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Prehypertension among Undergraduates: A Cross-Sectional Study of Medical and Non-Medical Students in Bangladesh

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Abstract: Prehypertension in young adults is a modifiable precursor to hypertension and later cardiovascular disease. Robust, stream-wise estimates among Bangladeshi university students are limited. We conducted an analytical cross-sectional study (October 2024-March 2025) among 402 undergraduates recruited via convenience sampling from Bangladesh Medical College (medical stream) and North South University (non-medical stream), Dhaka. Seated blood pressure was measured twice (1min apart) using a validated device; the mean was classified per JNC-7. A structured questionnaire captured sociodemographic and lifestyle factors. We reported prevalence, bivariate associations (χ^2), and multivariable logistic regressions for sociodemographic and lifestyle predictors. Overall prehypertension prevalence was 22.6% (91/402). The proportion was higher among medical students (24.9%) than non-medical students (20.4%); the difference was not statistically significant. Descriptively, prehypertension was more common in males, overweight students, smokers, short sleepers (5-6 h), hostel residents, and those reporting moderate stress. In adjusted models, no variable reached statistical significance; point estimates suggested higher odds with obesity and short sleep and lower odds with moderate (vs. mild) stress, with wide confidence intervals. More than one in five undergraduates screened had prehypertension, with concerning patterns across modifiable risks despite no single independent predictor. University health systems should implement routine BP screening and campus-tailored programs for weight management, sleep hygiene, stress reduction, and tobacco control.

Keywords: Prehypertension; Undergraduates; Medical vs Non-Medical; BMI; Bangladesh

1.Introduction

Cardiovascular diseases (CVDs) remain the leading global cause of mortality and are increasingly prominent in low and middle-income countries, including Bangladesh **(World Health Organization, 2020; Kuddus et al., 2022).** Blood pressure (BP) tracks along a continuum in which risk accrues before the conventional hypertension threshold. The category commonly termed "prehypertension" marks a clinically important, modifiable phase in that continuum. In the widely used JNC-7 schema, prehypertension corresponds to systolic BP 120-139 mmHg and/or diastolic BP 80-89 mmHg a range associated with accelerated progression to overt hypertension and elevated cardiovascular risk compared with normotension **(Chobanian et al., 2003; Greenlund et al., 2004; Gu et al., 2002).** The public-health logic flowing from this evidence is straightforward: detecting and addressing elevated-but sub-hypertensive-BP in young adults can compress future CVD risk and reduce the lifetime burden on primary care systems **(Addo, Smeeth and Leon, 2007; Happy et al., 2025; Sazzad et al., 2025).**

University students are a strategically important population for early BP prevention. Campus life can concentrate several drivers of elevated BP: high academic pressure, irregular sleep schedules, prolonged sedentary study time, convenience-driven dietary patterns with excess sodium and low potassium, social smoking, and ubiquitous caffeine use **(He and MacGregor, 2018; Ibrahim et al., 2014)**. Although students are typically young and perceived as healthy, the clustering of these modifiable factors can nudge resting BP upward in subtle but consequential ways. The problem is also systematically under-detected: young adults rarely present for routine primary care, so opportunistic campus screening may be both efficient and impactful **(Ibrahim et al., 2014).** Multi-country and regional studies in student cohorts frequently report that one in five or more fall into the prehypertensive range, with higher proportions among males and among those with higher body mass index (BMI), low physical activity, tobacco exposure, and short sleep **(Al-Mohaissen, 2020; Gyamfi et al., 2018; Abeetha et al., 2016; He and MacGregor, 2018; Tiva et al., 2025a).**

Bangladesh's demographic and lifestyle transitions heighten the relevance of student BP surveillance. Rapid urbanization, constrained opportunities for structured physical activity in dense cities, competitive academic pathways, and changing dietary patterns combine to shape cardiovascular risk at young ages **(Bangladesh Bureau of Statistics (BBS), 2020; World Health Organization, 2020)**. National risk-factor monitoring shows substantial burdens of elevated BP among adults, while disaggregated data for university populations remain comparatively sparse. The policy stakes are high: if a meaningful share of students already exhibit prehypertension, there is an actionable window to intervene before trajectories harden into established hypertension in the third and fourth decades of life **(Addo, Smeeth and Leon, 2007; World Health Organization, 2020; Rahman et al., 2024).**

Within student populations, there are plausible and policy-relevant differences between academic streams that deserve explicit study. Medical curricula often entail intensive study, irregular hours, night-time exam preparation, clinical postings, and cumulative sleep curtailment factors that can affect BP via neuroendocrine and behavioural pathways, potentially counterbalancing any protective effect of formal health knowledge **(Islam, Rahman and Ali, 2021; Javaheri, Omobomi and Redline, 2019; Tiva et al., 2025b).** Non-medical programs, by contrast, may feature different daily routines, social contexts, and cafeteria reliance that influence diet quality, sedentariness, and stimulant intake. Whether these distinct rhythms translate into measurable BP

differences is an empirical question with practical implications for campus-tailored prevention in Bangladesh's urban universities.

A second set of considerations concerns measurement and design. Reported prevalence of prehypertension varies widely across studies due to differences in sampling (single-site vs. multi-site; convenience vs. probabilistic), BP protocol (device type, rest period, number of readings), classification criteria, and behavioural measurement quality **(Addo, Smeeth and Leon, 2007; Ibrahim et al., 2014).** Single-visit BP with two readings the standard in many campus surveys can misclassify a small fraction of borderline cases due to transient influences (e.g., recent caffeine, acute stress), though standardized seated protocols still provide a credible snapshot for service planning **(Chobanian et al., 2003)**. Behavioural correlates such as perceived stress and sleep duration also vary by instrument and cut points; nonetheless, both have biologically plausible links to BP and repeatedly emerge in young-adult studies **(Grant et al., 2018; Javaheri, Omobomi, 2019; Al-Mohaissen, 2020; Tiva & Urbi, 2025**). Tobacco exposure often intermittent and social in university settings can acutely raise BP and, with repetition, contribute to endothelial dysfunction; hence strong tobacco-free campus policies remain a cornerstone of prevention **(Ibrahim et al., 2014).** On diet, the population effect of sodium reduction is especially salient in urban Bangladesh, where inexpensive, high-salt foods are readily available **(He and MacGregor, 2018; BBS, 2020).**

Against this background, the present study focuses on undergraduates drawn from two large, contrasting institutions in Dhaka one medical college and one non-medical university designed to enable both overall and stream-specific characterization of prehypertension. Dhaka's megacity context long commutes, limited recreational space, abundant low-cost processed foods, and sustained academic competition is an informative stress test for student cardiovascular risk. Disentangling how socio-demographic position (sex, income, residential status), lifestyle (smoking, physical activity, diet, salt use, caffeine), sedentary time, and sleep patterns align with BP in this setting can guide pragmatic campus interventions **(BBS, 2020; Ibrahim et al., 2014; He and MacGregor, 2018).**

Perceived stress merits particular attention. Experimental and observational studies suggest that sympathetic and hypothalamic-pituitary-adrenal activation under chronic stress can elevate BP and also trigger coping behaviors snacking, stimulants, tobacco that indirectly raise BP **(Grant, Magruder and Friedman, 2018).** In students, stress is episodic (e.g., midterms, finals) and often coincides with short sleep and higher caffeine intake, creating plausible "risk clusters." Evidence linking stress and prehypertension in campus samples is mixed partly due to measurement heterogeneity and limited sample sizes but the interventions (stress-management training, cognitive-behavioural strategies, schedule hygiene) are low-cost and scalable within university infrastructures **(Grant, Magruder and Friedman, 2018; Al-Mohaissen, 2020).** Sleep is equally actionable: short sleep duration and irregular timing are associated with higher BP via autonomic imbalance, sodium handling, and metabolic effects **(Javaheri, Omobomi and Redline, 2019).** Embedding sleep-hygiene content into student orientation and counselling services is, therefore, a high-leverage opportunity.

Two additional context points sharpen the study's policy relevance. First, young adults in Bangladesh are at a stage where campus services health centers, counselling, sports facilities can deliver preventive interventions at

scale with minimal stigma. Second, the same institutions often run mandatory health talks or co-curricular programs that could incorporate BP education, diet and salt reduction, tobacco cessation, sleep-hygiene, and structured physical activity with relatively minor operational changes **(Ibrahim et al., 2014; He and MacGregor, 2018).** If stream-specific differences exist, curricula can be tailored: for example, integrating sleep-hygiene modules and stress-management workshops into medical timetables, or re-engineering cafeteria menus and facilitating intramural activity in non-medical campuses **(Islam, Rahman and Ali, 2021).**

Despite growing regional literature, three gaps persist. First, relatively few Bangladesh-based studies have reported stream-specific estimates within a single urban context using a common protocol; most are single-stream or multi-site without within-city contrasts **(Al-Mohaissen, 2020; Gyamfi et al., 2018).** Second, many campus surveys under-measure behaviors such as caffeine intake, sitting time, or discretionary salt use, despite their theoretical and practical relevance **(He and MacGregor, 2018; Ibrahim et al., 2014).** Third, limited power is common: with outcome prevalence near 20-25%, detecting adjusted associations of modest magnitude requires sample sizes that many student studies lack **(Addo, Smeeth and Leon, 2007)**. Clarifying these issues in Dhaka is valuable for calibrating campus programs and for informing national NCD strategies that increasingly recognize youth as a prevention priority **(World Health Organization, 2020; BBS, 2020).**

Accordingly, we conducted an analytical cross-sectional study among 402 undergraduates from a medical college and a non-medical university in Dhaka, Bangladesh, using standardized seated BP measurement (two readings with a validated device after rest) and a structured questionnaire covering socio-demographic variables, health behaviors (smoking, physical activity, diet, red-meat intake, discretionary salt, caffeine), daily sitting time, sleep duration, and perceived stress. The study was designed to (i) estimate the prevalence of prehypertension in this urban student population; (ii) examine socio-demographic and lifestyle correlates that are modifiable within campus health systems; and (iii) compare distributions and associations between medical and nonmedical streams under a shared measurement protocol. In line with prior literature, we hypothesized higher proportions of prehypertension in males and in students with elevated BMI, tobacco exposure, short sleep, and higher perceived stress, with possible stream-specific differences reflecting distinct academic demands and daily routines **(He and MacGregor, 2018).**

By providing stream-specific estimates and a broad behavioural profile within Bangladesh's largest urban center, this study seeks to inform pragmatic campus interventions capable of bending early BP trajectories before they consolidate into adult hypertension **(Ansari et al., 2024; Hossain et al., 2024)**. The approach aligns with contemporary prevention strategy shifting the distribution of BP in the population through upstream, environment-sensitive measures rather than waiting for clinical thresholds to be crossed **(Addo, Smeeth and Leon, 2007; World Health Organization, 2020; He and MacGregor, 2018).** In doing so, it adds context-rich evidence to a literature that is still thin for Bangladeshi university students and directly actionable for student health services.

2. Methodology

2.1 Study design and setting

This analytical cross-sectional study was implemented among undergraduate students in Dhaka, Bangladesh, to characterize the prevalence and correlates of prehypertension in an urban university context. Two institutions were purposefully selected to represent contrasting academic streams within the same city: a medical college and a non-medical private university. Conducting the study within a single megacity reduced heterogeneity in environmental exposures while allowing a meaningful comparison between programmatic streams that differ in academic demands, schedules, and daily routines relevant to blood pressure risk.

2.2 Study period

Data collection took place between October 2024 and March 2025, covering regular teaching weeks as well as typical midterm and final-exam periods at both institutions. This window captured natural variation in student stress, sleep, and time-use patterns that could plausibly influence blood pressure and related behaviors, while avoiding extended campus closures or holiday periods that might distort usual routines.

2.3 Target population and eligibility

The target population comprised full-time undergraduate students aged eighteen years or older who were currently enrolled at either institution at the time of recruitment. Eligibility required the ability and willingness to provide written informed consent and to complete both the questionnaire and the blood pressure assessment during a single session. Students who self-reported a prior diagnosis of hypertension or prehypertension were excluded to focus on undiagnosed elevation within the student population and to avoid classification ambiguity introduced by treatment or prior clinical labelling.

2.4 Sampling strategy and sample size

A convenience sampling approach was used at both sites because it allowed efficient on-campus recruitment during short breaks and noninstructional windows without disrupting scheduled classes. The sample size was determined a priori using a two-proportion comparison framework to detect a plausible difference in prehypertension between academic streams with a two-sided alpha of 0.05 and power of 80 percent. Drawing on regional estimates for student populations, the calculation yielded a target of 201 participants per stream, for a total of 402 undergraduates. Fixing equal allocation across the two strata enhanced precision for stream-specific estimates and facilitated balanced multivariable modelling.

2.5 Recruitment procedures and field workflow

Following administrative permission at each institution, trained field researchers introduced the study in classrooms and common areas, screened interested students for eligibility, and obtained written informed consent prior to data collection. To minimize measurement artefacts, the sequence began with a brief waiting period and a seated rest of at least five minutes before blood pressure measurement. Questionnaire administration and blood pressure assessment were completed in a quiet, well-ventilated space with seating that supported correct posture and arm positioning. Daily field logs documented the number approached,

screened, consented, and enrolled, alongside timing, setting, and any protocol deviations, which supported contemporaneous supervision and quality control.

2.6 Variables and operational definitions

The primary outcome was prehypertension defined according to the JNC-7 classification as a mean systolic blood pressure of 120-139 mmHg and/or a mean diastolic blood pressure of 80 89 mmHg obtained during a single visit. For descriptive completeness, students with mean readings below 120/80 mmHg were considered normotensive and those at or above 140/90 mmHg were considered hypertensive, although analyses centered on prehypertension. Explanatory variables were captured using a structured instrument consistent with the thesis. Sociodemographic variables included age in years, sex, year of study, residential status distinguished as living with family or in a hostel, and household income categorized into predefined bands. Anthropometry included body mass index calculated from measured height and weight and categorized using World Health Organization cut-points into underweight, normal, overweight, and obese. Lifestyle and behavioural variables encompassed current smoking status, frequency of physical activity as typically practiced during a regular week, habitual consumption of fruits and vegetables, frequency of red-meat intake, discretionary or extra salt use during or after meal preparation, habitual caffeine intake from tea, coffee, or energy drinks according to the questionnaire's bands, daily sitting time expressed in hours and grouped by study thresholds, average nightly sleep duration categorized into short, adequate, and longer sleep, and perceived stress level assessed on an ordinal scale consistent with the thesis instrument.

2.7 Instruments and measurement protocols

Blood pressure was measured with a validated oscillometric upper-arm device suitable for adult use. Participants were seated with back support and feet flat on the floor, and the measurement arm was positioned at heart level. After a minimum of five minutes of quiet rest, two readings were taken one minute apart and the mean was used for classification. The cuff was selected to match mid-arm circumference to avoid systematic measurement error from sizing errors. Where feasible in the campus setting, students were advised to abstain from caffeine, smoking, or vigorous activity for at least thirty minutes before measurement; when this was not possible, the timing of recent intake was noted. The bilingual questionnaire, developed in Bangla and English, underwent forward translation, reconciliation, and pilot testing to ensure clarity and appropriateness across different academic backgrounds. Minor refinements to wording and item order were implemented following the pilot to optimize comprehension and response distributions. Trained researchers administered the instrument in a standardized order immediately before or after blood pressure measurement to minimize participant burden and loss to follow-up.

2.8 Data quality assurance

Multiple safeguards were built into field operations to protect data integrity. All researchers received protocol training that emphasized standardized interviewing, environmental control before blood pressure assessment, and correct posture, rest, and repeated-measure procedures. A concise set of standard operating procedures and a quick-reference checklist supported adherence during sessions. On-site supervision ensured that rest time, cuff

placement, device operation, and interview flow remained consistent across teams and days. Completed forms were reviewed each day for completeness and logical consistency, and clarifications were obtained promptly when feasible. Devices were inspected each morning for battery status and proper function, and cuffs were checked regularly for wear and fit. These procedures reduced avoidable variation and improved the reliability of both questionnaire and biometric measurements.

2.9 Data management

Paper forms were stored securely and transported for entry into a structured database for analysis in STATA, consistent with the version used in the thesis. Data cleaning followed a predefined plan that included range and validity checks for continuous and categorical variables, verification of skip logic, inspection for outliers, and reconciliation of any minor inconsistencies. De-identification was applied at the point of entry by assigning unique study identifiers, while any linkage to personally identifying information was stored separately under restricted access. The analytic dataset used for modelling and tables excluded direct identifiers and preserved only the variables necessary for replication of the reported results.

2.10 Statistical analysis

Analyses proceeded according to the thesis plan in a sequence designed to balance transparency and parsimony. Descriptive statistics summarized the sample overall and by academic stream, with counts and percentages reported for categorical variables and the overall and stream-specific prevalence of prehypertension presented to frame subsequent modelling. Bivariate associations between prehypertension and each covariate were examined using chi-square tests or Fisher's exact tests when expected cell counts were small, and crude effect sizes were conveyed through prevalence comparisons or unadjusted odds ratios as appropriate. To address measured confounding while preserving model stability in relation to outcome frequency, two logistic regression models were specified a priori. The sociodemographic model included age, sex, year of study, residential status, and household income. The lifestyle model included body mass index category, smoking status, physical activity frequency, fruit and vegetable intake, red-meat intake, discretionary salt use, habitual caffeine intake, daily sitting time, sleep duration, and perceived stress. Adjusted odds ratios with 95 percent confidence intervals were reported for both models, and statistical significance was assessed at a two-sided alpha of 0.05. Given that prehypertension prevalence in student populations often lies near one in five, interpretation emphasized the direction and magnitude of effects and their precision rather than exclusive reliance on p-values. Model diagnostics included standard goodness-of-fit assessments and evaluation of multicollinearity with variance-inflation factors where applicable.

2.11 Ethical considerations

The study protocol received approval from the Institutional Review Board of North South University. Participation was voluntary, and all students provided written informed consent after receiving information about the study objectives, procedures, minimal risks associated with cuff inflation, expected time commitment, confidentiality protections, and their right to decline or withdraw at any time without academic penalty. Identifying information was stored separately from analytic data, which were maintained in password-

protected files accessible only to the research team. All procedures adhered to the principles of the Declaration of Helsinki throughout recruitment, data collection, and data handling.

2.12 Bias and limitations embedded in design

The design acknowledges several limitations that inform interpretation. Convenience sampling at two institutions limits generalizability to other campuses in Bangladesh, particularly those outside Dhaka or with different academic structures. Self-reported behaviors, including diet, physical activity, sleep, caffeine intake, and perceived stress, are potentially subject to recall and social desirability bias. Single-visit blood pressure with two seated readings, while standardized and practical for campus surveys, may misclassify some borderline cases due to transient influences such as recent caffeine consumption or acute academic stress. Multivariable models addressed measured covariates identified a priori; nonetheless, residual confounding from unmeasured factors remains possible. These considerations reinforce cautious interpretation of adjusted associations and support a pragmatic emphasis on modifiable patterns that are actionable within campus health services and student-life programming.

Bangladesh's student population.

3. Results and Discussion

3.1 Participant Profile and Stream-Wise Context

A total of 402 undergraduates participated with equal allocation across academic streams (201 medical; 201 non-medical). The sample reflects typical urban university life in Dhaka, with a slightly male-skewed composition overall and a mix of living arrangements (family homes vs hostels). Baseline contrasts between streams provide an interpretive lens for blood-pressure (BP) results: medical students were somewhat older on average, included a greater proportion of females, and showed a higher frequency of overweight/obesity, whereas non-medical students were more often male, more likely to live in hostels, and reported higher smoking prevalence, greater red-meat intake, and shorter sleep duration. These stream-specific exposure bundles plausibly intersect with BP risk and help situate the subsequent findings.

Table 1. Sociodemographic Characteristics of the Participants

Variables	Medical (n=201)	Non-Medical (n=201)	p-value (χ^2)
Age (years)			<0.001
≤ 20 years	28 (13.9%)	71 (35.3%)	
21–23 years	125 (62.2%)	112 (55.7%)	
≥ 24 years	48 (23.9%)	18 (9.0%)	
Sex			<0.001
Male	74 (36.8%)	127 (63.2%)	

Variables	Medical (n=201)	Non-Medical (n=201)	p-value (χ^2)
Female	127 (63.2%)	74 (36.8%)	
Year of study			0.001
1st–2nd year	49 (24.4%)	76 (37.8%)	
3rd–4th year	126 (62.7%)	110 (54.7%)	
≥ 5th year	26 (12.9%)	15 (7.5%)	
Residence			<0.001
With family	97 (48.3%)	58 (28.9%)	
Hostel	104 (51.7%)	143 (71.1%)	
Marital status			0.157
Unmarried	187 (93.0%)	185 (92.0%)	
Married	14 (7.0%)	16 (8.0%)	
Income (monthly)			<0.001
≤ 50,000 BDT	61 (30.3%)	99 (49.3%)	
50,001–100,000 BDT	116 (57.7%)	49 (24.4%)	
> 100,000 BDT	24 (11.9%)	53 (26.4%)	

Table 2. Lifestyle and Behavioural Characteristics of the Participants

Variables	Medical (n=201)	Non-Medical (n=201)	p-value (χ^2)
BMI category			0.003
Underweight	16 (8.0%)	23 (11.4%)	
Normal	117 (58.2%)	134 (66.7%)	
Overweight	50 (24.9%)	38 (18.9%)	
Obese	18 (9.0%)	6 (3.0%)	
Smoking			<0.001
Yes	50 (24.9%)	92 (45.8%)	

Variables	Medical (n=201)	Non-Medical (n=201)	p-value (χ^2)
No	151 (75.1%)	109 (54.2%)	
Physical activity			<0.001
None	37 (18.4%)	24 (11.9%)	
Occasional	109 (54.2%)	78 (38.8%)	
Regular	55 (27.4%)	99 (49.3%)	
Fruit/veg intake			0.010
Low	72 (35.8%)	96 (47.8%)	
Moderate	92 (45.8%)	82 (40.8%)	
High	37 (18.4%)	23 (11.4%)	
Red-meat intake			0.020
Low	90 (44.8%)	72 (35.8%)	
Moderate	79 (39.3%)	83 (41.3%)	
High	32 (15.9%)	46 (22.9%)	
Extra salt use			0.001
Yes	61 (30.3%)	96 (47.8%)	
No	140 (69.7%)	105 (52.2%)	
Caffeine intake			<0.001
Low/None	100 (49.8%)	63 (31.3%)	
Moderate	78 (38.8%)	96 (47.8%)	
High	23 (11.4%)	42 (20.9%)	
Daily sitting (h)			0.012
< 4 hours	66 (32.8%)	42 (20.9%)	
4–6 hours	95 (47.3%)	97 (48.3%)	
> 6 hours	40 (19.9%)	62 (30.8%)	

Variables	Medical (n=201)	Non-Medical (n=201)	p-value (χ^2)
Sleep duration			0.004
≤ 6 hours	65 (32.3%)	92 (45.8%)	
7–8 hours	106 (52.7%)	78 (38.8%)	
> 8 hours	30 (14.9%)	31 (15.4%)	
Perceived stress			0.224
Mild	80 (39.8%)	67 (33.3%)	
Moderate	93 (46.3%)	97 (48.3%)	
High	28 (13.9%)	37 (18.4%)	

3.2 Overall Burden of Prehypertension

Using JNC-7 classification from the mean of two seated readings, overall prehypertension prevalence was 22.6% (91/402), with 311 students remaining normotensive. Stream-wise proportions were modestly higher among medical students (24.9%; 50/201) than non-medical students (20.4%; 41/201), although this difference did not reach statistical significance. In practical terms, roughly one in five students fell into the prehypertensive range consistent with regional campus surveys that often report similar or higher subclinical elevations (**Al-Mohaissen, 2020; Gyamfi et al., 2018; Abeetha et al., 2018**). The slightly higher proportion among medical students' mirrors reports from intensive academic programs where prolonged nocturnal study, early clinical responsibilities, and chronic sleep restriction are common; each can increase sympathetic tone and encourage compensatory behaviors (caffeine use, irregular meals) that nudge BP upward in otherwise healthy young adults (**Javaheri, Omobomi, & Redline, 2019; He & MacGregor, 2018**).

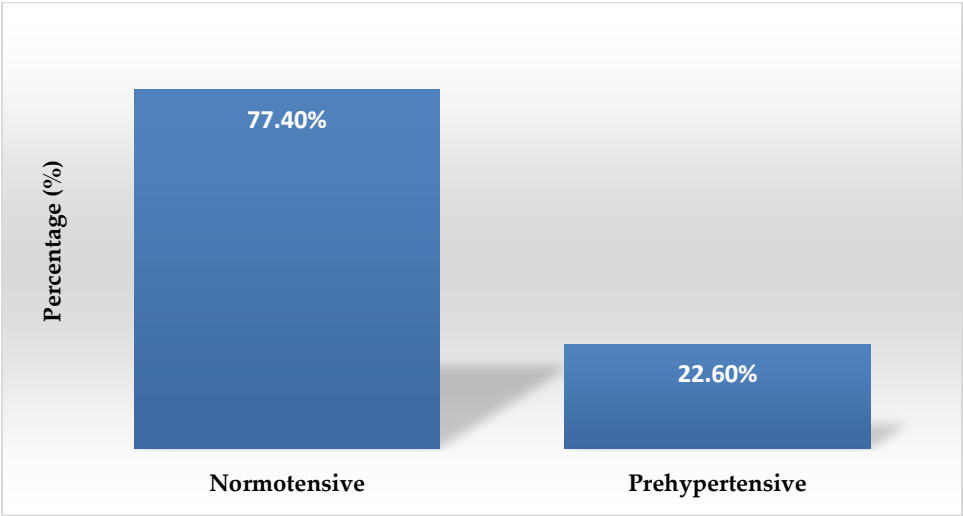

Figure 1. Overall Prevalence of Prehypertension Among Bangladeshi Undergraduates

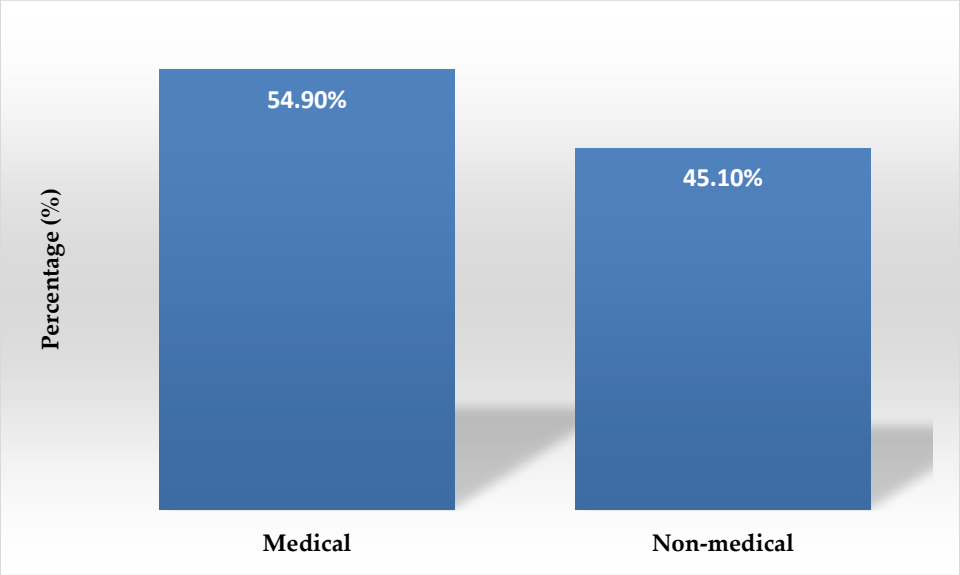

Figure 2. Prehypertensive Students by Academic Stream

3.3 Bivariate Associations: Directional Risk Patterns

Crude cross-tabulations suggested higher proportions of prehypertension among males, students with elevated BMI, smokers, hostel residents, and short sleepers (≤6 hours). Several comparisons approached but did not cross conventional statistical thresholds; others were clearly non-significant yet moved in risk-concordant directions, which is expected when multiple modest effects co-occur in a relatively homogeneous young cohort. Mechanistically, adiposity increases resting BP via insulin resistance, renin–angiotensin–aldosterone system activation, sympathetic overactivity, and vascular remodeling; even modest BMI increments can raise resting BP (**Addo, Smeeth, & Leon, 2007**). Tobacco exposure common in intermittent "social" patterns on campus produces acute pressor responses and, with repetition, endothelial injury and arterial stiffening (**Yun et al., 2015**). Sleep curtailment and irregular timing endemic around exams heighten sympathetic activity and impair sodium handling, raising BP in otherwise healthy students (**Javaheri, Omobomi, & Redline, 2019; Meena & Rita, 2017**). Dietary factors, notably high sodium and frequent red-meat intake, also matter in urban Bangladesh, where low-cost, salty prepared foods and discretionary table salt are entrenched (**He & MacGregor, 2018; Renata, Dariush, & Sarah, 2010**). Hostel living can bundle late-night schedules, cafeteria reliance, and sporadic activity into a coherent risk pattern (**Sogari et al., 2018**).

Table 3. Bivariate Associations Between Sociodemographic Factors and Prehypertension

Variables	No prehypertension	Prehypertension	χ^2 (df)	p-value
Sex			2.807 (1)	0.094
Male	164 (52.7%)	37 (40.7%)		
Female	147 (47.3%)	54 (59.3%)		
Year of study			1.347 (2)	0.510

Variables	No prehypertension	Prehypertension	χ^2 (df)	p-value
1st–2nd year	102 (32.8%)	23 (25.3%)		
3rd–4th year	194 (62.2%)	42 (46.2%)		
≥ 5th year	15 (4.8%)	26 (28.6%)		
Residence			0.002 (1)	0.964
With family	113 (36.3%)	28 (30.8%)		
Hostel	198 (63.7%)	63 (69.2%)		
Marital status			0.030 (1)	0.862
Unmarried	329 (96.6%)	43 (47.3%)		
Married	12 (3.4%)	48 (52.7%)		
Income			1.478 (2)	0.478
≤ 50,000 BDT	140 (45.1%)	20 (22.0%)		
50,001–100,000 BDT	132 (42.5%)	33 (36.3%)		
> 100,000 BDT	38 (12.2%)	38 (41.8%)		

Table 4. Bivariate Associations Between Lifestyle Factors and Prehypertension

Variables	No prehypertension	Prehypertension	χ^2 (df)	p-value
BMI category			6.916 (3)	0.075
Underweight	30 (9.7%)	9 (9.9%)		
Normal	206 (66.3%)	45 (49.5%)		
Overweight	54 (17.4%)	20 (22.0%)		
Obese	21 (6.8%)	17 (18.7%)		
Smoking			0.260 (1)	0.610
Yes	121 (38.9%)	21 (23.1%)		
No	190 (61.1%)	70 (76.9%)		
Physical activity			2.349 (2)	0.309
None	43 (13.8%)	18 (19.8%)		
Occasional	153 (49.2%)	34 (37.4%)		
Regular	115 (37.0%)	39 (42.9%)		
Fruit/vegetable intake			5.968 (2)	0.051

Variables	No prehypertension	Prehypertension	χ^2 (df)	p-value
Low	133 (42.8%)	35 (38.5%)		
Moderate	143 (46.0%)	31 (34.1%)		
High	35 (11.3%)	25 (27.5%)		
Red-meat intake			2.282 (2)	0.320
Low	125 (40.3%)	37 (40.7%)		
Moderate	132 (42.5%)	30 (33.0%)		
High	54 (17.4%)	24 (26.4%)		
Extra salt use			1.223 (1)	0.269
Yes	116 (37.3%)	41 (45.1%)		
No	195 (62.7%)	50 (54.9%)		
Caffeine intake			3.472 (2)	0.176
Low/None	109 (35.1%)	34 (37.4%)		
Moderate	157 (50.5%)	17 (18.7%)		
High	45 (14.5%)	40 (44.0%)		
Daily sitting (hours)			0.347 (2)	0.840
< 4 hours	84 (27.0%)	24 (26.4%)		
4–6 hours	143 (46.0%)	49 (53.8%)		
> 6 hours	84 (27.0%)	18 (19.8%)		
Sleep duration			4.866 (2)	0.088
≤ 6 hours	119 (38.3%)	38 (41.8%)		
7–8 hours	140 (45.0%)	44 (48.4%)		
> 8 hours	52 (16.7%)	9 (9.9%)		
Perceived stress			0.399 (2)	0.819
Mild	121 (38.9%)	26 (28.6%)		
Moderate	153 (49.2%)	37 (40.7%)		
High	37 (11.9%)	28 (30.8%)		

3.4 Multivariable Models: Adjusted Signals and Precision

Two prespecified logistic models one emphasizing sociodemographic variables, another focusing on lifestyle/behavioral factors did not yield statistically significant independent predictors at α=0.05. Still, point estimates trended as expected (e.g., higher odds with obesity vs normal BMI; higher odds with short sleep vs longer sleep; lower odds with moderate vs mild perceived stress), albeit with wide confidence intervals. This lack of conventional significance is unsurprising given (i) limited statistical power with 91 outcomes (the analysis was geared to detect large effects; modest adjusted odds ratios are typical in multifactorial young-adult BP) (**Addo, Smeeth, & Leon, 2007**), (ii) compressed exposure variance in a narrow age band with shared routines, (iii) non-differential misclassification from feasible self-report categories for diet, sleep, sitting time, caffeine, and stress (bias toward the null) (**Grant, Magruder, & Friedman, 2018**), and (iv) single-visit BP susceptible to transient influences (recent caffeine, acute exam stress, short prior-night sleep) that can misclassify borderline cases (**Chobanian et al., 2003**). In this context, effect sizes and interval widths are more informative than p-values alone.

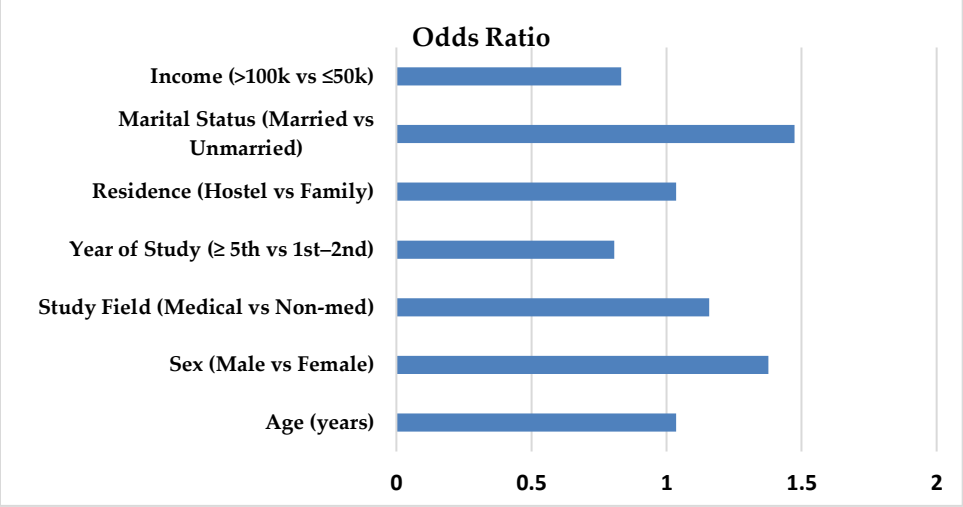

Figure 3. Multivariable logistic regression for prehypertension: sociodemographic model (Model A)

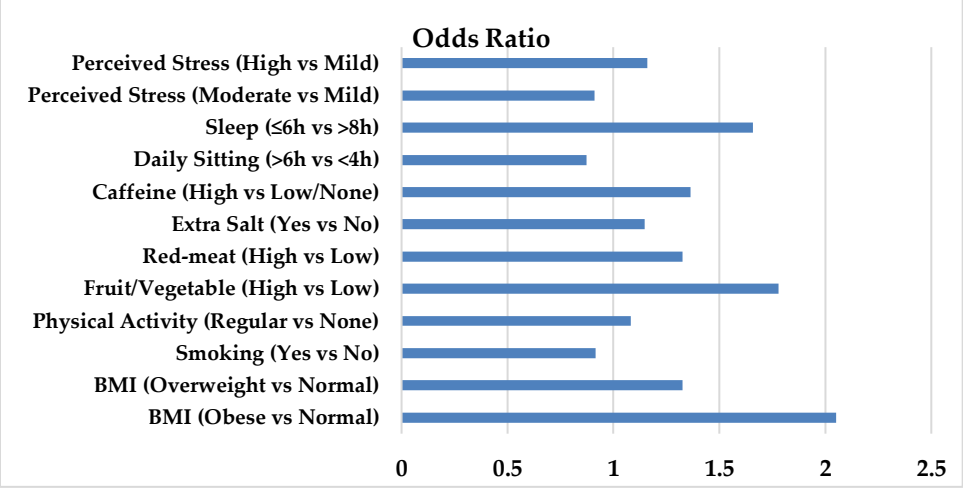

Figure 4. Multivariable logistic regression for prehypertension: lifestyle model (Model B)

3.5 Synthesis with Literature: A Diffuse, Modifiable Risk Landscape

The pattern observed here early, sub-threshold BP elevation that tracks with modifiable behaviours and resists attribution to a single dominant determinant is typical of university cohorts globally (**Greenlund et al., 2004; Gu et al., 2002; Al-Mohaissen, 2020; Gyamfi et al., 2018**). Male-greater tendencies align with body composition, autonomic tone, and behavior bundles (tobacco, caffeine, late-night schedules) that often intensify during the university years (**Ibrahim et al., 2014**). Recurrent short-sleep signals in epidemiology and mechanism bolster the plausibility of imprecise estimates in small student samples (**Javaheri, Omobomi, & Redline, 2019; Joshua, Soumya, & Naima, 2021**). Dietary sodium remains a cornerstone theme; reformulating common foods in canteens and nearby vendors is a realistic lever in Dhaka (**He & MacGregor, 2018**). Collectively, these strands suggest many small levers acting together, a scenario where population-level health promotion is more impactful than hunting for a single culprit (**Addo, Smeeth, & Leon, 2007**).

3.6 Practical Implications for Campus Health Policy

Given the diffuse risk architecture, campus-level strategies should aim to shift the entire BP distribution slightly downward across the student body rather than treating only those who cross a threshold:

Normalize screening: Embed routine BP checks in registration weeks and pre-exam periods with brief counselling and digital reminders for follow-up (**Chobanian et al., 2003**).

Food environment: Partner with dining services and adjacent vendors to reduce sodium in common items, flag lower-salt options, and increase fruit/vegetable availability with salient labels that reduce decision friction (**He & MacGregor, 2018**).

Sleep regularity: Incorporate short sleep-hygiene modules into orientation and deploy micro-nudges (lights-out cues, study-break timers) during exam cycles (**Javaheri, Omobomi, & Redline, 2019**).

Movement and weight: Offer time-efficient gym circuits, peer-led clubs, and intramurals that fit busy timetables; add brief nutrition counselling at clinic touchpoints (**Kazuko, Toshiki, & Hirofumi, 2003**).

Tobacco control: Pair smoke-free policies with easy-access cessation support tailored to intermittent/social users (brief advice, quitlines, low-burden follow-ups) (**Ibrahim et al., 2014; Yun et al., 2015**).

Hostel-focused nudges: Pilot late-evening caffeine limits, low-sodium night snacks, movement prompts in study lounges, and quiet-hour norms to address concentrated risk clusters (**Sogari et al., 2018**).

3.7 Strengths, Limitations, and Next Steps

Strengths include a dual-institution design within one megacity (lowering environmental heterogeneity), a standardized two-reading seated BP protocol, bilingual instrument development with piloting, and prespecified analyses spanning both crude and adjusted views. These features support internal validity and help explain alignment with external evidence (**Al-Mohaissen, 2020; Ibrahim et al., 2014**).

Limitations temper causal interpretation: convenience sampling at two institutions limits generalizability; self-reported exposures are coarse and vulnerable to recall/social-desirability bias; single-visit BP increases

misclassification risk at the prehypertensive boundary; and residual confounding remains from unmeasured or imprecisely measured factors (objective sodium intake, sleep regularity, family history, stimulant use) (**Chobanian et al., 2003; Grant, Magruder, & Friedman, 2018**). The modest number of events (n=91) further explains wide confidence intervals and why otherwise plausible predictors did not reach conventional significance.

Design refinements are straightforward: (i) multi-site, probability-based sampling across public and private universities; (ii) repeated BP measures on separate days or use of home/ambulatory monitoring in a subsample; (iii) objective exposures (24-h urine sodium or repeated recalls; accelerometry for activity/sitting; wearables or diaries for sleep regularity; validated multi-item stress scales) to reduce bias-toward-the-null (**Grant, Magruder, & Friedman, 2018**); (iv) longitudinal follow-up across terms to resolve temporal ordering among stress, sleep disruption, behavior change, and BP transitions; and (v) campus-embedded pragmatic trials (canteen salt reformulation, sleep-hygiene micro-modules, low-touch tobacco cessation) to estimate real-world, scalable effects (**He & MacGregor, 2018**).

3.8 Actionable outcomes

In this Dhaka student cohort, just over one in five undergraduates met JNC-7 criteria for prehypertension, with a slightly higher proportion among medical students that did not reach statistical significance. Crude associations clustered in expected, modifiable domains adiposity, smoking, short sleep, hostel living, and diet while adjusted models were imprecise rather than contradictory **(Akhter et al., 2025)**. Read together, the evidence depicts a diffuse risk landscape in which many small levers each nudge BP upward, creating an early warning signal for later hypertension. The most effective response is to shift the distribution: normalize screening, tune the food environment toward lower sodium and higher produce, scaffold sleep regularity around exam cycles, promote feasible movement, and pair smoke-free policies with friction-free cessation support. In population-prevention terms, moving the whole curve a few millimetres of mercury downward across thousands of young adults will likely yield larger long-term benefits than focusing narrowly on a small group already beyond a diagnostic threshold (**Addo, Smeeth, & Leon, 2007; He & MacGregor, 2018; Javaheri, Omobomi, & Redline, 2019**).

4. Conclusion and Policy Recommendations

This study shows that prehypertension is common among undergraduates in Dhaka, with 22.6 percent meeting JNC-7 criteria under standardized seated measurement. The proportion was modestly higher in medical students than in non-medical students, although the difference was not statistically significant. Descriptive patterns indicated greater burden among males, students with excess weight, current smokers, short sleepers, and hostel residents; however, none of these covariates achieved statistical significance in prespecified multivariable models and confidence intervals were wide. Taken together, the evidence points to a diffuse, multifactorial risk profile in which several small, modifiable influences act concurrently rather than a single dominant determinant, underscoring the value of broad campus-level prevention rather than narrowly targeted interventions.

University health services should institutionalize routine blood pressure screening with brief, structured counselling and follow-up to normalize awareness and facilitate early risk modification. Campus programming ought to emphasize healthy weight through accessible nutrition guidance and time-efficient physical activity opportunities aligned to academic timetables. Sleep-hygiene education should be embedded in orientation and reinforced before assessment periods, coupled with practical supports that improve sleep regularity and duration. Tobacco control should combine a smoke-free campus environment with easy access to cessation support appropriate for intermittent and social use patterns seen in this age group. Dining services should progressively reduce discretionary salt and expand appealing, affordable options rich in fruits and vegetables, accompanied by simple menu labelling to enable lower-sodium choices without added burden. Because adjusted associations in this study were imprecise, these actions are best framed as population-wide health promotion delivered to all students, aiming to shift the overall blood pressure distribution rather than focusing solely on high-risk subgroups.

Future research should strengthen external validity through probability-based sampling across multiple universities and reduce outcome misclassification with repeated blood pressure assessments on separate days or the inclusion of home or ambulatory monitoring in subsamples. Exposure assessment should be enhanced using objective or validated tools, including accelerometry for activity and sedentary time, 24-hour urine or repeated dietary recalls for sodium intake, and wearable-based logs for sleep duration and regularity, alongside validated stress instruments to separate perceived stress from related constructs. Longitudinal designs following students across academic terms would clarify temporal ordering among stress, sleep, behaviour change, and blood pressure transitions. Pragmatic trials or phased operational changes such as cafeteria salt reformulation, structured sleep-hygiene modules, or brief tobacco-cessation interventions should be embedded within university systems to estimate real-world effects and inform scalable policy across Bangladeshi campuses

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Author Contribution

The authors were involved in the creation of the study design, data analysis, and execution stages. Every writer gave their consent after seeing the final work.

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A statement of conflicting interests

The authors declare that none of the work reported in this study could have been impacted by any known competing financial interests or personal relationships.

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