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Unveiling the Burden of NCDs Among University Students and Associated Risk Factors Using the WHO STEPwise Approach: A Cross-Sectional Study in Bangladesh

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ABSTRACT

Background and Aims: The burden of noncommunicable diseases (NCDs) is on the rise, even among university students, and is responsible for a high proportion of death and disability worldwide, especially in developing countries. Hence, this study aimed to identify the prevalence and distribution of risk factors for NCDs among university students in Bangladesh.

Methods: A cross-sectional study was conducted among 460 students from different universities in Bangladesh from October to November 2023 using a validated and structured WHO STEPS Questionnaire.

Results: Of the 460 students, 63.7% were male, and most of the participants belonged to 21–25 years of age. A lower prevalence of smoking (10%) and alcohol consumption (2.8%) was observed among them. More than half of the students were involved in low physical activity (< 600 metabolic equivalent tasks [MET] minutes/week). Insufficient fruit and vegetable intake (< 5 servings daily) was more prevalent (80%) among the respondents. Approximately two-fifty of the participants were overweight/obese (Body mass index [BMI] ≥ 23 kg/m²). The prevalence of elevated blood pressure, high blood sugar, and raised cholesterol was 24.1%, 8%, and 10.2%, respectively. Only 5.2% of students were free from any NCD risk factors, and each student had an average of two risk factors.

Conclusion: The high prevalence of NCD risk factors among undergraduate and graduate university students warrants effective public health strategies to minimize the development of NCDs in their later lives.

Md Shahedul Islam and Marjia Sultana contributed equally to this study.

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1 | Introduction

Noncommunicable diseases (NCDs), a group of illnesses, are the leading causes of mortality worldwide [1]. Globally, about 41 million deaths, or more than 74% of all fatalities per year, occurred due to NCDs [2]. World Health Organization (WHO) mainly emphasizes four categories of NCDs: diabetes, cancer, chronic respiratory diseases, and cardiovascular diseases (CVDs), which are responsible for 80% of all premature deaths per year globally. Among these, CVDs account for the majority of mortality (17.9 million/year) caused by NCDs, followed by malignancies (9.3 million/year), chronic respiratory diseases (4.1 million/year), and diabetes (2.0 million/year). For low and middle-income countries, including Bangladesh, NCDs became a serious threat, as around 77% of all NCDs global fatalities occurred in these countries [3]. Adverse financial and social repercussions affect individuals, families, society, and the country as a whole when premature deaths and disabilities from NCDs occur [4].

NCDs resulting from individual or combination of familial, physiological, environmental, and lifestyle issues have chronic health effects and frequently require long-term therapy and care [5]. The risk factors of NCDs can be behavioral, such as poor dietary habits, smoking, insufficient physical activity, excessive alcohol consumption, raised fat and sodium intake, and low fruit and vegetable intake, all of which result in metabolic risk factors, including increased blood pressure, raised blood glucose level, overweight/obesity and hyperlipidemia [6]. However, the risk factors are highly modifiable or avoidable if proper measures can be taken. The complications of NCDs generally clinically appear long after exposure to the risk factors and an asymptomatic period. Young people, especially university students, are more susceptible to many of these risk factors [7].

University students comprise a significant portion of the young adults of a country. This is the period when an individual has to adapt to a new environment different from their home [8]. A number of social and cultural changes happens, which sometimes reinforce them to develop unhealthy lifestyle such as smoking, sedentary physical activity, poor dietary habit, drinking alcohol, and so forth, which are the behavioral risk factors of NCDs [9]. Furthermore, the risk factors of NCDs become likely to increase and may last throughout life, resulting in negative impacts on their overall health [10]. Therefore, it is imperative to determine the NCDs risk factors among university students because universities could be an ideal place to exhibit health-promoting and disease-control activities to change their attitudes towards a healthy life as well as to reduce NCDs in their later life [7].

A study among university students from 24 countries, including Bangladesh (North South University, Dhaka), revealed that around 16% of students had three or more risk behaviors for NCDs with a high prevalence of overweight/obesity [11]. A significant number of first-year undergraduate students of Jahangirnagar University (Dhaka, Bangladesh) had different types of NCDs found in the study of Hossain et al., [9] where their family history of NCD and their own lifestyle were observed to be significantly responsible for this extent. Nowsheen et al. [12] reported that around 55% and 16% of the postgraduate students

from three universities in Dhaka City, Bangladesh, had two or more and three or more NCDs risk factors, respectively. To the best of our knowledge, no study has been conducted in Bangladesh that assessed the prevalence and risk factors of NCDs among undergraduate and graduate students studying in different universities situated in different divisions of Bangladesh. Hence, this study aims to ascertain the prevalence and determinants of risk factors of NCDs among university students.

2 | Methods

2.1 | Study Design, Settings and Subjects

A cross-sectional study was carried out among university students in Bangladesh from October to November 2023. Bangladesh has a total of 170 universities affiliated with the University Grants Commission of Bangladesh [13]. Among these, 55 are public, 112 are private and 3 are international universities. The target population was students currently enrolled in any public/private/international university in Bangladesh. Figure 1 shows different universities in Bangladesh from where the study participants were enrolled. Students who were critically ill, pregnant, mentally unstable, or declined to participate were excluded. The sample size was computed using Cochran's formula [14]:

$$Z^2pq/d^2.$$

Where Z is standard normal variate (1.96 at 5% type I error), p is the estimated proportion of the population (i.e., assuming 50% in this case), q is $1 - p$, and d is the desired level of precision (5%). The aforementioned equation indicates that 384 subjects would be sufficient for this study. However, we randomly approached a total of 500 students and among them, 460 subjects returned the completed questionnaire (response rate 92%).

2.2 | Study Instrument

In this study, we adopted the Step I and Step II (all the core components except for cervical cancer (for females) and urinary sodium or creatinine) of the WHO STEPS questionnaire (version 3.2) [15]. In Step I, socio-demographic information regarding age, gender, accommodation, academic status, marital status, and history of NCDs, and behavioral measurements such as tobacco use, alcohol consumption, fruit and vegetable intake, salt intake, and physical activity were included. Step II focused on self-reported physical measures (height and weight) and hypertensive, diabetic, and hyperlipidemic status. For this study, we utilized the previously validated Bengali version of the WHO STEPS questionnaire [16].

2.3 | Outcomes and Measures

Four behavioral (current smoking, alcohol consumption, insufficient fruit and vegetable intake, and low physical activity) and four metabolic (overweight/obesity, raised blood pressure, raised blood sugar, and raised cholesterol level) risk factors of

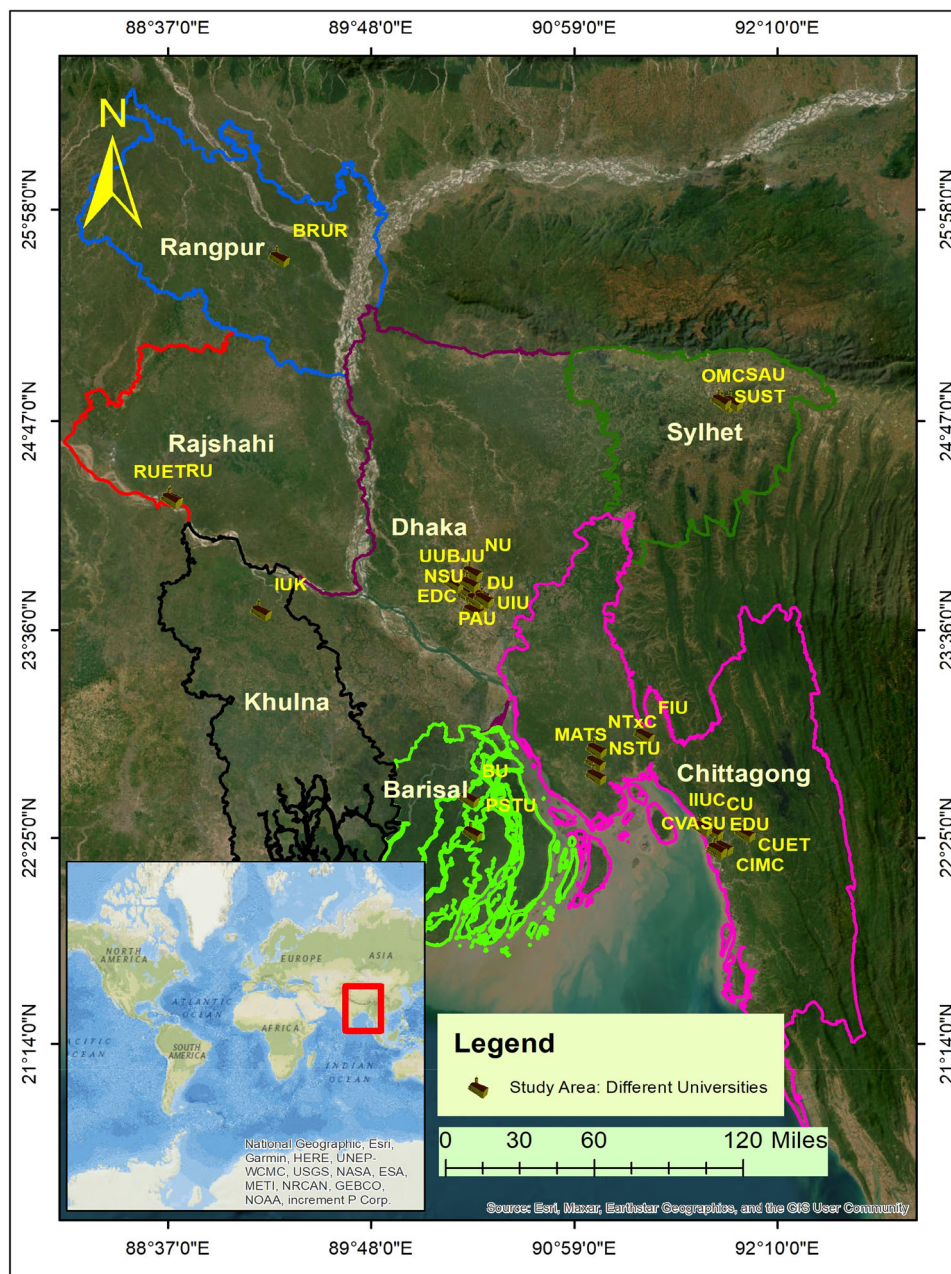


FIGURE 1 | Sampling site showing the universities of Bangladesh.

NCDs were determined as the outcome variables for the present study.

2.3.1 | Smoking

Current smokers were those individuals who had used tobacco (smoke or smokeless) products in the previous 30 days. Pictures of different forms and types of tobacco products were used as cue cards according to WHO recommendations.

2.3.2 | Alcohol Consumption

Individuals consuming alcohol in the last 30 days were considered to have harmful use of alcohol.

2.3.3 | Physical Activity Level

The Global Physical Activity Questionnaire was used to assess the physical activity level of the students. Participants were classified as having low physical activity when their total physical activity was observed to be < 600 metabolic equivalent tasks (MET) minutes/week.

2.3.4 | Fruit and Vegetable Intake

Information on fruit and vegetable consumption in the previous 7 days, with an average serving of fruit and vegetable intake per day, was recorded. Participants were included in the insufficient fruit and vegetable intake category if they consumed less than five servings of fruit and vegetable per day.

2.3.5 | Overweight/Obesity

Students were asked to report their height (cm) and weight (kg). Body mass index (BMI) was calculated for each of the students by dividing their weight (kg) by their height (m) squared. Overweight and obese students were identified when their BMI was observed at about 23.0-24.9 kg/m² and ≥ 25.0 kg/m², respectively [17].

2.3.6 | Blood Pressure, Blood Sugar and Blood Cholesterol Level

Participants reported their blood pressure, blood sugar, and blood cholesterol levels in this section. Those respondents were noted to have raised blood pressure/blood sugar/blood cholesterol levels when the doctor or health workers told them that they have high levels of blood pressure/blood sugar/blood cholesterol and/or they take medication for lowering blood pressure/blood sugar/blood cholesterol level. The research team cross-checked the report or prescription before considering them as having raised blood pressure/blood sugar/blood cholesterol levels. The respondent failed to attach a report, prescription, or any relevant evidence was considered as being nonhypertensive/non-diabetic/nonhyperlipidemia.

2.4 | Data Collection

Ethical approval was obtained from the Ethical Committee, Noakhali Science and Technology University Ethical Committee (Ref: NSTU/SCI/EC/2023/187). Additionally, informed consent (both verbal and written) was taken from each of the respondents before data collection. Data were collected through an online survey portal (i.e., Google Form), with a consent form appended to it. The university students were approached by the authors through social media (i.e., WhatsApp and Instagram) and electronic mail (Email), and they were invited to complete and submit the form. The purpose and details of the study, along with the benefits and risks of participating in the study were clearly mentioned to the students. Confidentiality of the information and the option to opt out of the study at any time was also assured to the students. The whole data collection procedure took around 20 min to complete.

2.5 | Data Management and Analysis

Data cleaning and analyses were performed using SPSS (version 27.0) for Windows (SPSS Inc. Chicago. IL, USA). Statistical significance was set at < 0.05 for all tests (two-tailed test). The socio-demographic and risk factors prevalence data were shown by frequency and percentages. The proportion of NCDs risk factors by socio-demographic characteristics was estimated as percentages, and 95% confidence intervals (CIs) were calculated. Chi-square statistics was applied to test the associations between covariates (i.e., socio-demographic characteristics) and NCDs risk factors. The determinants of NCDs risk factors were identified by a multivariate logistic regression model adjusting socio-demographic

variables, such as gender, age, accommodation, academic status, faculty, and marital status. For clustering analysis, we calculated the total number of NCDs risk factors (0–8) present within each participant at 95% CIs. Then, we assessed the association between the number of risk factors and covariates utilizing a linear regression model.

3 | Results

3.1 | Participants' Characteristics

A total of 460 students participated in the study. The socio-demographic data of the survey participants are included in Table 1. Around two-thirds of the participants were male, and

TABLE 1 | Socio-demographic characteristics of the participants.

Variables	n (%)
<i>Gender</i>	
Male	293 (63.7)
Female	167 (36.3)
<i>Age (years)</i>	
≤ 20	32 (7.0)
21–25	370 (80.4)
> 25	58 (12.6)
<i>Accommodation</i>	
University hall	160 (34.8)
With family/friends/mess	300 (65.2)
<i>Academic status</i>	
Undergraduate	349 (75.9)
Postgraduate	111 (24.1)
<i>Faculty</i>	
Humanities and Arts	28 (6.1)
Social science	32 (7.0)
Business administration	42 (9.1)
Law	5 (1.1)
Agriculture	2 (0.4)
Science and Technology	295 (64.1)
Health and Medicine	56 (12.2)
<i>Marital status</i>	
Unmarried	394 (85.7)
Currently married	65 (14.1)
Divorced/separated/widowed	1 (0.2)
<i>BMI (kg/m²)</i>	
< 18.5	48 (10.4)
18.5–22.9	235 (51.1)
23.0–24.9	74 (16.1)
25.0–29.9	65 (14.1)
≥ 30	38 (8.3)

Abbreviation: BMI, body mass index.

the majority of them ranged from 21 to 25 years old. Most of the students lived with their families/friends/in mess. About three out of four students were undergraduates, and more than half were from scientific and technological faculty. More than four-fifths of the students were unmarried, and around half had normal nutrition status (BMI 18.5–22.9 kg/m²).

3.2 | Prevalence of NCDs Risk Factors

Table 2 lists the overall behavioral risk factors for NCDs among university students. Most of the students did not smoke or consume alcohol. However, more than half of the students were involved in low physical activity, and majority consumed insufficient quantity of fruits and vegetables. The overall metabolic risk factors for NCDs among participants are also summarized in Table 2. More than one-third of the students were overweight and obese, and a relatively lower proportion was reported having raised blood pressure, blood sugar and cholesterol levels.

TABLE 2 | Prevalence of NCDs risk factors among the participants.

Variables	n (%)
Behavioral risk factors	
<i>Smoking (current)</i>	
No	414 (90.0)
Yes	46 (10.0)
<i>Alcohol consumption (current)</i>	
No	447 (97.2)
Yes	13 (2.8)
<i>Physical activity</i>	
Insufficient (< 600 MET minute/week)	234 (50.9)
Sufficient (≥ 600 MET minute/week)	226 (49.1)
<i>Fruits and vegetables intake</i>	
< 5 servings per day	379 (82.4)
≥ 5 servings per day	81 (17.6)
Metabolic risk factors	
<i>Overweight and obesity</i>	
No	283 (61.5)
Yes	177 (38.5)
<i>Raised blood pressure</i>	
No	349 (75.9)
Yes	111 (24.1)
<i>Raised blood sugar</i>	
No	423 (92.0)
Yes	37 (8.0)
<i>Raised cholesterol level</i>	
No	413 (89.9)
Yes	47 (10.2)

Abbreviation: MET, metabolic equivalent task.

3.2.1 | Current Smoking

Male students smoked more than female students (15.4% vs. 0.6%), and the majority belonged to 21–25 years of age. A higher percentage of smokers were undergraduate students. The current smoking status was not associated with students' accommodation, faculty, and marital status (Table 3).

3.2.2 | Alcohol Consumption

Alcohol consumption was noticed to be higher among male students (4.1%) compared to their female counterparts (0.6%). The students residing in the university hall consumed alcohol more than those who lived with their family/friends/in mess, and this tendency was higher among undergraduate students (Table 3).

3.2.3 | Low Physical Activity

According to Table 3, about two-thirds of female students did not meet WHO recommended duration of physical activity, and low physical activity was prevalent among individuals 20 years or below. This proportion was relatively higher among postgraduate (60.4%, 95% CI: 51.3–69.5) and ever-married (72.7%, 95% CI: 62.0–83.5) students.

3.2.4 | Insufficient Fruit and Vegetable Intake

The recommended consumption of five or more servings of fruits and vegetables per day was not significantly associated with any demographic variables, such as gender, age, accommodation, academic status, faculty, and marital status of the students (Table 3).

3.2.5 | Overweight/Obesity

Postgraduate students were more overweight and obese than undergraduate students (48.6% vs. 35.2%). Overweight and obesity status did not show significant association with any other demographic variables of the students (Table 3).

3.2.6 | Elevated Blood Pressure

Female students and who were 20 years or younger reported having raised blood pressure. Furthermore, the prevalence of elevated blood pressure was higher among postgraduates (48.6%) than undergraduates (35.2%) (Table 3).

3.2.7 | High Blood Sugar

It was marked from Table 3 that the participants of the age group 21–25 years, postgraduates, students of faculties other than science, and ever married were more likely to have raised blood pressure.

TABLE 3 | Proportion of participants with NCDs risk factors by socio-demographic characteristics.

Variables	Current smoking	Alcohol consumption	Low physical activity	Insufficient fruit and vegetable intake	Overweight and obesity	Raised blood pressure	Raised blood sugar	Raised cholesterol level
<i>Gender</i>								
Male	15.4 (11.2 to 19.5)	4.1 (1.83 to 6.4)	43.0 (37.3 to 48.7)	81.9 (77.5 to 86.3)	41.6 (36.0 to 47.3)	21.2 (16.5 to 25.8)	10.2 (5.6 to 14.8)	8.5 (5.2 to 11.7)
Female	0.6 (−0.6 to 1.8)	0.6 (−0.6 to 1.8)	64.7 (57.4 to 71.9)	83.2 (77.6 to 88.9)	32.9 (25.8 to 40.1)	29.3 (22.4 to 36.2)	6.8 (3.9 to 9.7)	13.2 (8.0 to 18.3)
P-value	<0.001	0.030	<0.001	0.720	0.065	0.049	0.203	0.114
<i>Age (years)</i>								
≤ 20	3.1 (−2.9 to 9.2)	0.0	65.6 (49.2 to 82.1)	87.5 (76.0 to 99.0)	25.0 (10.0 to 40.0)	28.1 (12.5 to 43.7)	3.1 (−2.9 to 9.2)	0.0
21–25	11.9 (8.6 to 15.2)	3.5 (1.6 to 5.4)	48.4 (48.4 to 53.5)	83.0 (79.1 to 86.8)	38.1 (33.2 to 43.1)	21.1 (16.9 to 25.2)	5.9 (3.5 to 8.4)	9.7 (6.7 to 12.7)
> 25	0.2 (−0.2 to 0.6)	0.0	7.4 (5.0 to 9.8)	9.6 (6.9 to 12.3)	6.1 (3.9 to 8.3)	5.2 (3.2 to 7.2)	3.0 (1.5 to 4.6)	2.4 (1.0 to 3.8)
p value	0.023	0.196	0.078	0.306	0.089	0.003	<0.001	0.014
<i>Accommodation</i>								
University hall	7.5 (3.4 to 11.6)	5.6 (2.1 to 9.2)	53.8 (46.0 to 61.5)	85.6 (80.2 to 91.1)	36.9 (29.4 to 44.4)	23.8 (17.2 to 30.3)	5.6 (2.1 to 9.2)	9.4 (4.9 to 13.9)
With family/ friends/mess	11.3 (7.7 to 14.9)	1.3 (0.0 to 2.6)	49.3 (43.7 to 55.0)	80.7 (76.2 to 85.1)	39.3 (33.3 to 44.9)	24.3 (19.5 to 29.2)	9.3 (6.0 to 12.6)	10.7 (7.2 to 14.2)
p value	0.192	0.008	0.367	0.184	0.606	0.889	0.164	0.663
<i>Academic status</i>								
Undergraduate	12.0 (8.6 to 15.4)	2.9 (1.1 to 4.6)	47.9 (42.6 to 53.1)	82.8 (78.8 to 86.8)	35.2 (30.2 to 40.3)	21.5 (17.2 to 25.8)	5.7 (3.3 to 8.2)	8.6 (5.7 to 11.5)
Postgraduate	3.6 (0.1 to 7.1)	2.7 (−0.3 to 5.7)	60.4 (51.3 to 69.5)	81.1 (73.8 to 88.4)	48.6 (39.4 to 57.9)	32.4 (23.7 to 41.1)	15.3 (8.6 to 22.0)	15.3 (8.6 to 22.0)
p value	0.010	0.928	0.022	0.677	0.011	0.019	0.001	0.042
<i>Faculty</i>								
Science	11.3 (8.0 to 14.6)	3.1 (1.3 to 4.9)	48.4 (43.2 to 53.7)	83.0 (79.1 to 86.9)	38.2 (33.2 to 43.3)	22.1 (17.8 to 26.4)	6.5 (3.9 to 9.1)	10.5 (7.3 to 13.7)
Others	5.6 (1.2 to 10.0)	1.9 (−0.7 to 4.4)	58.9 (49.6 to 68.2)	80.4 (72.8 to 87.9)	39.3 (30.0 to 48.5)	30.8 (22.1 to 39.6)	13.1 (6.7 to 19.5)	9.3 (3.8 to 14.9)
p value	0.084	0.495	0.059	0.532	0.851	0.064	0.029	0.734

(Continues)

TABLE 3 | (Continued)

Variables	Current smoking	Alcohol consumption	Low physical activity	Insufficient fruit and vegetable intake	Overweight and obesity	Raised blood pressure	Raised blood sugar	Raised cholesterol level
<i>Marital status</i>								
Unmarried	10.4 (7.4 to 13.4)	3.0 (1.3 to 4.7)	47.2 (42.3 to 52.1)	83.2 (79.6-86.9)	37.8 (33.0-42.6)	22.6 (18.5 to 26.7)	6.1 (3.7 to 8.5)	8.6 (5.9 to 11.4)
Ever married	7.6 (1.2 to 14.0)	1.5 (–1.4 to 4.5)	72.7 (62.0 to 83.5)	77.3 (67.2 to 87.4)	42.4 (30.5 to 54.3)	33.3 (22.0 to 44.7)	19.7 (10.1 to 29.3)	19.7 (10.1 to 29.3)
<i>p value</i>	0.478	0.487	<0.001	0.238	0.477	0.059	<0.001	0.006

Note: Data are prevalence (%) and 95% confidence interval.

3.2.8 | Raised Cholesterol

Students aged 21–25 years and postgraduates were found to have cholesterol levels higher than other age groups and undergraduate students, respectively. Around two-fifth of the ever-married students had raised cholesterol. No difference was found in prevalence by gender, accommodation, and faculty status (Table 3).

Overall, few (5.2%) students were completely free from the selected NCDs risk factors. The proportion of individuals with no risk factors was high among females, aged > 25, students residing in university hall, undergraduates, students from science faculty, and those who were ever-married (Figure 2a–f).

3.3 | Factors Associated With NCDs Risk

Table 4 represents the socio-demographic determinants of NCDs risk factors among university students. Males had higher odds of being a current smoker and drinker, while females had higher odds of doing low physical activity and having raised blood pressure. Students living with family/friends/in mess had a lower propensity to consume alcohol compared to residential students (AOR: 0.174, 95% CI: 0.051–0.594, $p < 0.01$). There was a significant positive association between marital status and involvement in low physical activity and the odds were twice as high for ever-married than unmarried students (AOR: 2.290, 95% CI: 1.230–4.264, $p < 0.01$).

3.4 | Clustering of Risk Factors

Results of combined risk factors, including current smoking habits, alcohol consumption, inadequate physical activity, intake of fewer than five servings of fruits and vegetables, being overweight and obese, elevated blood pressure, high blood sugar, and raised cholesterol, are presented in Table 5. Each respondent had, on average, about two risk factors. Furthermore, ever-married students had fewer risk factors than unmarried students (ARR: 0.405, 95% CI: 0.060–0.750).

4 | Discussion

The rising burden of NCDs poses a significant global challenge, with university students emerging as a vulnerable group. This study reveals an alarming 95% of university students in Bangladesh possess at least one modifiable NCD risk factor, with each student carrying an average of two risk factors. These include insufficient physical activity, inadequate fruit and vegetable intake, and overweight or obesity. By employing the WHO STEPS instrument, this study provides the first comprehensive analysis of NCD prevalence and its determinants among students from diverse universities in Bangladesh.

The WHO recognized tobacco use in the form of smoking cigarettes as a serious threat to health and a leading cause of death from NCDs worldwide. The extremely addictive substance nicotine found in tobacco products increases the risk of cancer,

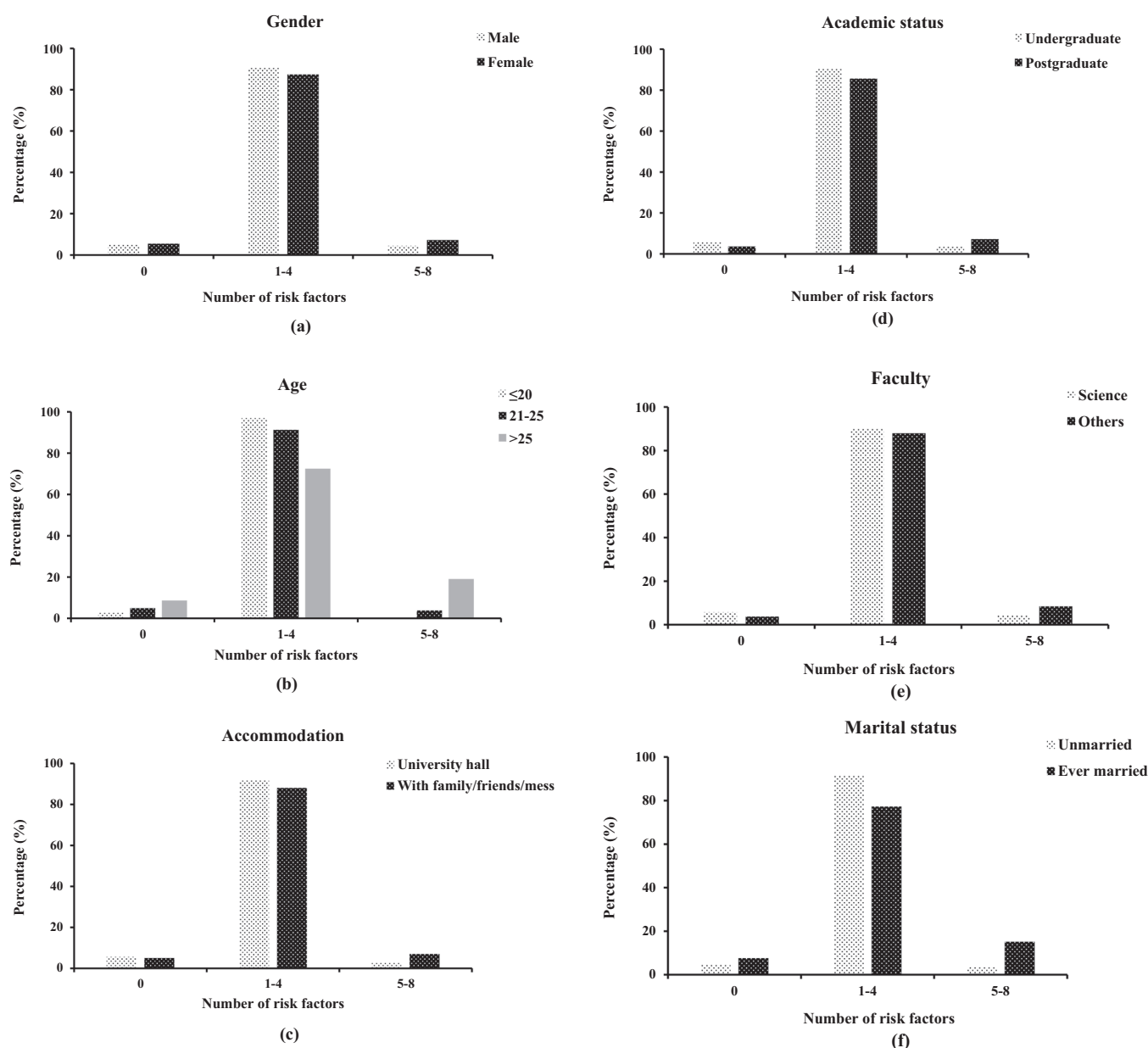


FIGURE 2 | Percentage of participants with number of risk factors for NCDs according to (a) gender, (b) age, (c) accommodation, (d) academic status, (e) faculty, and (f) marital status.

heart disease, lung problems, and several other crippling illnesses [18]. The current prevalence of smoking among university students, which is 10%, is similar to the findings of two other studies conducted in Bangladesh [9, 12]. However, this finding is lower compared to a study in Bangladesh [11]. Additionally, the occurrence of NCDs among students was shown to be greater in a few studies conducted in other countries [7, 19], while the rates were considerably lower in several studies [20–22]. Based on the students' self-reporting, males were found to be greater smokers than female students. This might be because cigarette smoking by the female is believed to be an impolite behavior in society [6]. Our findings corroborate those of similar studies conducted among different university students [7, 9, 12]. These statistics emphasize the necessity of stringent enforcement and effective monitoring of the tobacco control regulations existing in various countries, including Bangladesh.

About 90% of the population in Bangladesh are Muslims [23], where alcohol consumption is forbidden. Consequently, cultural traditions and religious convictions prohibit the people of Bangladesh from buying and selling alcohol in public markets [6]. For this reason, the prevalence of alcohol consumption among university students is very low (2.8%). It is similar to the findings of other studies conducted in Bangladesh [11, 12]; however, several other studies reported higher use of alcohol among students in Bangladesh and other countries [7, 19, 21, 22, 24]. Males and students residing in university hall students were noticed to drink alcohol more than their female peers and those living with family/friends/in a mess. Consequently, gender, especially being male, and accommodation, particularly university hall, emerge as factors influencing alcohol use. Hence, it is essential to thoroughly investigate the underlying reasons that drive male students and those staying at university halls to consume more alcohol.

TABLE 4 | Logistic regression (adjusted odds ratios) analyses of NCDs risk factors by socio-demographic characteristics of participants.

Variables	Current smoking (95% CI)	Alcohol consumption (95% CI)	Low physical activity (95% CI)	Insufficient fruit and vegetable intake (95% CI)	Overweight and obesity (95% CI)	Raised blood pressure (95% CI)	Raised blood sugar (95% CI)	Raised cholesterol level (95% CI)
<i>Gender</i>								
Female	1	1	1	1	1	1	1	1
Male	32.718 (4.396–243.487)***	11.683 (1.440–94.815)*	0.456 (0.301–0.691)***	0.971 (0.570–1.654)	1.459 (0.958–2.222)	0.603 (0.378–0.963)*	0.550 (0.2577–1.178)	0.591 (0.307–1.128)
<i>Age (years)</i>								
≤ 20	1	—	1	1	1	1	1	—
21–25	4.084 (0.524–31.852)	—	0.459 (0.207–1.017)	0.612 (0.204–1.838)	1.658 (0.714–3.846)	0.710 (0.307–1.642)	2.599 (0.324–20.849)	—
> 25	0.788 (0.039–15.963)	—	0.416 (0.142–1.225)	0.377 (0.093–1.527)	1.598 (0.538–4.748)	1.659 (0.541–5.086)	9.644 (0.940–98.949)	—
<i>Accommodation</i>								
University hall	1	1	1	1	1	1	1	1
With family/ friends/mess	1.287 (0.621–2.667)	0.174 (0.051–0.594)**	0.847 (0.560–1.282)	0.696 (0.45–1.197)	1.020 (0.676–1.540)	1.006 (0.626–1.615)	1.739 (0.765–3.949)	1.294 (0.660–2.540)
<i>Academic status</i>								
Undergraduate	1	1	1	1	1	1	1	1
Postgraduate	0.400 (0.125–1.281)	2.125 (0.527–8.567)	1.654 (0.941–2.908)	1.326 (0.638–2.757)	1.644 (0.956–2.827)	1.163 (0.620–2.181)	1.017 (0.373–2.772)	1.113 (0.481–2.577)
<i>Faculty</i>								
Science	1	1	1	1	1	1	1	1
Others	0.490 (0.196–1.229)	0.657 (0.138–3.138)	1.532 (0.967–2.428)	0.889 (0.506–1.559)	0.991 (0.629–1.561)	1.446 (0.880–2.375)	1.780 (0.842–3.762)	0.787 (0.367–1.688)
<i>Marital status</i>								
Unmarried	1	1	1	1	1	1	1	1
Ever married	1.699 (0.565–5.108)	1.125 (0.127–9.972)	2.290 (1.230–4.264)**	0.728 (0.366–1.451)	1.150 (0.647–2.047)	1.125 (0.601–2.107)	2.218 (0.914–4.953)	1.892 (0.866–4.134)

Abbreviation: CI, confidence interval.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 5 | Clustering of NCDs risk factors and its multivariate analysis.

Variable	Mean number of risk factors (95% CI)	ARR (95% CI)
<i>Gender</i>		
Female	2.35 (2.16–2.54)	1
Male	2.23 (2.08–2.38)	−0.079 (−0.325 to 0.167)
<i>Age (years)</i>		
≤ 20	2.13 (1.75 to 2.50)	1
21–25	2.22 (2.09 to 2.34)	0.058 (−0.396 to 0.521)
> 25	2.69 (2.27 to 3.11)	0.213 (−0.407 to 0.833)
<i>Accommodation</i>		
University hall	2.28 (2.11 to 2.45)	1
With family/friends/mess	2.26 (2.11 to 2.41)	−0.046 (−0.219 to 0.198)
<i>Academic status</i>		
Undergraduate	2.17 (2.04 to 2.29)	1
Postgraduate	2.59 (2.35 to 2.84)	0.269 (−0.061 to 0.600)
<i>Faculty</i>		
Science	2.23 (2.11 to 2.39)	1
Others	2.39 (2.13 to 2.65)	0.111 (−0.159 to 0.381)
<i>Marital status</i>		
Unmarried	2.19 (2.07 to 2.31)	1
Ever married	2.74 (2.38 to 3.10)	0.405 (0.060 to 0.750)*
Total	2.27 (2.16 to 2.38)	

Abbreviations: AOR, adjusted relative risk; CI, confidence interval.

* $p < 0.05$.

Consistent engagement in physical exercise has been scientifically shown to effectively prevent and control NCDs such as CVDs, cerebrovascular accidents, diabetes, and many forms of cancer. Additionally, regular physical activity aids in maintaining a healthy body weight and may enhance mental health and overall well-being [25]. The research revealed that a substantial percentage of university students exhibited a sedentary lifestyle (50.9%), a finding supported by early studies [7, 20, 24]. However, it is higher compared to some previous findings [9, 11, 12, 22]. Poorly planned urbanization, including recreational facilities such as parks, playgrounds, sports centers, and so forth, inside universities and mechanization of life might be attributed to it. The current results call for creative approaches to enhance physical activity levels, especially among women, taking into account societal and religious customs.

It is well-established that diet plays a pivotal role in both the advancement and prevention of chronic diseases [26]. Diets containing adequate amount of fruits and vegetables have several health-beneficial effects and reduce the risk for CVDs, stomach cancer, and colorectal cancer [25]. The majority of the university students (82.4%) examined do not eat an optimal quantity of fruits and vegetables (< 5 servings per day). The figure closely approximates the findings of previously published studies [11, 12, 24]. However, the incidence is somewhat lower in a few studies [7, 19, 20]. The students' insufficient intake of fruits and vegetables may stem from a lack of awareness and knowledge regarding the recommended daily consumption. This necessitates an urgent and ongoing public health initiative

aimed at promoting WHO proposed “5A Day” campaign and encouraging higher consumption of fruits and vegetables.

Being overweight and obese ($\text{BMI} \geq 23 \text{ kg/m}^2$) greatly increases the likelihood of developing several chronic illnesses, notably cardiovascular conditions, including heart disease and stroke, which are the primary causes of mortality globally [27]. The prevalence of overweight and obesity among university students in the present research is comparable to previous studies in Bangladesh [11, 12] and other countries [7, 19, 20]. However, this percentage is greater compared to other studies [9, 21]. Rapid urbanization, socioeconomic improvements, readily accessible food, adoption of a Western diet (for instance, a rise in fat and protein consumption over a balanced diet), and the shift towards a more sedentary lifestyle are likely primary factors contributing to the high prevalence of overweight and obesity in developing nations like Bangladesh. So, the government should organize extensive public awareness campaigns to tackle the risk of becoming an obese nation.

Elevated blood pressure, commonly known as hypertension, is a grave medical problem that heightens the likelihood of developing heart, brain, kidney, and other ailments. It is a significant contributor to early mortality on a global scale, affecting more than one in four men and one in five women, which amounts to over a billion individuals [28]. We observed a higher incidence of elevated blood pressure (24.1%) among university students in Bangladesh. The proportion is similar to some other study [24]. However, this rate surpasses the results of previous

research [7, 12]. This high proportion of hypertension could be attributed to the fact that hypertension remains asymptomatic in most cases, and individuals, including university students, overlook its potential adverse effects. Therefore, there is a pressing need for strategies to prevent and control hypertension. Furthermore, males were reported to have a lower risk of elevated blood pressure than females. This might be due to the fact that male students are involved in more physical activity compared to females, as indicated earlier.

Prolonged high blood sugar (or glucose) level is an attribute of diabetes, a metabolic disorder that causes severe harm to the heart, blood vessels, eyes, kidneys, and nerves [29]. In this study, about one-tenth of university students were noticed to have higher blood glucose, which aligns with the results of previous research [7, 12, 20]. Evidence suggests that changes in lifestyle greatly enhance the chance of falling victim to diabetes. A sedentary lifestyle with minimal physical exercise, consumption of processed and high-fat foods, and the stress of modern living have adverse effects on health. Additionally, ignorance and unwillingness to consistent glucose monitoring and adhere to a healthy diet may contribute to the high incidence of diabetes among participants. So, it is crucial for both governmental and nongovernmental organizations to frequently conduct awareness programs to emphasize the significance of regular blood glucose monitoring and the harmful consequences of high blood sugar.

Raised cholesterol levels are associated with an increased likelihood of developing heart disease and stroke. Worldwide, raised cholesterol is responsible for an estimated one-third of Ischemic heart disease and 2.6 million fatalities (4.5% of the total) [29]. The research revealed the occurrence of raised cholesterol among university students to be 10.2%. A previous study also cited a similar scenario [7]. The reasons behind this prevalence might be many, for example, students' lifestyle, including dietary behavior, physical activity, habits and so forth, genetic susceptibility, and other factors not assessed in this study.

Overall, each student had an average of two risk factors, with only 5.2% of the students being noticed to be devoid of all the studied NCD risk factors. The accumulation of the risk factors, both individually and in aggregation, raises the susceptibility to CVDs, chronic respiratory diseases, diabetes, and cancer. This augmented number of risk factors suggests that the burden of NCDs may escalate in the future if it is not promptly addressed by stakeholders, including the Government of Bangladesh. Hence, future research may be useful in tracking the progression of NCD risk factors from isolated instances to concurrent occurrences.

5 | Limitations

There are a few limitations of this study that need to be addressed. Firstly, our findings are based on observations from students of several universities in Bangladesh, which may not be representative of all university students across Bangladesh. Secondly, we reported results of anthropometric (height and weight) and biochemical (i.e., blood glucose, serum cholesterol

level, etc.) data based on students' self-reporting, which increases the likelihood of overestimation or underestimation.

6 | Conclusion

The findings of the present study denote a high prevalence of NCD risk factors such as low physical activity, insufficient fruit and vegetable intake, and overweight and obesity among graduate and undergraduate university students. However, the above risk factors are highly modifiable, and multiple university-based health promotional interventions may prevent the development of NCDs among university students.

Author Contributions

Md Shahedul Islam: conceptualization, data curation, methodology, writing – original draft. **Marjia Sultana:** conceptualization, methodology, formal analysis, writing – review and editing. **Towhid Hasan:** methodology, writing – review and editing, formal analysis. **Md. Rezaul Karim:** data curation, writing – original draft. **Mahmuda Akter Lina:** data curation, writing – original draft. **Abdur Rahman Shanna:** data curation, writing – original draft. **Md. Shamim Alam:** data curation, writing – original draft. **Khadija Akter:** data curation, writing – original draft. **Tasfia Khanom:** data curation, writing – original draft. **Syed Ashir Abrar:** data curation, writing – original draft. **Md Shah Poran:** data curation, writing – original draft.

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Ethics Statement

Ethical approval was obtained from the Noakhali Science and Technology University Ethical Committee (Ref: NSTU/SCI/EC/2023/187). Additionally, informed consent (both verbal and written) was taken from each of the respondents before data collection.

Conflicts of Interest

The authors declare no conflict of interest. All authors have read and approved the final version of the manuscript and corresponding author, Towhid Hasan had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Transparency Statement

The lead author Towhid Hasan affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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