	68 (50.4%)
≥3 ASCVD risk factors	21 (15.6%)

ASCVD risk factors included overweight/obesity (BMI ≥25 kg/m^2), hypertension (SBP ≥140 mmHg and/or DBP ≥90 mmHg), dyslipidemia, impaired glucose regulation (prediabetes or diabetes), and smoking.

DISCUSSION

This study demonstrates a substantial burden of cardiometabolic risk factors among undergraduate medical students in Bangladesh. Despite the young mean age of the cohort, nearly one-third of participants were overweight or obese, and more than half exhibited prediabetes, alongside a high prevalence of dyslipidemia and features of metabolic syndrome. These findings are consistent with evidence indicating that South Asian populations develop cardiometabolic abnormalities at lower BMI thresholds and at younger ages compared with other ethnic groups, reflecting an inherent susceptibility to impaired glucose metabolism and cardiovascular risk early in life [12].

The observed prevalence of overweight and obesity (28.9%) underscores the ongoing epidemiologic transition in South Asia, characterized by dietary shifts, reduced physical activity, and increased sedentary behavior. Similar trends have been documented across South Asian populations, where rapid urbanization and lifestyle changes have contributed to rising adiposity and its cardiometabolic consequences [13]. The prevalence of overweight and obesity observed in this study is comparable to reports among medical students in other South Asian countries, including India and Sri Lanka, where prevalence estimates range from approximately 20% to 35%, reflecting a growing burden of excess adiposity in this population [14,15**].** Although prolonged sedentary behavior and inadequate physical activity were highly prevalent in this cohort, these factors were not independently associated with overweight/obesity in bivariate analyses. This lack of statistically significant association likely reflects limited variability in exposure, given the high prevalence of unhealthy behaviors across the cohort, thereby limiting the ability to detect differences between groups.

The metabolic profile of the cohort was notable for a high prevalence of dyslipidemia (64.4%) and prediabetes (51.9%), indicating early metabolic dysregulation. Dyslipidemia is a well-established contributor to atherosclerotic cardiovascular disease and has been reported at similarly high rates in urban South Asian populations [16]. While the prevalence of overt diabetes was low, the substantial burden of prediabetes mirrors regional estimates suggesting widespread early-stage glycemic abnormalities across South Asia [17]. The high prevalence of prediabetes observed in this cohort likely reflects early metabolic vulnerability characteristic of South Asian populations, combined with behavioral and lifestyle risk factors such as sedentary behavior, suboptimal dietary patterns, and psychosocial stress, which may accelerate the development of insulin resistance even in young adults [15]**.** These findings emphasize that metabolic risk frequently precedes clinically manifest disease in this demographic.

Bivariate analyses revealed strong associations between overweight/obesity and both hypertension and dyslipidemia. These associations are biologically plausible and align with established pathophysiological mechanisms linking excess adiposity with insulin resistance, chronic low-grade inflammation, endothelial dysfunction, and neurohormonal activation, all of which contribute to elevated blood pressure and adverse lipid profiles. The absence of statistically significant associations between overweight/obesity and other lifestyle factors should be interpreted cautiously, as the uniformly high prevalence of unhealthy behaviors reduces exposure contrast and statistical power, a limitation commonly encountered in cross-sectional studies of relatively homogeneous populations [18].

The high prevalence and clustering of ASCVD risk factors observed in this study are particularly concerning. More than 80% of participants had at least one major cardiovascular risk factor, and over half had multiple risk factors, indicating early cardiovascular risk accumulation. Previous longitudinal studies have demonstrated that clustering of cardiometabolic risk factors in early adulthood is strongly associated with increased

lifetime risk of cardiovascular disease, independent of risk factor severity at a single time point, underscoring the importance of early detection and intervention [19]. Although formal 10-year ASCVD risk estimation is not applicable in this age group, the presence of multiple cardiometabolic abnormalities suggests elevated lifetime cardiovascular risk. Early clustering of risk factors has been shown to significantly increase the likelihood of future cardiovascular disease, underscoring the importance of early prevention strategies in young adults [20, 21].

From a public health perspective, these findings are particularly concerning. Medical students represent future healthcare providers, and their personal health behaviors and metabolic profiles may influence both their long-term health and their effectiveness in promoting preventive health behaviors among patients. Early identification and targeted interventions aimed at improving lifestyle behaviors, promoting physical activity, encouraging healthy dietary habits, and reducing sedentary time may therefore have substantial long-term benefits. Integrating structured health promotion programs within medical education may serve as an effective strategy to mitigate cardiometabolic risk and improve overall health outcomes in this population.

Limitations

This study has several limitations. Its cross-sectional design precludes causal inference, and lifestyle behaviors were self-reported, introducing potential recall and reporting bias. Additionally, the single-institution setting may limit the generalizability of the findings to all medical students in Bangladesh. However, the study is strengthened by a comprehensive cardiometabolic assessment, including biochemical measurements, the use of oral glucose tolerance testing for accurate classification of glucose abnormalities, and standardized anthropometric and clinical evaluations.

CONCLUSION

Cardiometabolic risk factors are highly prevalent among undergraduate medical students in Bangladesh, with substantial rates of overweight/obesity, prediabetes, dyslipidemia, and clustering of cardiovascular risk factors. These findings underscore the urgent need for early, targeted preventive strategies and institutional health promotion initiatives in medical education to reduce the long-term risk of cardiometabolic disease and improve future population health outcomes.

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