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Title Page

Manuscript Title:

Risk Factors for Non Communicable Diseases in Bangladesh: Findings of the Country-wide STEPS Survey 2018

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Risk Factors for Non Communicable Diseases in Bangladesh: Findings of the Country-Wide STEPS Survey 2018

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ABSTRACT

Objectives: To determine the national prevalence of risk factors of non-communicable diseases (NCD) in adult population of Bangladesh.

Design: This was a population-based cross-sectional national survey.

Setting: This study used 496 primary sampling units (PSUs) developed by Bangladesh Bureau of Statistics. PSUs were equally allocated to each division and within each division, were equally allocated to urban and rural stratum.

Participants: The participants were en and women aged 18-69 years who have been the usual residents of the households for at least six months and have stayed in the household the night before the survey. Out of 9900 respondents, 8185 (82.7%) completed STEP-1 and STEP-2 while 7208 participants took part in STEP-3.

Primary and secondary outcome: Prevalence of behavioural, physical and biochemical risk factors of NCD. Data were weighted to generate national estimates.

Results: In Bangladesh, tobacco was consumed by 43.7% (59.6% males and 28.3% females) population. Inadequate fruits and/or vegetables consumption and insufficient physical activity were found in 89.6% and 12.3% population respectively. The prevalence of overweight and hypertension were 25.9% and 21.0% respectively. The mean salt intake per day was 9.0 gm. The prevalence of hyperglycemia and hypercholesterolemia were 8.3% and 28.4% respectively. Among the population, 3.0% had no NCD risk factor while 70.9% and 26.2% had 1-2 and 3-4 NCD risk factors respectively.

Conclusions: High prevalence of behavioral, physical and biochemical risk factors of NCDs are evident in Bangladesh. There is an urgent need to implement population, individual and programme wide prevention and control interventions to combat the rising burden of NCDs.

Key Words: Bangladesh; Behavioral; Biochemical; Non communicable diseases; Physical; Prevalence; Risk factors; STEPS survey;

Strengths and limitations of this study

- The survey covered the entire country for the first time to estimate the prevalence of NCD risk factors comprising all the three steps of WHO STEPS approach.
- Rigorous methodology and cross matching the data with their physical and biochemical parameters helped us to generate country representative data by controlling bias.
- Comprehensive findings on behavioral, physical and biochemical risk factors could be used to devise diverse intervention programmes to reduce the rising burden of NCD.
- As a cross sectional study, limits its ability to infer causal relation among the risk factors.
- Behavioral data may have little bias as the participants of this self-report survey may tend to report in socially desirable ways.

INTRODUCTION

Non-communicable diseases (NCDs) are the result of a combination of genetic, socio-demographic, physical, biochemical and behavioral factors. The global report on death by cause shows that more than 65% of 56 million global deaths were due to NCDs[1]. Three-fourths of this global mortality due to NCDs occurred in low and middle-income countries[2]. Each year premature deaths affect equally both man and women (15 million each) due to NCDs[3]. Four major NCDs; cardiovascular disease, cancer, diabetes and respiratory diseases are responsible for 82% of NCD mortality[4].

Demographic transition and rapid urbanization have led to changes in lifestyles; food and tobacco consumption continue to experience high morbidity and mortality from NCDs. The rise in NCDs largely stems from four behavioral risk factors: tobacco use, unhealthy diet, insufficient physical activity, and the harmful use of tobacco and alcohol[5]. Life style change in an individual following the trend of globalization, supermarket growth, rapid urbanization and sedentary lifestyles invites these risk factors around him[6].

In Bangladeshi adult population, NCD related risk factors are found to exist in clusters which become more prominent with the increasing age of that individual[7]. Bangladesh is passing through demographic transition and an epidemiological transition and currently has a double burden of diseases[8]. NCDs are account for 67% of total deaths in Bangladesh, 44% is contributed by cardiovascular diseases[9]. Diverse epidemiological studies have identified risk factors including unhealthy diet, tobacco use, less physical inactivity, high BMI, raised blood pressure, unfavorable blood lipid, and raised blood glucose levels[10]. Tobacco consumption is the leading risk factor for major NCDs in Bangladesh[11]. First national STEPS survey was done in 2010, but there were lack of biochemical measurements and hence no national estimations of diabetes and dyslipidemia prevalence existed. There are limited evidences on certain risk factors exist in Bangladesh at national level[12]. This second nationwide STEPS survey along with biochemical measurement for blood glucose, lipid profile and urinary sodium helped to provide first comprehensive estimates of NCD risk factors in the country.

Member states of WHO have agreed 25 indicators across three areas which focus on the key outcomes, risk factors and national systems response needed to prevent and control NCDs. One mortality target, six risk factor targets and two national systems targets are considered[13]. Targets have been set for 2025, with a baseline of 2010. As a member state, Bangladesh intends to estimate the prevalence of NCD risk factors in the adult people of the country. STEP wise approach is a WHO-developed, standardized framework for monitoring the magnitude of NCD risk factors comprising 3 steps; STEP 1 determines

behavioral risk factors; STEP 2 determines anthropometric risk factors; and STEP 3 finds out biological risk factors. The STEPS survey 2018 for NCD risk factors in Bangladesh was carried out to determine the national prevalence of NCDs risk factors in adult population of Bangladesh.

METHODS

Study design and setting

The STEPs survey 2018 was a country-wide cross-sectional population-based study conducted from September 2017 to June 2018. Samples were collected by multi-stage, geographically stratified probability based sampling on the basis of Primary Sampling Unit (PSU) developed by Bangladesh Bureau of Statistics (BBS) for census.

Study population

The study population included men and women aged 18-69 years who have been the usual residents of the household for at least six months and were present there the night before the survey. People who primarily resided in military base or group quarters, hospitals, prisons, nursing homes and other institutions or those too frail and mentally or physically unfit to participate in the study or those unable or unwilling to participate were excluded from the study.

Sample size

To ensure generalization and reliability of the study results to the entire target population in Bangladesh, the sample size calculator as recommended by WHO (Sample size calculator STEPS) was used to derive a sample size. The sample size was calculated that is sufficient to produce reliable estimates for all the indicators for men and women and for 4 age-groups (18-24, 25-39, 40-54, 55-69). The sample size was calculated considering prevalence of different NCD risk factors, relative precision rate (20%) and feasibility of the survey. Using the prevalence of obesity, 472 people were required for effective analysis for each group. To calculate the final sample size, considering the findings of Demographic Health Survey and previous BBS surveys, the person non-response rate shared around 10% and household non-coverage rate around 10%. So, overall 20% non-response rate and design effect of 2 were considered. Initially the survey considered 496 PSUs as updated by BBS in 2017. During field work, one PSU was excluded due to inaccessibility. As a result, the final adjusted sample size was 9,900 adults of 495 PSUs.

Sampling frame

Sampling frame was the complete list of PSU prepared by BBS for the Population and Housing Census. Sampling frame contained information about PSU location, type of residence and the estimated

number of residential households. All the PSUs were mapped for STEPS survey 2018 and comprised of 293,533 PSUs: 65,193 urban and 228,340 rural PSUs. Households` lists updated by BBS in 2017 served as sampling frame for the selection of households. Twenty households were randomly selected from each sampled PSU and randomly assigned as "male" or "female" in a ratio that produced equal numbers of male and female households. One individual was sampled randomly from all the eligible adults in a household. No replacement or change of the pre-selected households was allowed at the implementing stage to prevent bias.

Sampling strategy

PSUs were equally allocated to each division (62 each), and within each division, were equally allocated to urban and rural stratum (248 PSUs each to both urban and rural strata). PSUs were arranged by population size in terms of household numbers for both urban and rural stratum in each division. In each stratum, 31 PSUs were selected independently in each division by probability proportional to size (PPS) sampling.

Data collection

Data were collected using a standardized pre-tested questionnaire developed considering WHO STEPS questionnaire version 3.2. All the core questions along with some selected expanded questions and country-specific questions were incorporated. Questionnaire was translated in to Bengali. Validation of the translated questionnaire was done by translation and back translation. Data collection techniques included face-to-face interview (STEP 1), physical measurements (STEP 2) and body fluid (blood and urine) collection (STEP 3). Data were collected by android device on spot and were transferred into cloud through ODK software.

STEP 1 (Behavioral risk factors ascertainment):

Core items included basic demographic information and measures of tobacco use, fruit and vegetable, alcohol, and salt consumption, physical activity, blood pressure, diabetes, and total cholesterol. Data enumerators with post-graduation in sociology/psychology/anthropology conducted interviews and physical measurements while sample collection and processing were done by medical technologists with diploma/bachelor/master's degree in medical laboratory science. All recruited staff underwent training covering all the steps with interactive sessions, skill development and pilot testing.

STEP 2 (Physical measurements):

Core item included measurement of blood pressure, height, weight, hip and waist circumference. Validated instruments were used for measuring these parameters. Height and weight of the participants

were measured with barefoot and light clothing. Weight was measured to the nearest 10 gms using a digital weight measuring machine, while height was measured to the nearest 0.1 cm using a portable stadiometer. Tailor measuring tape was used for measuring waist and hip circumference. All the instruments were calibrated routinely during the survey. Digital blood pressure measuring machine, supplied by WHO with uniform cuff-size with automatic measurement of BP and pulse, was used for measuring blood pressure.

STEP 3 (Biochemical measurements):

For estimation of blood sugar and lipid profile level, participants were advised to remain nothing per oral (except plain water) for at least 12 hours before blood collection. Blood and urine samples were collected under strict aseptic precautions. Written instructions regarding fasting, appointment date for blood test, were given to the participant for STEP 3 on first visit and was asked to visit maintaining schedule. Initially 5 ml of blood was collected by disposable syringe followed by plasma and serum being separated by centrifuging within 30 minutes to 1 hour after collection. 2 ml of this blood was transferred to fluoride-oxalate vacutainer for serum glucose testing and 3 ml of the blood was kept in a normal tube and allowed to stand for separation of plasma (for lipid profile) with proper labeling. The sample for blood glucose was left in upright position in vacutainer rack and then centrifuged and separated serum was keep in the cold box (2-8^{0}C) surrounded by ice packs.

Respondents were asked to collect 20 ml urine in supplied labeled screw capped plastic urine pot at evening before bed time to submit to medical technologist on following day for blood sample collection at the prefixed place. All the collected blood and urine samples of a day were sent to NIPSOM laboratory within 24 hours of collection. At the central laboratory, the blood and urine samples were received and sent with laboratory ID number for testing sodium and urine. After estimation of blood glucose and lipid profile remaining sample of serum was kept in Cryo vials at -70^{0}C while after estimation of urinary sodium, remaining sample was discarded.

Quality control

Quality control procedures included regular field supervision and daily review of collected data. Laboratory instruments were calibrated following standard procedure and the findings were validated with the same sample findings of other standard national laboratory. The blood and urine samples were tested in the NIPSOM central laboratory dividing the sample into multiple samples and same samples in multiples times to compare the findings and to validate the instruments and procedure. To ensure accurate findings of the biochemical samples; pretesting was done in both urban and rural areas from

where samples were sent to NIPSOM laboratory. Accordingly samples were received at different time's interval after collection and were tested in different time period and the findings were compared.

Data management

Data were entered directly in the ODK software on the PDAs. Data were sent electronically and stored in ONA data base server. Field team daily uploaded data on the server and data were downloaded at central office for consistency and validity check. Stored data were downloaded into Microsoft Excel® format. Each participant had a unique identifier QR-code and personal identification number (PID) which were used for merging data for steps 1, 2, 3. Data were cleaned and analyzed following WHO STEPS recommended guidelines.

Statistical methods

Data were analyzed by age, sex, and residence. Prevalence was estimated using the STEPS recommended cut-off values[14]. Data analysis was performed using STATA version 15.0 and Epi Info version 3.4 was used as a reference for programming purposes and cross-validation of STATA outputs. Descriptive statistics included percentage and mean while inferential statistics included logistic regression to determine the determinants of NCD risk factors. Outcome measures and differences between groups were calculated with 95% confidence interval and significant at p-value <0.05.

Ethics

Ethical approval was obtained from the National Research Ethics Committee (NREC) of Bangladesh. Informed consent was obtained from all participants prior to data/specimen collection. Confidentiality and privacy of the participants along with anonymity of data were maintained. All activities were carried out in conformity with the revised declarations of Helsinki.

RESULTS

Among the target 9900 population, 8185 (82.7%) completed STEP-1 & 2 while 7208 took part in STEP-3. Out of 7208, blood sample was collected from 7056 and urine was collected from 7028 participants. Results are presented in descriptive manner for age, sex and residence separately and combined. Out of total 8185 participants, female (53.5%) were higher than male (46.5%). For unweighted data, 51.1% were rural residents, around 45% male and female were found having no formal schooling or less than primary level schooling, 85.1% women were homemakers and 63.9% men were employed. For weighted data, 77.5% were rural residents, 43.8% had less than primary level education including non-formal education, 85.9% women were homemaker and 63.5% men were employed (Table 1).

Table 1. Socio-demographic profile of the participants in STEPS survey, Bangladesh

Attributes		Unweighted, %			Weighted, %		
		Males (n=3804)	Females (n=4381)	Both sexes (n=8185)	Males (n=3804)	Females (n=4381)	Both sexes (n=8185)
Age	18 – 24	10.6	14.2	12.5	22.1	25.8	23.9
	25 – 39	38.6	46.1	42.6	39.4	40.1	39.7
	40 – 54	32.0	29.3	30.6	19.9	19.5	19.7
	55 – 69	18.7	10.4	14.3	18.7	14.7	16.6
Residence	Urban	49.6	48.3	48.9	23.5	21.5	22.5
	Rural	50.4	51.7	51.1	76.5	78.5	77.5
Highest level of Education	No education/<primary	45.2	45.0	45.1	43.5	44.1	43.8
	Primary	26.5	35.0	31.0	27.2	34.8	31.0
	Secondary	11.9	10.0	10.9	13.1	12.1	12.6
	More than secondary	16.4	10.1	13.0	16.3	8.7	12.5
Marital status	Never married	10.8	2.9	6.5	20.0	4.9	12.3
	Currently married	89.0	88.2	88.6	79.8	85.5	82.7
	Ever married*	0.2	8.9	4.9	0.3	9.6	5.0
Occupation	Employed	63.9	11.0	35.6	63.5	9.1	35.9
	Businessman	25.9	0.7	12.4	21.8	0.3	10.9
	Student	4.6	2.2	3.3	8.8	3.5	6.1
	Homemaker	0.2	85.1	45.7	0.3	85.9	43.7
	Unemployed	3.1	0.5	1.7	3.5	0.8	2.1
	Others	2.4	0.5	1.4	2.1	0.6	1.3

%: Percentage; n: Number; *Ever married: Separated/divorced/widow/widowed

The prevalence of tobacco consumption was 43.7% but it was higher in males (59.6%), and rural (45.2%) population. Prevalence of inadequate intake of fruits and/or vegetables was 89.6% and prevalence of insufficient physical activity was 12.3%. Prevalence of overweight and obesity was 25.9%. Prevalence of hypertension was 21.0%, prevalence of diabetes was 8.3% and prevalence of hypercholesterolemia was 28.4% (Table 2).

Table 2. Prevalence of various NCD risk factors in Bangladesh, overall and stratified by age, sex and residence

Behavioral risk factors (n=8185), %					
Attributes		**Current tobacco consumption (in any form)**	**Current alcohol consumption (in past 30 days)**	***Inadequate fruits and/or vegetables intake**	****Insufficient physical activity**
Age	18 – 24	22.3	2.4	90.5	11.2

	25 – 39	38.7	1.5	87.3	8.8
	40 – 54	59.1	1.0	91.1	11.3
	55 – 69	68.4	0.4	92.3	23.1
Sex	Male	59.6	2.9	90.0	9.6
	Female	28.3	0.0	89.3	14.8
Residence	Urban	38.8	1.8	92.1	14.2
	Rural	45.2	1.4	88.9	11.7
Overall		43.7	1.5	89.6	12.3

Physical measurements, (%)

Attributes		***Overweight and Obese (n=8013)	****Central Obesity (n=8013)	Hypertension (n=8154)
Age	18 – 24	15.9	16.2	8.8
	25 – 39	31.4	30.5	20.7
	40 – 54	28.8	32.5	34.4
	55 – 69	23.6	31.9	46.9
Sex	Male	18.3	14.7	17.9
	Female	33.7	41.1	24.1
Residence	urban	34.3	36.2	25.2
	Rural	23.5	25.4	19.8
Overall		25.9	27.8	21.0

Biochemical risk factors (n=7056), (%)

Attributes		**Hyperglycemia (≥7.0 mmol/L or, ≥126 mg/dl)**	**Raised Total Cholesterol (≥5.0 mmol/L)**
Age	18 – 24	2.9	20.6
	25 – 39	8.1	26.7
	40 – 54	12.4	36.4
	55 – 69	16.3	39.5
Sex	Male	8.9	27.4
	Female	7.9	29.3
Residence	Urban	13.2	32.4
	Rural	7.1	27.4
Overall		8.3	28.4

%: Percentage; n: Number;

*Participants taking <5 servings fruits and/or vegetables on average per day

** Participants doing less than 150 minutes of moderate-intensity physical activity per week

***Overweight & obese: BMI≥25kg/m^2

****Waist circumference: >90 cm for men; >80 cm for women

Mean serving of fruits and/or vegetables per day was 2.6 (CI: 2.5-2.7); and mean duration of physical activity per day was 247.9 (CI: 247.8-248.0) minutes. Mean BMI was 22.7 (95% CI: 22.5-22.8) kg/m^2 and mean waist circumference was 78.6 (95% CI: 78.2-79.1) cm. Both mean SBP [122.6 (95% CI: 122.0-123.1) mmHg] and DBP [80.6 (95% CI: 80.2-81.0) mmHg] was higher in urban population. Mean fasting blood glucose was 5.4 (95% CI: 5.3-5.5) mmol/L, mean total cholesterol was 4.4 (95% CI: 4.4-4.5) mmol/L and mean salt intake per day was 9.0 (95% CI: 8.9-9.1) gm (Table-3).

Table 3. Means (CI) of different parameters of behavioral, physical and biochemical measurements in population of Bangladesh

Means (CI) of behavioral risk factors of NCD					
Attributes		**Mean number of servings of fruits on average per day**	**Mean number of servings of vegetables on average per day**	**Mean number of servings of fruits and/or vegetables on average per day**	**Mean physical activity in minutes of moderate-intensity activity (min/day) ***
Age	18 – 24	0.4 (0.4-0.5)	2.3 (2.1-2.5)	2.7 (2.5 - 2.9)	213.3 (213.1-213.5)
	25 – 39	0.4 (0.3-0.4)	2.4(2.2-2.5)	2.7(2.6 - 2.9)	272.2 (272.1-272.3)
	40 – 54	0.3 (0.3-0.3)	2.2 (2.1-2.3)	2.5 (2.3 - 2.6)	291.8 (291.6-291.9)
	55 – 69	0.3 (0.2-0.3)	2.1(1.9-2.2)	2.3 (2.1 - 2.5)	187.7 (187.5-187.8)
Sex	Male	0.4 (0.3-0.4)	2.2 (2.0-2.3)	2.5 (2.3 - 2.7)	354.6 (354.5-354.7)
	Female	0.4 (0.3-0.4)	2.4 (2.2-2.5)	2.7 (2.6 - 2.8)	144.8 (144.7-144.8)
Residence	Urban	0.5(0.4-0.5)	1.9(1.8-2.1)	2.4(2.2 - 2.5)	196.7(196.6-196.8)
	Rural	0.3(0.3-0.4)	2.4(2.2-2.5)	2.7 (2.5 - 2.8)	262.7(262.5-262.8)
Overall		0.4 (0.3-0.4)	2.3 (2.2-2.4)	2.6 (2.5 - 2.7)	247.9 (247.8-248.0)
Means (CI) of physical risk factors of NCD					
Attributes		**BMI (Kg/m²)**	**WC (cm)**	**SBP (mmHg)**	**DBP (mmHg)**
Age	18 – 24	21.6(21.3-22.0)	74.5(73.7-75.3)	113.7 (112.9-114.4)	74.3 (73.7-74.9)
	25 – 39	23.2(23.0-23.4)	79.4(78.8-79.0)	117.1 (116.7-117.6)	78.5 (78.1-78.8)
	40 – 54	23.0(22.8-23.3)	80.4(79.7-81.0)	125.0 (124.2-125.8)	82.2 (81.6-82.7)
	55 – 69	22.3(21.8-22.7)	80.4(79.2-81.7)	130.9 (129.6-132.3)	81.3 (80.6-82.1)
Sex	Male	21.9(21.7-22.0)	79.1 (78.5-79.6)	121.5 (120.9-122.0)	77.9 (77.5-78.3)
	Female	23.5 (23.2-23.7)	78.2 (77.5-78.8)	120.7 (120.2-121.3)	80.8 (80.5-81.2)
Residence	Urban	23.6 (23.3-23.9)	81.4 (80.7-82.1)	122.6(122.0-123.1)	80.6 (80.2-81.0)
	Rural	22.4 (22.2-22.6)	77.8(77.3-78.3)	119.7(119.1-120.2)	78.4 (78.0-78.8)
Overall		22.7 (22.5-22.8)	78.6 (78.2-79.1)	121.1 (120.7-121.5)	79.5 (79.2-79.7)
Means (CI) of biochemical risk factors of NCD					
Attributes		**Fasting blood glucose (mmol/L)**	**Total cholesterol (mmol/L)**	**Salt intake**(gm/day)**	
Age	18 – 24	5.0 (5.0-5.1)	4.2 (4.1-4.3)	9.1 (8.9-9.3)	
	25 – 39	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
	40 – 54	5.7 (5.6-5.8)	4.6 (4.6-4.7)	9.0 (8.9-9.1)	
	55 – 69	5.6 (5.5-5.6)	4.6 (4.5-4.8)	8.9 (8.8-9.1)	
Sex	Male	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.2)	
	Female	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
Residence	Urban	5.8 (5.7-5.8)	4.4 (4.4-4.5)	8.9(8.7-9.0)	
	Rural	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0(8.9-9.1)	
Overall		5.4 (5.3-5.5)	4.4 (4.4-4.5)	9.0 (8.9-9.1)	

CI: Confidence Interval; NCD: Non-communicable diseases; BMI: Body mass index; WC: West circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure;

*Minutes spent on vigorous-intensity activities per day are multiplied by 2, to derive equivalent minutes of moderate-intensity activities, which is then summed up to derive total physical activity in minutes of moderate-intensity activity per day

** Calculated using 'Tanaka Equation' (Based on Urinary Na+ concentration)

Ever married (OR: 1.6, 95% CI: 1.6–1.6) and less physically active (OR: 4.9, 95% CI: 4.9–4.9) people were more likely to have current smoking. Women were more likely to have hypertension (OR: 1.5, 95% CI: 1.5–1.5), raised total cholesterol (OR: 1.3, 95% CI: 1.3–1.3) and obesity (OR: 1.9, 95% CI: 1.9–1.9). Rural population was less likely to have insufficient physical activity (OR: 0.8, 95% CI: 0.8–0.8), obesity (OR: 0.6, 95% CI: 0.6–0.6), raised BP (OR: 0.7, 95% CI: 0.7–0.7) and hyperglycemia (OR: 0.5, 95% CI: 0.5–0.5) (Table 4).

Table 4. Determinants of NCD risk factors among the adult population (aged 18-68 year) of Bangladesh

Attributes		Current Smoking OR (95%CI)	Current Alcohol consumption OR 95%CI)	Physical Activity OR (95% CI)	Inadequate Servings OR (95%CI)	Raised BP OR (95%CI)	Obesity OR (95%CI)	Raised Glucose OR (95%CI)	Raised Total Cholesterol OR (95% CI)
Age (Years)	18-29	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	30-44	2.0*(2.0-2.1)	0.4*(0.4-0.4)	0.8*(0.8-0.8)	1.1*(1.1-1.1)	1.8*(1.8-1.8)	1.5*(1.5-1.5)	2.3*(2.3-0.2.3)	1.3*(1.3-1.3)
	45-59	4.4*(4.4-4.4)	0.2*(0.2-0.2)	1.1*(1.1-1.1)	1.3*(1.3-1.3)	5.1*(5.1-5.1)	1.2*(1.2-1.2)	3.7*(3.7-3.7)	2.1*(2.1-2.1)
	60-69	5.7*(5.7-5.78)	0.2*(0.2-0.2)	1.9(1.9-1.9)	1.7*(1.7-1.7)	7.2*(7.2-7.3)	0.9*(0.9-0.9)	4.3*(4.3-4.3)	2.4*(2.4-2.4)
Gender	Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Female	0.2*(0.2-0.2)	0.01*(0.01-0.01)	1.7*(1.7-1.7)	0.6*(0.6-0.6)	1.5*(1.5-1.5)	1.9*(1.9-1.9)	0.8*(0.8-0.8)	1.3*(1.3-1.3)
Marital status	Never married	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Currently married	0.9*(0.9-0.9)	0.9*(0.9-0.9)	1.9*(1.9-1.9)	0.9(0.9-0.9)	1.1*(1.1-1.1)	1.7*(1.7-1.7)	1.7*(1.7-1.7)	1.1*(1.1-1.1)
	Ever married	1.6*(1.6-1.6)	3.2*(3.1-3.3)	4.9*(4.9-4.9)	1.8*(1.8-1.8)	1.5*(1.5-1.5)	1.6*(1.6-1.6)	2.7*(2.7-2.7)	1.8*(1.8-1.8)
Residence	Urban	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Rural	1.3(1.3-1.4)	0.8*(0.8-0.8)	0.8*(0.8-0.8)	0.7*(0.7-0.7)	0.7*(0.7-0.7)	0.6*(0.6-0.6)	0.5*(0.5-0.5)	0.8*(0.8-0.8)
Occupation	Employed	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	Business	0.9*(0.9-0.9)	1.1*(1.1-1.1)	2.5*(2.5-2.5)	1.0*(1.0-1.0)	1.5*(1.5-1.5)	1.8*(1.8-1.8)	1.9*(1.9-1.9)	2.0*(2.0-2.0)
	Student	0.3*(0.3-0.3)	0.3*(0.3-0.3)	2.4*(2.4-2.4)	1.5*(1.5-1.5)	1.5*(1.5-1.5)	0.8*(0.8-0.8)	1.1*(1.1-1.2)	1.0*(1.0-1.0)
	Homemaker	0.8*(0.8-0.8)	0.8*(0.8-0.8)	1.3*(1.3-1.3)	1.8*(1.8-1.8)	1.4*(1.4-1.4)	1.5*(1.5-1.5)	1.5*(1.5-1.5)	1.0*(1.0-1.0)
	Unemployed	0.5*(0.5-0.5)	0.9*(0.9-0.9)	7.8*(7.8-7.9)	0.5*(0.5-0.5)	2.0*(2.0-2.0)	1.9*(1.9-1.9)	1.6*(1.6-1.6)	1.2*(1.2-1.2)
	Others	0.3*(0.3-0.3)	0.6*(0.6-0.6)	4.4*(4.3-4.4)	0.5*(0.5-0.5)	2.7*(2.7-2.7)	2.4*(2.4-2.4)	4.0*(3.9-4.0)	1.2*(1.2-1.2)

OR: Odds Ratio; CI: Confidence Interval; Inadequate Servings: Intake <5 servings fruits and/or vegetables on average per day; *p-value <0.05: Significant.

Regarding combined risk factors, 3% (men 1.9%, women 4.0%) population had no risk factor while 70.9% had 1-2 and 26.2% had ≥3 NCD risk factors, which was higher in males (29.6%) than in females (22.8%) (Figure 1).

Figure 1. Summary of combined *risk factors of NCD

DISCUSSION

This country-wide study determined national prevalence on NCD risk factors in three steps including socio-demographic factors; increased tobacco and salt consumption; insufficient fruits and vegetable consumption, and physical activity; overweight and obesity; hypertension; hyperglycemia; and hypercholesterolemia. The prevalence of current tobacco consumption was higher than that observed in Global Adult Tobacco Survey (GATS)[15]. It was higher in rural than in urban setting but an average 10% reduction was observed in both areas compared to STEPS 2010[16], which reflects the success of anti-tobacco intervention programs. Tobacco consumption was significantly lower in females than in males (OR=0.2) and it could due to cultural and social attitude towards tobacco use by women in Bangladesh. Higher prevalence in the elderly people imitates the real picture of South Asia region[17,18] except Bhutan[19]. Prevalence of alcohol consumption was much lower in Bangladesh than in India (1.5% vs. 14.9%)[20], which could be due to cultural and religious differences. In spite of some recall bias, majority of the population consumed <5 servings of vegetables and fruits per day; though it is more than earlier[16] but lower than the neighboring countries[18,20]. Public fear regarding presence of heavy metals and pesticides in fruits and vegetables[21,22] is not tenuous rather their dietary habit seems to be the driving factor behind it.

The prevalence of insufficient physical activity (12.3%) is a glaring pointer towards a growing epidemic of overweight and obesity in our country. Insufficient physical activity was more in urban than in rural population (14.2% vs. 11.7%), and in women than in men (OR=1.7), which is inconsistent with the previous studies in the low- and middle-income and South Asian countries[23,24,25]. Including limitation of recall data given by the participants, it could also be argued that heavier activities are done by men in our country. Prevalence of insufficient physical activity has spiked up significantly in comparison with the previous STEPS survey[16]. It is evident that high income excites sedentary lifestyle including use of smart phones, computers[26].

In comparison with previous survey, a rising trend was found in the prevalence of overweight and obesity (25.9%) and central obesity (27.8%). Females were more obese than the males (33.7% vs.

18.3%) and this difference was also noticed to become wider over the years[16]. Central obesity was found to be decreased in urban population (36.2% vs. 45.2%) but it increased in rural population (23.5% vs. 22.5%)[16]. Shifting towards sedentary life style in rural area and a growing health consciousness in the urban people may be the reasons behind it. Prevalence of obesity is comparable to the neighboring[19,27,28] and many developed countries[29]. About one-fourth population had hypertension with a significant sex and age differences. Like obesity, prevalence of hypertension was also lower in rural population (OR=0.7) but higher in unemployed (OR=2.0). Another population-based study reported prevalence of hypertension as 12-13%[30]. It is evident that sedentary lifestyle predisposes hypertension and higher prevalence in females is possibly a bane from the revolutionary success of contraceptive usage among them.

Diabetes mellitus has been steadily creeping into the low- and middle-income countries to reach an epidemic proportion[31].The current prevalence is a testament to the exponential trend of diabetes as reported in previous systemic reviews[32,33]. With the increasing ages, the prevalence rose steadily and significant difference was observed among the age groups. Rural population showed half the burden of urban population (OR=0.5) which mimics the effect of unplanned urbanization, sedentary urban life and altered food habits. If effective strategy is not adopted, all these will pose an ominous potential to trigger a range of cardio-vascular disease epidemic in the recent future[34]. Reviews from surrounding countries indicate that dyslipidemias are slowly increasing in the region[35,36]. About 28.4% had higher serum cholesterol with a greater propensity in urban than in rural population (32.4%vs. 27.4%).

Health education and raised public awareness seems to be the only viable option for modifying the mass dietary habit and tobacco consumption behavior of the people. Bangladesh can adopt several strategies (e.g. modifying building design to encourage the use of stairs, making neighborhoods more walk able and increasing healthy foods in schools and work cafeterias to modify the growing obesogenic environment. For early detection and treatment of the major NCDs, specific intervention programs should be launched in the country.

CONCLUSION

Despite diverse challenges, this survey aligned with the WHO protocol revealed crucial population based information on NCD risk factors. Across all strata the magnitude of NCD risk factors is appalling in Bangladesh and will continue to rise if individual and collective intervention programs are not launched. The survey findings will contribute to devise future action plans to combat NCDs.

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Author Contributions

BK Riaz and MZ Islam were responsible for the concept and design, analysis and interpretation of data, and writing the manuscript. MM Zaman and MM Rahman participated in acquisition, analysis and interpretation of data, and critical revision of the manuscript. ANMS Islam and MA Hossain performed the statistical analyses and participated in preparing the manuscript. F Khanam, KMB Amin and IN Noor participated in acquisition and analysis of data. All authors wrote the article, edited and approved the final draft of the manuscript.

Role of the funding source

The Ministry of Health and Family Welfare of Bangladesh was the funder of the study. The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author (M.Z. Islam) had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Competing interests

We declare no competing interests.

Data sharing

The investigators will publish de-identified individual participant dataset in Dryad data depository from the email: dr.ziaul.islam@gmail.com.

Patient and public involvement: Patients and/or the public were not involved in the design or conduction or reporting or dissemination plans of this research.

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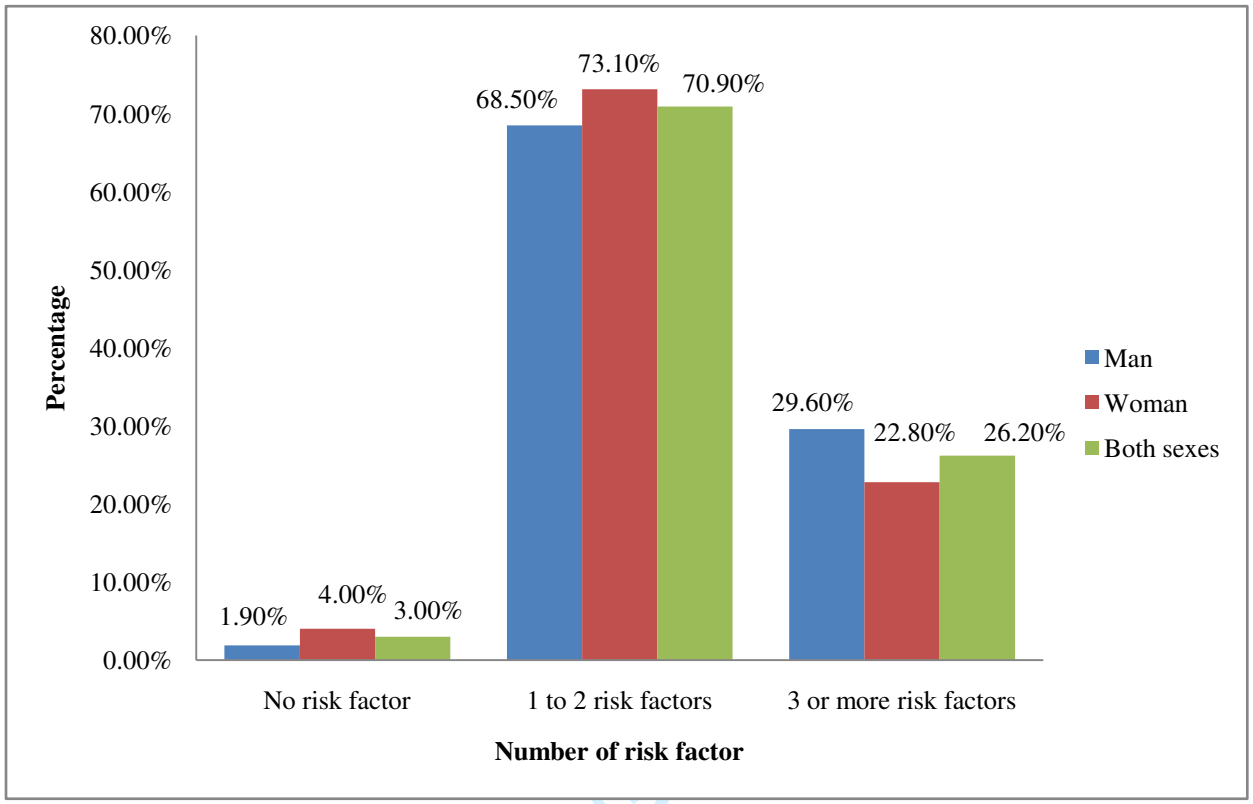

Figure 1. Summary of combined *risk factors of NCD

*Risk factors: Current daily smokers, Less than five servings of fruits and vegetables per day, Insufficient physical activity, Overweight (BMI≥25 Kg/m²), Raised blood pressure and raised total cholesterol.

Title: Risk Factors for Non Communicable Diseases in Bangladesh: Findings of the Country-wide STEPS Survey 2018

Research checklist

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	03
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	03
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	04
Objectives	#3	State specific objectives, including any pre-specified hypotheses	05
Methods			
Study design	#4	Present key elements of study design early in the paper	05
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	05
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	05
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	N/A
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for exposed and unexposed groups if applicable.	06
Bias	#9	Describe any efforts to address potential sources of bias	05,07
Study size	#10	Explain how the study size was arrived at	05

Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	08
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	08
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	N/A
Statistical methods	#12c	Explain how missing data were addressed	N/A
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	N/A
Statistical methods	#12e	Describe any sensitivity analyses	08
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for exposed and unexposed groups if applicable.	08
Participants	#13b	Give reasons for non-participation at each stage	08
Participants	#13c	Consider use of a flow diagram	N/A
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	08-11
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	N/A
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
Main results	#16b	Report category boundaries when continuous variables were categorized	N/A

Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	13
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	14
Generalisability	#21	Discuss the generalisability (external validity) of the study results	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

We used the STROBE cross sectional reporting guidelines to develop this research checklist (Von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies).

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Title Page

Manuscript Title:

Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

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Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

Original research article

ABSTRACT

Objectives: To determine the national prevalence of risk factors of non-communicable diseases (NCD) in the adult population of Bangladesh.

Design: The study was a population-based national cross-sectional study.

Setting: This study used 496 primary sampling units (PSUs) developed by the Bangladesh Bureau of Statistics. The PSUs were equally allocated to each division and urban and rural stratum within each division.

Participants: The participants were adults aged 18-69 years, who were usual residents of the households for at least six months, and stayed the night before the survey. Out of 9900 participants, 8185 (82.7%) completed STEP-1 and STEP-2, and 7208 took part in STEP-3.

Primary and secondary outcome: The prevalence of behavioral, physical, and biochemical risk factors of NCD. Data were weighted to generate national estimates.

Results: Tobacco use was significantly ($p<0.05$) higher in the rural (45.2%) than the urban (38.8%) population. Inadequate fruit/vegetable intake was significantly ($P<0.05$) higher in the urban (92.1%) than in the rural (88.9%) population. The mean salt intake per day was higher in the rural (9.0 gm) than urban (8.9 gm) population. Among all, 3.0% had no, 70.9% had 1-2, and 26.2% had 3-4 NCD risk factors. The urban population was more likely to have insufficient physical activity (AOR: 1.2, 95% CI: 1.2–1.2), obesity (AOR: 1.5, 95% CI: 1.5–1.5), hypertension (AOR: 1.3, 95% CI: 1.3–1.3), diabetes (AOR: 1.6, 95% CI: 1.6–1.6), and hyperglycemia (AOR: 1.1, 95% CI: 1.1–1.1).

Conclusions: Considering the high prevalence of the behavioral, physical, and biochemical risk factors, diverse population and high-risk group targeted interventions are essential to combat the rising burden of NCDs.

Key Words: Bangladesh; Behavioral; Biochemical; Non communicable diseases; Physical; Prevalence; Risk factors; STEPS survey;

Strengths and limitations of this study

- The survey covered the entire country for the first time to estimate the prevalence of NCD risk factors comprising all the three steps of the WHO STEPS approach.
- Rigorous methodology and cross-matching the data with their physical and biochemical parameters helped us to generate country representative data by controlling bias.
- Comprehensive findings on behavioral, physical, and biochemical risk factors could be used to devise diverse intervention programmes to reduce the rising burden of NCD.
- As a cross-sectional study, limits its ability to infer causal relationships among the risk factors.
- Behavioral data may have little bias as the participants of this self-report survey may tend to report in socially desirable ways.

INTRODUCTION

Non-communicable diseases (NCDs) are the result of a combination of genetic, socio-demographic, physical, biochemical, and behavioral factors. The global report on death by cause shows that more than 65% of 56 million global deaths were due to NCDs[1]. Three-fourths of this global mortality due to NCDs occur in low and middle-income countries[2]. Each year premature deaths affect equally both males and females (15 million each) due to NCDs[3]. Four major NCDs; cardiovascular disease, cancer, diabetes, and respiratory diseases are responsible for 82% of NCD mortality[4].

Demographic transition and rapid urbanization have led to changes in lifestyles; food and tobacco consumption continues to experience high morbidity and mortality from NCDs. The rise in NCDs largely stems from four behavioral risk factors: tobacco use, unhealthy diet, insufficient physical activity, and the harmful use of tobacco and alcohol[5]. Lifestyle change in an individual following the trend of globalization, supermarket growth, rapid urbanization, and sedentary lifestyles invites these risk factors around him[6].

In the Bangladeshi adult population, NCD risk factors are found to exist in clusters that become more prominent with the increasing age of that individual[7]. Bangladesh is passing through a demographic transition and an epidemiological transition and currently has a double burden of diseases[8]. NCDs account for 67% of total deaths in Bangladesh[9]. Diverse epidemiological studies have identified risk factors including unhealthy food consumption, tobacco use, insufficient physical inactivity, high BMI, raised blood pressure, unfavorable blood lipid, and raised blood glucose level[10]. Tobacco consumption is the leading risk factor for major NCDs in Bangladesh[11]. The first STEPS survey was done in 2010, but there was a lack of biochemical measurements and hence no national estimations of diabetes and dyslipidemia prevalence existed. There is limited evidence on certain risk factors that exist in Bangladesh at the national level[12]. This second nationwide STEPS survey along with biochemical measurement for blood glucose, lipid profile, and urinary sodium helped to provide the first comprehensive estimates of NCD risk factors in the country.

Member states of WHO have agreed 25 indicators across three areas that focus on the key outcomes, risk factors, and national systems response needed to prevent and control NCDs. One mortality target, six risk factor targets, and two national systems targets are considered[13]. As a member state, Bangladesh intends to estimate the prevalence of NCD risk factors in the adult people of the country. STEP wise approach is a WHO-developed, standardized framework for monitoring the magnitude of NCD risk factors comprising 3 steps; STEP 1 determines behavioral risk factors; STEP 2 determines

physical risk factors, and STEP 3 finds out biological risk factors. The STEPS survey 2018 for NCD risk factors in Bangladesh was carried out to determine the national prevalence of NCDs risk factors in the adult population of Bangladesh.

METHODS

Study design and setting

The STEPs survey 2018 was a country-wide population-based cross-sectional study conducted from September 2017 to June 2018. The samples were collected by multi-stage, geographically stratified probability-based sampling using the PSUs developed by the Bangladesh Bureau of Statistics (BBS) for the census.

Study population

The study population included adults aged 18-69 years, the usual residents of the household for at least six months and were present there the night before the survey. We excluded those people who primarily resided in a military base or group quarters, hospitals, prisons, nursing homes, and other institutions or those too frail and mentally or physically unfit to participate in the study or those unable or unwilling to participate in the study.

Sample size

To ensure generalization and reliability of the study results to the entire target population in Bangladesh, the WHO recommended sample size calculator (Sample size calculator STEPS) was used to derive a sample size. The calculated sample size was sufficient to produce reliable estimates for all the indicators for males and females and four age-groups (18-24, 25-39, 40-54, 55-69). The prevalence of NCD risk factors, relative precision rate (20%), and the feasibility of the survey were considered to calculate the sample size. Based on the prevalence of obesity, 472 people were required for effective analysis for each group. Considering the person non-response rate (10%) and household non-coverage rate (10%) shared by the previous surveys of Bangladesh Demographic Health Survey and BBS, overall, 20% non-response rate and a design effect of 2 were used to calculate the final sample size. Initially, we considered 496 PSUs updated by BBS in 2017. During the fieldwork, we excluded one PSU due to inaccessibility. As a result, the final adjusted sample size was 9900 adults of 495 PSUs.

Sampling frame

The sampling frame was developed based on the complete list of PSUs prepared by the BBS containing information about PSU location, type of residence, and the estimated number of residential households. All the PSUs were mapped for the survey and comprised of 293533 PSUs: 65193 urban and 228340

rural PSUs. The household lists updated by BBS served as the sampling frame for the selection of households. Twenty households were randomly selected from each PSU and randomly assigned as "male" or "female" in a ratio that produced equal numbers of male and female households. One individual was sampled randomly from all the eligible adults in a household. No replacement or change of the pre-selected households was allowed at the implementing stage to prevent bias.

Sampling strategy

The PSUs were allocated equally to each division (62 each), and urban and rural stratum (248 PSUs each). The PSUs were arranged by population size in terms of household numbers for both urban and rural stratum. In each stratum, 31 PSUs were selected independently in each division by probability proportional to size (PPS) sampling.

Data collection

Data were collected using a standardized pre-tested questionnaire developed considering WHO STEPS questionnaire (version 3.2) by incorporating all the core questions with some selected expanded and country-specific questions. The questionnaire was translated into Bengali and validated by translation and back translation. Data collection techniques included a face-to-face interview (STEP 1), physical measurements (STEP 2), and body fluid (blood and urine) collection (STEP 3). Data were collected by an android device on the spot and transferred into the cloud through ODK software.

STEP 1 (Behavioral risk factors ascertainment):

Core items included demographic information and measures of tobacco use, fruit and vegetable, alcohol, and salt consumption, physical activity, blood pressure, diabetes, and total cholesterol. Data enumerators having post-graduation in sociology/psychology/anthropology conducted the interviews and physical measurements. Medical technologists having diploma/bachelor/master's degree in medical laboratory science collected and processed the samples. The recruited staff underwent training covering all the steps with interactive sessions, skill development, and pilot testing.

STEP 2 (Physical measurements):

Core items included measurement of blood pressure, height, weight, hip, and waist circumference. Validated instruments were used for measuring these parameters. The height and weight of the participants were measured with barefoot and light clothing. Weight was measured to the nearest 10 gms using a digital weight measuring machine, while height was measured to the nearest 0.1 cm using a portable stadiometer. The tailor measuring tape was used for measuring waist and hip circumference. All the instruments were calibrated routinely during the survey. A digital blood pressure measuring

machine, supplied by WHO with uniform cuff-size with automatic measurement of BP and pulse, was used for measuring blood pressure.

STEP 3 (Biochemical measurements):

For estimation of blood sugar and lipid profile level, each participant was advised to remain nothing per mouth (except plain water) for at least 12 hours before blood collection. Blood and urine samples were collected under strict aseptic precautions. On the first visit of STEP 3, written instructions on fasting state, and appointment date for the blood test were given to each participant and asked to visit maintaining the schedule. Initially, 5 ml of blood was collected by disposable syringe, and plasma and serum were separated by centrifuging within 30 minutes to 1 hour after collection. Followed by 2 ml of this blood was transferred to a fluoride-oxalate vacutainer for serum glucose testing, and 3 ml of the blood was kept in a normal tube and allowed to stand for the separation of plasma (for lipid profile) with proper labeling. The sample for blood glucose was left in the upright position in a vacutainer rack and then centrifuged and separated serum was keep in the cold box (2-8^{0}C) surrounded by ice packs.

The participants were asked to collect 20 ml urine in supplied labeled screw-capped plastic urine pot in the evening before bedtime to submit to the medical technologist on the following day for blood sample collection at the prefixed place. All the collected blood and urine samples of a day were sent to the NIPSOM laboratory within 24 hours of collection. At the central laboratory, the blood and urine samples were received and sent with a laboratory ID number for testing sodium and urine. After the estimation of blood glucose and lipid profile, the remaining serum sample was kept in Cryo vials at -70^{0}C. After the estimation of urinary sodium, and the remaining urine sample was discarded.

Quality control

Quality control procedures included regular field supervision and daily review of collected data. Laboratory instruments were calibrated following the standard procedure and the findings were validated with the same sample findings of another standard national laboratory. The blood and urine samples were tested in the NIPSOM central laboratory dividing the sample into multiple samples and the same samples multiple times to compare the findings and to validate the instruments and procedure. To ensure accurate findings of the biochemical samples; pretesting was done in both urban and rural areas from where samples were sent to the NIPSOM laboratory. Accordingly, samples were received at different time intervals after collection and were tested at different times and the findings were compared.

Data management

Data were entered directly in the ODK software on the PDAs. Data were sent electronically and stored in the ONA database server. The field team uploaded data daily on the server. The stored data were downloaded into Microsoft Excel® format for consistency and validity check at the central office. Each participant had a unique identifier QR-code and personal identification number (PID), which were used for merging data of steps 1, 2, 3. Data were cleaned and analyzed following WHO STEPS recommended guidelines.

Statistical methods

We weighted the data considering selection probabilities of PSU, household, sex, and individuals within the household so that the study results conform to the population of Bangladesh. Calibration was done to replicate population distribution. Prevalence was estimated using the STEPS recommended cut-off values[14]. Data were analyzed using STATA version 15.0, and Epi Info version 3.4 was used as a reference for programming purposes and cross-validation of STATA outputs. Missing data were excluded from analysis. Economic status was determined by the principal component analysis of the wealth index. Descriptive statistics included percentage, and inferential statistics included logistic regression to determine the NCD risk factors. Background characteristics were cross-tabulated with NCD risk factors, and the chi-square test was performed to investigate the significance of the relationships. Outcome measures and differences between groups were calculated at 95% CI and significant at p-value <0.05.

Ethics

We obtained the ethical approval of the National Research Ethics Committee (NREC) of Bangladesh. We took informed consent from each participant before data collection. Confidentiality and privacy of the participants and anonymity of data were maintained strictly. We carried out all the activities in conformity with the revised declarations of Helsinki.

RESULTS

Among the target 9900 population, 8185 (82.7%) completed STEP-1 & 2 while 7208 took part in STEP-3. Out of 7208 participants, 7056 gave the blood and 7028 urine sample. The majority of the urban participants were male (51.5%), and the majority of the rural participants were female (51.4%). Around 33.0% of urban and 47.0% of rural participants had no education or less than primary level education. The majority of the rural (45.7%) and urban (36.9%) participants were homemakers. The

'richest' comprised 28.5% urban and 12.6% rural, and the 'poorest' included 18.1% urban and 17.6% rural population (Table 1).

Table 1. Background characteristics (weighted) of the adult population of Bangladesh (n=8185)

Background characteristics		Urban, %	Rural, %	Both, %
Age	18 – 24	23.6	24.0	23.9
	25 – 39	42.1	39.0	39.7
	40 – 54	19.7	19.7	19.7
	55 – 69	14.6	17.2	16.6
Sex	Male	51.5	48.6	49.3
	Female	48.5	51.4	50.7
Highest level of Education	No education/<primary	32.9	47.0	43.9
	Primary	27.8	32.0	31.1
	Secondary	18.6	10.8	12.6
	More than secondary	20.7	10.1	12.5
Marital status	Never married	14.2	11.8	12.3
	Currently married	80.9	83.2	82.7
	Ever married*	04.8	05.1	05.0
Occupation	Employed	36.7	35.7	35.9
	Businessman	13.3	10.1	10.9
	Student	08.4	05.4	06.1
	Homemaker	36.9	45.7	43.7
	Unemployed	02.3	02.1	02.1
	Others	02.3	01.0	01.3
Economic status (Based on Wealth Index)	Poorest	18.1	17.6	17.7
	Poor	15.5	22.2	20.7
	Average	16.2	24.6	22.7
	Rich	21.7	23.0	22.7
	Richest	28.5	12.6	16.2

%: Weighted percentage; n: Number; *Ever married: Separated/divorced/widow/widowed

Mean serving of fruits and/or vegetables per day was 2.6 (CI: 2.5-2.7), and the mean duration of physical activity per day was 247.9 (CI: 247.8-248.0) minutes. Mean BMI was 22.7 (95% CI: 22.5-22.8) kg/m², and mean waist circumference was 78.6 (95% CI: 78.2-79.1) cm. Both mean SBP [122.6 (95% CI: 122.0-123.1) mmHg] and DBP [80.6 (95% CI: 80.2-81.0) mmHg] was higher in urban population. Both mean fasting blood glucose [5.6 (95% CI: 5.5-5.6) mmol/L] and mean total cholesterol [4.4 (95% CI: 4.4-4.5) mmol/L] was higher in the richest but mean salt intake per day was [9.1 (95% CI: 9.1-9.1) gm] in the poor population (Table-2).

Table 2. Means (CI) of behavioral, physical and biochemical parameters of the adult population

Means (CI) of behavioral risk factors of NCD					
Attributes		**Mean number of servings of fruits on average per day**	**Mean number of servings of vegetables on average per day**	**Mean number of servings of fruits and/or vegetables on average per day**	**Mean physical activity in minutes of moderate-intensity activity (Min/day) ***
Age	18 – 24	0.4 (0.4-0.5)	2.3 (2.1-2.5)	2.7 (2.5 - 2.9)	213.3 (213.1-213.5)
	25 – 39	0.4 (0.3-0.4)	2.4(2.2-2.5)	2.7(2.6 - 2.9)	272.2 (272.1-272.3)
	40 – 54	0.3 (0.3-0.3)	2.2 (2.1-2.3)	2.5 (2.3 - 2.6)	291.8 (291.6-291.9)
	55 – 69	0.3 (0.2-0.3)	2.1(1.9-2.2)	2.3 (2.1 - 2.5)	187.7 (187.5-187.8)
Sex	Male	0.4 (0.3-0.4)	2.2 (2.0-2.3)	2.5 (2.3 - 2.7)	354.6 (354.5-354.7)
	Female	0.4 (0.3-0.4)	2.4 (2.2-2.5)	2.7 (2.6 - 2.8)	144.8 (144.7-144.8)
Residence	Urban	0.5(0.4-0.5)	1.9(1.8-2.1)	2.4(2.2 - 2.5)	196.7(196.6-196.8)
	Rural	0.3(0.3-0.4)	2.4(2.2-2.5)	2.7 (2.5 - 2.8)	262.7(262.5-262.8)
Overall		0.4 (0.3-0.4)	2.3 (2.2-2.4)	2.6 (2.5 - 2.7)	247.9 (247.8-248.0)
Economic status	Poorest	0.4 (0.4-0.4)	2.1 (2.1-2.1)	2.5 (2.4-2.5)	258.0 (257.9-258.2)
	Poor	0.3 (0.3-0.3)	2.3 (2.2-2.3)	2.6 (2.5-2.6)	264.5 (264.4-254.7)
	Average	0.4 (0.3-0.4)	2.4 (2.4-2.4)	2.8 (2.7-2.8)	260.0 (259.9-260.1)
	Rich	0.4 (0.3-0.4)	2.1 (2.1-2.1)	2.5 (2.4-2.5)	221.5 (221.4-221.6)
	Richest	0.5 (0.5-0.5)	2.3 (2.3-2.3)	2.7 (2.7-2.8)	231.2 (231.1-231.3)
	Overall	0.4 (0.3-0.4)	2.3 (2.2-2.4)	2.6 (2.5-2.7)	247.9 (247.8-248.0)
Means (CI) of physical risk factors of NCD					
Attributes		**BMI (Kg/m²)**	**WC (cm)**	**SBP (mmHg)**	**DBP (mmHg)**
Age	18 – 24	21.6(21.3-22.0)	74.5(73.7-75.3)	113.7 (112.9-114.4)	74.3 (73.7-74.9)
	25 – 39	23.2(23.0-23.4)	79.4(78.8-79.0)	117.1 (116.7-117.6)	78.5 (78.1-78.8)
	40 – 54	23.0(22.8-23.3)	80.4(79.7-81.0)	125.0 (124.2-125.8)	82.2 (81.6-82.7)
	55 – 69	22.3(21.8-22.7)	80.4(79.2-81.7)	130.9 (129.6-132.3)	81.3 (80.6-82.1)
Sex	Male	21.9(21.7-22.0)	79.1 (78.5-79.6)	121.5 (120.9-122.0)	77.9 (77.5-78.3)
	Female	23.5 (23.2-23.7)	78.2 (77.5-78.8)	120.7 (120.2-121.3)	80.8 (80.5-81.2)
Residence	Urban	23.6 (23.3-23.9)	81.4 (80.7-82.1)	122.6(122.0-123.1)	80.6 (80.2-81.0)
	Rural	22.4 (22.2-22.6)	77.8(77.3-78.3)	119.7(119.1-120.2)	78.4 (78.0-78.8)
Overall		22.7 (22.5-22.8)	78.6 (78.2-79.1)	121.1 (120.7-121.5)	79.5 (79.2-79.7)
Economic status	Poorest	22.0 (21.9-22.0)	77.0 (76.9-77.0)	120.4 (119.4-121.3)	79.2 (78.6-79.8)
	Poor	22.5 (22.5-22.5)	78.4 (78.3-78.4)	120.4 (119.5-121.2)	79.1 (78.5-79.7)
	Average	22.5 (22.4-22.5)	78.0 (78.0-78.0)	120.8 (119.9-121.7)	78.9 (78.3-79.5)
	Rich	22.6 (22.5-22.6)	78.6 (78.6-78.7)	120.9 (120.1-121.7)	79.3 (78.7-79.9)
	Richest	23.6 (23.6-23.6)	81.6 (81.5-81.6)	123.0 (122.1-123.9)	80.8 (80.3-81.4)
	Overall	22.7 (22.5-22.8)	78.6 (78.2-79.1)	121.1 (120.7-121.5)	79.5 (79.2-79.7)
Means (CI) of biochemical risk factors of NCD					
Attributes		**Fasting blood glucose (mmol/L)**	**Total cholesterol (mmol/L)**	**Salt intake**(gm/day)**	
Age	18 – 24	5.0 (5.0-5.1)	4.2 (4.1-4.3)	9.1 (8.9-9.3)	
	25 – 39	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
	40 – 54	5.7 (5.6-5.8)	4.6 (4.6-4.7)	9.0 (8.9-9.1)	

	55 – 69	5.6 (5.5-5.6)	4.6 (4.5-4.8)	8.9 (8.8-9.1)	
Sex	Male	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.2)	
	Female	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
Residence	Urban	5.8 (5.7-5.8)	4.4 (4.4-4.5)	8.9(8.7-9.0)	
	Rural	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0(8.9-9.1)	
Overall		5.4 (5.3-5.5)	4.4 (4.4-4.5)	9.0 (8.9-9.1)	
Economic status	Poorest	5.4 (5.4-5.4)	4.4 (4.3-4.4)	9.0 (8.9-9.0)	
	Poor	5.4 (5.4-5.5)	4.4 (4.4-4.4)	9.1 (9.1-9.1)	
	Average	5.3 (5.3-5.4)	4.4 (4.4-4.5)	8.9 (8.8-8.9)	
	Rich	5.3 (5.2-5.3)	4.4 (4.4-4.4)	9.1 (9.0-9.1)	
	Richest	5.6 (5.5-5.6)	4.5 (4.4-4.5)	9.0 (9.0-9.0)	
	Overall	5.4 (5.3-5.5)	4.4 (4.4-4.5)	9.0 (8.9-9.1)	

CI: Confidence Interval; NCD: Non-communicable diseases; Min: Minute; BMI: Body mass index; WC: West circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure;

*Minutes spent on vigorous-intensity activities per day are multiplied by 2, to derive equivalent minutes of moderate-intensity activities and then summed up to obtain the total physical activity in minutes of moderate-intensity activity per day. ** Calculated using 'Tanaka Equation' (Based on Urinary Na+ concentration)

The prevalence of tobacco consumption was 43.7% and was significantly ($p<0.05$) higher in males (59.6%) and rural (45.2%) population. The prevalence of alcohol consumption was 1.5% and was significantly ($p<0.05$) higher in males (2.9%) and businessman (3.2%). The prevalence of inadequate fruit and vegetable intake was 89.6% and was significantly ($p<0.05$) higher in the elderly (92.3%) and urban (92.1%) population. The prevalence of insufficient physical activity was 12.3% and was significantly ($p<0.05$) higher in the females (14.8%) and urban (14.1%) population (Table 3).

The prevalence of overweight and obesity was 25.9% and was significantly ($p<0.05$) higher in the females (33.7%), urban (34.3%), and 'richest' (34.3%) population. The prevalence of hypertension was 21.0% and was significantly ($p<0.05$) higher in the urban (25.2%) and 'richest' (24.9%) population. The prevalence of diabetes was 8.3% and was significantly ($p<0.05$) higher in the urban (13.2%), elderly (16.3%), and 'richest' (11.9%) population. The prevalence of hypercholesterolemia was 28.4% and was significantly ($p<0.05$) higher in females (29.3%) and urban (32.4%) population (Table 3).

Table 3. Bivariate analysis between NCD risk factors and background characteristics of the adult population of Bangladesh (Chi-square test)

Background characteristics	Current tobacco consumption (in any form) (n=8185)	Current alcohol consumption (in past 30 days) (n=8185)	**Inadequate fruits and/or vegetables intake (n=8185)	***Insufficient physical activity (n=8185)	[a]Overweight/ Obese (n=8013)	[b]Raised BP (Hypertension) (n=8154)	[c]Raised glucose (Diabetes)	[d]Raised total cholesterol
Age	%	%	%	%	%	%	%	%
18 – 24	22.3	2.4	90.5	11.2	15.9	08.8	02.9	20.6
25 – 39	38.7	1.5	87.3	08.8	31.4	20.7	08.1	26.7
40 – 54	59.1	1.0	91.1	11.3	28.8	34.4	12.4	36.4
55 – 69	68.4	0.4	92.3	23.1	23.6	46.9	16.3	39.5
Sex								
Male	59.6	2.9	90.0	09.6	18.3	17.9	08.9	27.4
Female	28.3	0.0	89.3	14.8	33.7	24.1	07.9	29.3
Residence								
Urban	38.8	1.8	92.1	14.1	34.3	25.2	13.2	32.4
Rural	45.2	1.4	88.9	11.7	23.5	19.8	07.1	27.4
Highest level of education								
No education /<Primary	60.2	1.2	92.2	13.0	20.2	22.8	07.3	27.0
Primary	35.6	2.0	87.1	10.4	29.1	19.1	08.5	28.7
Secondary	26.9	1.4	88.9	11.9	29.8	17.8	08.3	29.4
>Secondary	22.8	1.1	88.1	14.0	33.9	22.5	13.1	33.0
Marital status								
Never married	31.6	3.0	90.0	7.7	11.4	09.0	02.2	18.8
Currently married	44.7	1.3	89.3	11.5	27.8	21.2	08.6	28.3
Ever married*	57.3	0.2	94.8	35.6	30.3	47.0	13.6	45.9
Occupation								
Employed	60.0	2.7	89.2	6.8	17.9	16.1	07.0	25.1
Businessman	62.4	3.2	90.3	13.7	26.8	21.2	12.9	38.0
Student	15.4	1.1	91.6	9.8	10.0	9.1	02.0	17.3
Homemaker	29.1	0.0	90.1	14.5	34.5	25.0	08.0	29.2
Unemployed	51.8	2.0	83.7	40.4	24.6	33.5	14.9	29.5
Others	49.9	0.7	84.9	36.2	33.8	53.1	33.2	39.1
Economic status								
Poorest	49.6	2.2	92.2	13.8	19.3	18.8	07.9	26.9
Poor	44.6	0.9	89.7	11.6	26.3	21.2	09.2	26.3
Average	42.9	1.0	89.1	10.6	23.9	19.7	06.2	30.4
Rich	42.8	2.0	90.8	13.7	26.3	21.1	07.9	28.5
Richest	38.6	1.2	85.9	11.5	34.3	24.9	11.9	29.7
Overall	43.7	1.5	89.6	12.3	25.9	21.0	08.3	28.4

%: Percentage; n: Number;
*Ever married: Separated/divorced/widow/widowed
**Participants taking <5 servings fruits and/or vegetables on average per day
*** Participants doing less than 150 minutes of moderate-intensity physical activity per week
[a]Overweight & obese: BMI≥25kg/m^2; [b]Raised blood pressure (BP): Systolic BP≥140 or diastolic BP≥90mm Hg;
[c]Raised blood sugar: ≥7.0 mmol/L or, ≥126 mg/dl; [d]Raised total cholesterol: ≥5.0 mmol/L;
All the differences of findings are statistically significant at the p-value <0.05

The elderly (AOR: 4.5, 95% CI: 4.5–4.5) and ever married (OR: 1.4, 95% CI: 1.4–1.4) were more likely to have the smoking habit. The urban population was more likely to consume alcohol (AOR: 1.2, 95% CI: 1.2–1.2). The females (AOR: 1.7, 95% CI: 1.6–1.7), and unemployed (AOR: 7.8, 95% CI: 7.8–7.9) were more likely to have inadequate physical activity. The females were more likely to have hypertension (AOR: 1.5, 95% CI: 1.5–1.5), and obesity (AOR: 2.0, 95% CI: 2.0–2.0). The urban population was more likely to have insufficient physical activity (AOR: 1.2, 95% CI: 1.2–1.2), obesity (AOR: 1.5, 95% CI: 1.5–1.5), raised BP (AOR: 1.3, 95% CI: 1.3–1.3), diabetes (AOR: 1.6, 95% CI: 1.6–1.6) and hyperglycemia (AOR: 1.1, 95% CI: 1.1–1.1) (Table 4).

Table 4. Logistic regression analysis of the determinants of NCD risk factors in the adult population of Bangladesh

Determinants		Current Smoking AOR (95%CI)	Current Alcohol consumption AOR (95%CI)	Insufficient Physical Activity AOR (95% CI)	Inadequate Servings AOR (95%CI)	Raised BP (Hypertension) AOR (95%CI)	Obesity AOR (95%CI)	Raised Glucose (Diabetes) AOR (95%CI)	Raised Total Cholesterol AOR (95% CI)
Age (Years)	18-29	1	1	1	1	1	1	1	1
	30-44	1.7(1.7-1.7)	0.4(0.4-0.4)	0.7(0.7-0.7)	0.7(0.7-0.7)	1.9(1.9-1.9)	2.4(2.4-2.4)	3.3(3.2-3.3)	1.4(1.4-1.4)
	45-59	3.5(3.4-3.5)	0.3(0.3-0.3)	0.9(0.9-0.9)	0.9(0.9-1.0)	6.1(6.1-6.2)	2.5(2.5-2.5)	7.7(7.6-7.7)	2.6(2.6-2.6)
	60-69	4.5(4.5-4.5)	0.1(0.1-0.1)	1.5(1.5-1.5)	1.1(1.1-1.1)	9.2(9.2-9.2)	2.0(2.0-2.0)	8.7(8.6-8.7)	2.7(2.7-2.7)
Gender	Male	1	1	1	1	1	1	1	1
	Female	0.2(0.2-0.2)	0.01(0.01-0.01)	1.7(1.6-1.7)	0.6(0.6-0.6)	1.5(1.5-1.5)	2.0(2.0-2.0)	1.0(1.0-1.0)	1.3(1.3-1.3)
Residence	Rural	1	1	1	1	1	1	1	1
	Urban	0.9(0.9-0.9)	1.2(1.2-1.2)	1.2(1.2-1.2)	1.8(1.8-1.8)	1.3(1.3-1.3)	1.5(1.5-1.5)	1.6(1.6-1.6)	1.1(1.1-1.1)
Highest level of education	No education /<primary	1	1	1	1	1	1	1	1
	Primary	0.5(0.5-0.5)	1.5(1.5-1.5)	1.0(1.0-1.0)	0.6(0.6-0.6)	1.5(1.5-1.5)	1.7(1.7-1.7)	1.7(1.7-1.7)	1.4(1.4-1.4)
	Secondary	0.3(0.3-0.3)	0.9(0.9-1.0)	1.1(1.1-1.1)	0.7(0.7-0.7)	1.5(1.5-1.5)	2.2(2.2-2.2)	1.6(1.6-1.6)	1.6(1.6-1.6)
	>secondary	0.2(0.2-0.2)	0.7(0.7-0.7)	1.5(1.5-1.5)	0.6(0.6-0.6)	2.3(2.3-2.3)	3.7(3.7-3.7)	3.1(3.1-3.1)	2.1(2.1-2.1)
Marital status	Never married	1	1	1	1	1	1	1	1
	Currently married	0.9(0.9-0.9)	1.0(1.0-1.0)	1.9(1.9-1.9)	0.9(0.9-0.9)	1.1(1.1-1.1)	1.7(1.7-1.7)	2.2(2.2-2.2)	1.2(1.2-1.2)
	Ever married	1.4(1.4-1.4)	0.3(0.3-0.3)	5.1(5.1-5.1)	1.7(1.7-1.7)	1.6(1.6-1.6)	1.8(1.8-1.8)	2.9(2.8-2.9)	2.0(2.0-2.0)

Occupation	Employed	1	1	1	1	1	1	1	1
	Business	1.1(1.1-1.1)	1.0(1.0-1.0)	2.5(2.5-2.5)	1.1(1.1-1.1)	1.4(1.4-1.4)	1.7(1.7-1.7)	1.8(1.8-1.8)	1.9(1.9-1.9)
	Student	0.6(0.6-0.6)	0.3(0.3-0.3)	1.8(1.8-1.8)	1.6(1.6-1.6)	1.1(1.1-1.1)	0.6(0.6-0.6)	1.2(1.2-1.2)	0.8(0.8-0.8)
	Homemaker	0.9(0.9-0.9)	1.1(1.0-1.1)	1.4(1.4-1.4)	1.9(1.8-1.9)	1.4(1.4-1.4)	1.5(1.5-1.5)	1.4(1.4-1.4)	1.0(1.0-1.0)
	Unemployed	0.6(0.6-0.6)	1.2(1.2-1.2)	7.8(7.8-7.9)	0.5(0.5-0.6)	1.8(1.8-1.8)	1.6(1.6-1.6)	1.9(1.9-1.9)	1.1(1.1-1.1)
	Others	0.6(0.6-0.6)	1.0(1.0-1.0)	4.2(4.2-4.2)	0.7(0.7-0.7)	2.0(2.0-2.0)	1.3(1.3-1.3)	2.9(2.8-2.9)	1.1(1.1-1.1)
Economic status	1	1	1	1	1	1	1	1	1
	Poor	0.8(0.8-0.8)	0.3(0.3-0.3)	0.8(0.8-0.8)	0.8(0.8-0.8)	1.2(1.2-1.2)	1.6(1.6-1.6)	1.2(1.2-1.2)	1.0(1.0-1.1)
	Average	0.9(0.9-0.9)	0.4(0.4-0.4)	0.7(0.7-0.7)	0.7(0.7-0.8)	1.1(1.1-1.1)	1.3(1.3-1.3)	0.8(0.8-0.8)	1.2(1.2-1.2)
	Rich	0.9(0.9-0.9)	0.9*(0.9-0.9)	0.9*(0.9-1.0)	0.9*(0.9-0.9)	1.1*(1.1-1.1)	1.4*(1.4-1.4)	0.9*(0.9-0.9)	1.0*(1.0-1.0)
	Richest	0.8(0.8-0.8)	0.6(0.6-0.6)	0.8(0.8-0.8)	0.(0.5-0.5)	1.2(1.2-1.2)	1.7(1.7-1.7)	1.1(1.1-1.1)	1.0(1.0-1.1)

AOR: Adjusted Odds Ratio; CI: Confidence Interval; Inadequate Servings: Intake <5 servings` fruits and/or vegetables on average per day; p-value <0.05: Significant.

Regarding combined risk factors, 3% (men 1.9%, women 4.0%) population had no risk factor while 70.9% had 1-2 and 26.2% had ≥3 NCD risk factors, which was higher in males (29.6%) than in females (22.8%) (Figure 1).

Figure 1. Summary of combined *risk factors of NCD

DISCUSSION

Based on the analysis of weighted data, this country-wide survey determined the national prevalence of NCD risk factors in three steps including socio-demographic factors; tobacco and salt consumption; fruits and vegetable consumption, and physical activity; overweight and obesity; hypertension; hyperglycemia; and hypercholesterolemia. The prevalence of current tobacco consumption was higher than that observed in the Global Adult Tobacco Survey (GATS)[15]. It was higher in the rural than the urban population but an average 10% reduction was observed in both areas compared to STEPS 2010[16], which reflects the success of anti-tobacco intervention programs. The higher prevalence of tobacco uses in the males (OR=0.2) and elderly imitates the real picture of the South Asia region[17,18] except Bhutan[19].

The prevalence of alcohol consumption was much lower in Bangladesh than in India (1.5% vs. 14.9%)[20], which could be due to cultural and religious differences. Despite some recall bias, the majority of the population consumed <5 servings of vegetables and fruits per day; though it is more than earlier[16] but lower than the neighboring countries[18,20]. Public fear regarding the presence of heavy metals and pesticides in fruits and vegetables[21,22] is not tenuous rather their dietary habit seems to be the driving factor behind it.

The prevalence of insufficient physical activity (12.3%) is a glaring pointer towards a growing epidemic of overweight and obesity in our country. Insufficient physical activity was more in urban than in rural population (14.1% vs. 11.7%), and in females than in males (OR=1.7), which is inconsistent with the previous studies in the low- and middle-income and South Asian countries[23,24,25]. The prevalence of insufficient physical activity has spiked up significantly in comparison with the previous STEPS survey[16]. Despite a little recall bias, it could be argued that males are involved in more laborious activities than females. High income also excites a sedentary lifestyle like smartphone and computer use[26].

In comparison with the 2010 survey, the prevalence of overweight and obesity (25.9%) showed a rising trend with a higher proportion in females than males (33.7% vs. 18.3%)[16]. Shifting towards a sedentary lifestyle in the rural whereas growing health consciousness in the urban population may be the reasons behind it. The prevalence of obesity is comparable to the neighboring[19,27,28], and many developed countries[29]. About one-fourth population had hypertension with significant sex and age differences. The prevalence of hypertension was significantly higher in females (AOR=1.5), elderly (AOR=9.2), urban (AOR=1.3), and unemployed (AOR=1.8) population. Another population-based study reported the prevalence of hypertension as 12-13%[30]. A sedentary lifestyle predisposes hypertension and higher prevalence in females is possibly a bane from the revolutionary success of contraceptive usage among them.

Diabetes mellitus has been steadily creeping into the low- and middle-income countries to reach an epidemic proportion[31]. The current prevalence (8.3%) is a testament to the exponential trend of diabetes as reported in previous systemic reviews[32,33]. With the increasing ages, the prevalence rose steadily and a significant difference was observed in the urban population (OR=1.6). The effect of unplanned urbanization, sedentary lifestyle and altered food habits could make the urban population more vulnerable to hypertension. If an effective strategy is not adopted, all these will pose an ominous potential to trigger a range of cardiovascular disease epidemics in the recent future[34]. Reviews from

surrounding countries indicate that dyslipidemias are slowly increasing in the region[35,36]. About 28.4% had higher serum cholesterol with a greater propensity in urban than rural population (32.4%vs. 27.4%).

The current study found 3% had no, 70.9% had 1-2, and 26.2% had ≥3 NCD risk factors while the previous STEPS survey 2010 found 1.3%, 77.4%, and 28.3%.[16] These discrepancies could be due to the positive impacts of comprehensive NCD prevention and control activities in the country. In 2018, ≥3 risk factors were higher in females than in males (31.5% vs. 21.7%) while it was reversed in 2010 (22.8% Vs. 29.6%). This finding suggests an emphasized NCD risk factors alleviation programme for the females.

Despite few methodological limitations like recall bias with self-reported behavioral data of the participants, challenges of transportation of biological samples maintaining the cold chain, and the inability of the cross-sectional design to infer causal relationships among the risk factors, the study unveiled crucial nationally representative data on NCD risk factors.

Raising public awareness through health education seems to be a vital viable option for modifying the mass dietary habit and tobacco consumption behavior of the people. Bangladesh can adopt several strategies like healthy urban community design making neighborhoods more walkable and encouraging healthy foods in schools and cafeterias for modifying the growing obesogenic environment. Specific intervention programs must be designed based on risk factors and high-risk groups for the early detection and treatment of the major NCDs.

CONCLUSION

Despite diverse challenges, this comprehensive survey aligned with the WHO protocol identified the major NCD risk factors and high-risk groups. The study findings recommend individual and collective program interventions with an emphasis on the elderly, females, and urban population. The study will also contribute to devising future comprehensive national action plan to combat the rising NCD burden.

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Author Contributions

BK Riaz and MZ Islam were responsible for the concept and design, analysis and interpretation of data, and writing the manuscript. MM Zaman and MM Rahman participated in the acquisition, analysis, and interpretation of data, and critical revision of the manuscript. ANMS Islam and MA Hossain performed the statistical analysis and participated in preparing the manuscript. F Khanam, KMB Amin, and IN Noor participated in the acquisition and analysis of data. All authors wrote the article, edited, and approved the final draft of the manuscript.

Role of the funding source

As the funder of the study, the Ministry of Health and Family Welfare of Bangladesh had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author (M.Z. Islam) had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Competing interests

The authors declare that they have no competing interests.

Data sharing

The investigators will publish a de-identified individual participant dataset in the Dryad data repository from the email: dr.ziaul.islam@gmail.com.

Patient and public involvement: Patients and/or the public were not involved in the design or conduction or reporting or dissemination plans of this research.

Patient consent for publication: Not required.

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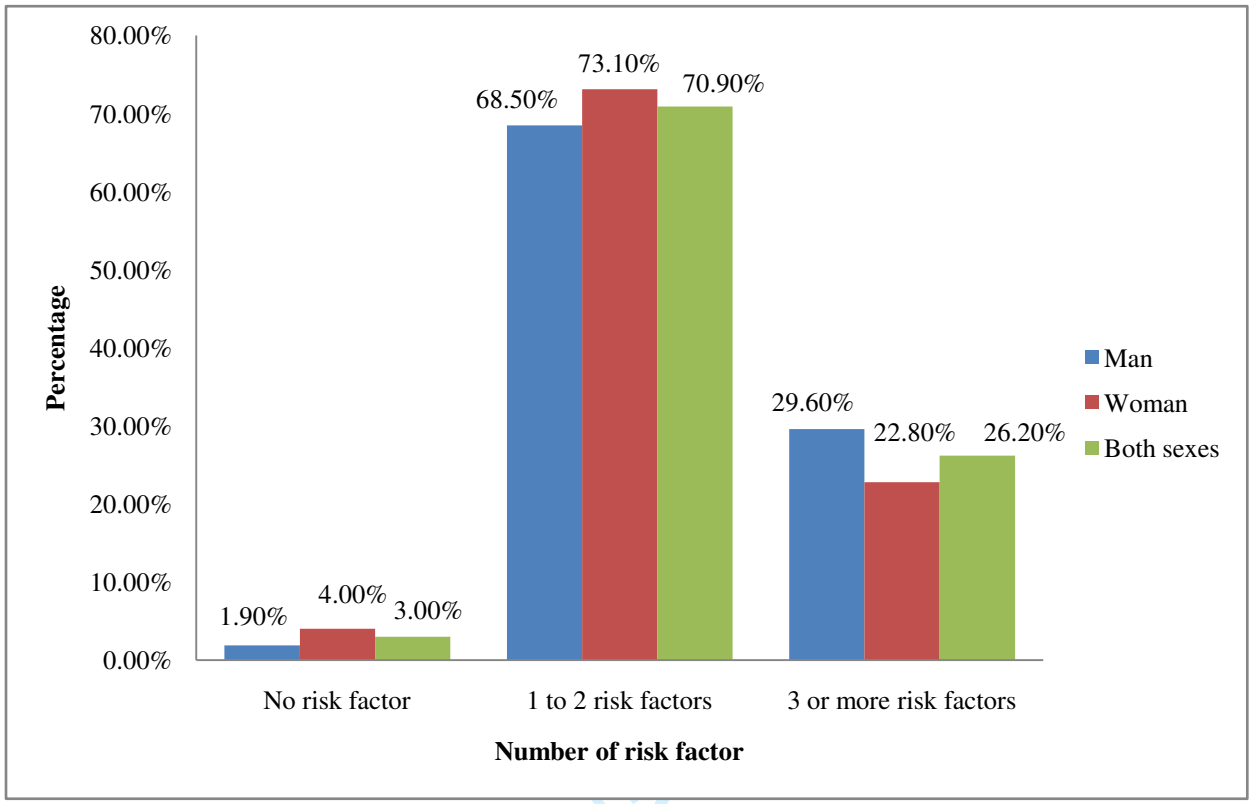

Figure 1. Summary of combined *risk factors of NCD

*Risk factors: Current daily smokers, Less than five servings of fruits and vegetables per day, Insufficient physical activity, Overweight (BMI≥25 Kg/m²), Raised blood pressure and raised total cholesterol.

Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

STROBE Checklist

Based on the STROBE cross sectional guidelines.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1, 2
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	5
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for exposed and unexposed groups if applicable. This cross-sectional study used one group of participants. So, there was no separate exposed and unexposed groups.	6,7

Bias	#9	Describe any efforts to address potential sources of bias (Recall bias)	14,15
Study size	#10	Explain how the study size was arrived at (Sample size)	5
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why (In case of age, Wealth index, duration of physical activity, fruit and vegetable intake BMI, blood pressure, blood glucose, serum cholesterol, salt intake, groupings are described under each table as foot notes)	5,7, 9-14
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	8
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions The study didn't require it	
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	8
Statistical methods	#12e	Describe any sensitivity analyses	8
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for exposed and unexposed groups if applicable.	8,9
Participants	#13b	Give reasons for non-participation at each stage	8
Participants	#13c	Consider use of a flow diagram	8
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable. Background characteristics are deployed in the table-1	9
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest (In the table 3)	12

Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable. As a cross-sectional study separate information on exposed and unexposed groups were not required	
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included As a cross-sectional study it was Not required	
Main results	#16b	Report category boundaries when continuous variables were categorized (Table 2)	10,11
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (The study didn't require it)	
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses Logistic regression analysis-Table 4	13,14
Discussion			
Key results	#18	Summarise key results with reference to study objectives	14
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15,16
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	15,16
Generalisability	#21	Discuss the generalisability (external validity) of the study results Nationally representative findings were obtained through analysis of weighted data	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

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Title Page

Manuscript Title:

Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

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Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

Original research article

ABSTRACT

Objectives: To determine the national prevalence of risk factors of non-communicable diseases (NCD) in the adult population of Bangladesh.

Design: The study was a population-based national cross-sectional study.

Setting: This study used 496 primary sampling units (PSUs) developed by the Bangladesh Bureau of Statistics. The PSUs were equally allocated to each division and urban and rural stratum within each division.

Participants: The participants were adults aged 18-69 years, who were usual residents of the households for at least six months, and stayed the night before the survey. Out of 9900 participants, 8185 (82.7%) completed STEP-1 and STEP-2, and 7208 took part in STEP-3.

Primary and secondary outcome: The prevalence of behavioral, physical, and biochemical risk factors of NCD. Data were weighted to generate national estimates.

Results: Tobacco use was significantly ($p<0.05$) higher in the rural (45.2%) than the urban (38.8%) population. Inadequate fruit/vegetable intake was significantly ($P<0.05$) higher in the urban (92.1%) than in the rural (88.9%) population. The mean salt intake per day was higher in the rural (9.0 gm) than urban (8.9 gm) population. Among all, 3.0% had no, 70.9% had 1-2, and 26.2% had ≥3 NCD risk factors. The urban population was more likely to have insufficient physical activity (AOR: 1.2, 95% CI: 1.2–1.2), obesity (AOR: 1.5, 95% CI: 1.5–1.5), hypertension (AOR: 1.3, 95% CI: 1.3–1.3), diabetes (AOR: 1.6, 95% CI: 1.6–1.6), and hyperglycemia (AOR: 1.1, 95% CI: 1.1–1.1).

Conclusions: Considering the high prevalence of the behavioral, physical, and biochemical risk factors, diverse population and high-risk group targeted interventions are essential to combat the rising burden of NCDs.

Key Words: Bangladesh; Behavioral; Biochemical; Non communicable diseases; Physical; Prevalence; Risk factors; STEPS survey;

Strengths and limitations of this study

- The survey covered the entire country for the first time to estimate the prevalence of NCD risk factors comprising all the three steps of the WHO STEPS approach.
- Rigorous methodology and cross-matching the data with their physical and biochemical parameters helped us to generate country representative data by controlling bias.
- Comprehensive findings on behavioral, physical, and biochemical risk factors could be used to devise diverse intervention programmes to reduce the rising burden of NCD.
- As a cross-sectional study, limits its ability to infer causal relationships among the risk factors.
- Behavioral data may have little bias as the participants of this self-report survey may tend to report in socially desirable ways.

INTRODUCTION

Non-communicable diseases (NCDs) are the result of a combination of genetic, socio-demographic, physical, biochemical, and behavioral factors. The global report on death by cause shows that more than 65% of 56 million global deaths were due to NCDs[1]. Three-fourths of this global mortality due to NCDs occur in low and middle-income countries[2]. Each year premature deaths affect equally both males and females (15 million each) due to NCDs[3]. Four major NCDs; cardiovascular disease, cancer, diabetes, and respiratory diseases are responsible for 82% of NCD mortality[4].

Demographic transition and rapid urbanization have led to changes in lifestyles; food and tobacco consumption continues to experience high morbidity and mortality from NCDs. The rise in NCDs largely stems from four behavioral risk factors: tobacco use, unhealthy diet, insufficient physical activity, and the harmful use of tobacco and alcohol[5]. Lifestyle change in an individual following the trend of globalization, supermarket growth, rapid urbanization, and sedentary lifestyles invites these risk factors around him[6].

In the Bangladeshi adult population, NCD risk factors are found to exist in clusters that become more prominent with the increasing age of that individual[7]. Bangladesh is passing through a demographic transition and an epidemiological transition and currently has a double burden of diseases[8]. NCDs account for 67% of total deaths in Bangladesh[9]. Diverse epidemiological studies have identified risk factors including unhealthy food consumption, tobacco use, insufficient physical inactivity, high BMI, raised blood pressure, unfavorable blood lipid, and raised blood glucose level[10]. Tobacco consumption is the leading risk factor for major NCDs in Bangladesh[11]. The first STEPS survey was done in 2010, but there was a lack of biochemical measurements and hence no national estimations of diabetes and dyslipidemia prevalence existed. There is limited evidence on certain risk factors that exist in Bangladesh at the national level[12]. This second nationwide STEPS survey along with biochemical measurement for blood glucose, lipid profile, and urinary sodium helped to provide the first comprehensive estimates of NCD risk factors in the country.

Member states of WHO have agreed 25 indicators across three areas that focus on the key outcomes, risk factors, and national systems response needed to prevent and control NCDs. One mortality target, six risk factor targets, and two national systems targets are considered[13]. As a member state, Bangladesh intends to estimate the prevalence of NCD risk factors in the adult people of the country. STEP wise approach is a WHO-developed, standardized framework for monitoring the magnitude of NCD risk factors comprising 3 steps; STEP 1 determines behavioral risk factors; STEP 2 determines

physical risk factors, and STEP 3 finds out biological risk factors. The STEPS survey 2018 for NCD risk factors in Bangladesh was carried out to determine the national prevalence of NCDs risk factors in the adult population of Bangladesh.

METHODS

Study design and setting

The STEPs survey 2018 was a country-wide population-based cross-sectional study conducted from September 2017 to June 2018. The samples were collected by multi-stage, geographically stratified probability-based sampling using the PSUs developed by the Bangladesh Bureau of Statistics (BBS) for the census.

Study population

The study population included adults aged 18-69 years, the usual residents of the household for at least six months and were present there the night before the survey. We excluded those people who primarily resided in a military base or group quarters, hospitals, prisons, nursing homes, and other institutions or those too frail and mentally or physically unfit to participate in the study or those unable or unwilling to participate in the study.

Sample size

To ensure generalization and reliability of the study results to the entire target population in Bangladesh, the WHO recommended sample size calculator (Sample size calculator STEPS) was used to derive a sample size. The calculated sample size was sufficient to produce reliable estimates for all the indicators for males and females and four age-groups (18-24, 25-39, 40-54, 55-69). The prevalence of NCD risk factors, relative precision rate (20%), and the feasibility of the survey were considered to calculate the sample size. Based on the prevalence of obesity, 472 people were required for effective analysis for each group. Considering the person non-response rate (10%) and household non-coverage rate (10%) shared by the previous surveys of Bangladesh Demographic Health Survey and BBS, overall, 20% non-response rate and a design effect of 2 were used to calculate the final sample size. Initially, we considered 496 PSUs updated by BBS in 2017. During the fieldwork, we excluded one PSU due to inaccessibility. As a result, the final adjusted sample size was 9900 adults of 495 PSUs.

Sampling frame

The sampling frame was developed based on the complete list of PSUs prepared by the BBS containing information about PSU location, type of residence, and the estimated number of residential households. All the PSUs were mapped for the survey and comprised of 293533 PSUs: 65193 urban and 228340

rural PSUs. The household lists updated by BBS served as the sampling frame for the selection of households. Twenty households were randomly selected from each PSU and randomly assigned as "male" or "female" in a ratio that produced equal numbers of male and female households. One individual was sampled randomly from all the eligible adults in a household. No replacement or change of the pre-selected households was allowed at the implementing stage to prevent bias.

Sampling strategy

The PSUs were allocated equally to each division (62 each), and urban and rural stratum (248 PSUs each). The PSUs were arranged by population size in terms of household numbers for both urban and rural stratum. In each stratum, 31 PSUs were selected independently in each division by probability proportional to size (PPS) sampling.

Data collection

Data were collected using a standardized pre-tested questionnaire developed considering WHO STEPS questionnaire (version 3.2) by incorporating all the core questions with some selected expanded and country-specific questions. The questionnaire was translated into Bengali and validated by translation and back translation. Data collection techniques included a face-to-face interview (STEP 1), physical measurements (STEP 2), and body fluid (blood and urine) collection (STEP 3). Data were collected by an android device on the spot and transferred into the cloud through ODK software.

STEP 1 (Behavioral risk factors ascertainment):

Core items included demographic information and measures of tobacco use, fruit and vegetable, alcohol, and salt consumption, physical activity, blood pressure, diabetes, and total cholesterol. Data enumerators having post-graduation in sociology/psychology/anthropology conducted the interviews and physical measurements. Medical technologists having diploma/bachelor/master's degree in medical laboratory science collected and processed the samples. The recruited staff underwent training covering all the steps with interactive sessions, skill development, and pilot testing.

STEP 2 (Physical measurements):

Core items included measurement of blood pressure, height, weight, hip, and waist circumference. Validated instruments were used for measuring these parameters. The height and weight of the participants were measured with barefoot and light clothing. Weight was measured to the nearest 10 gms using a digital weight measuring machine, while height was measured to the nearest 0.1 cm using a portable stadiometer. The tailor measuring tape was used for measuring waist and hip circumference. All the instruments were calibrated routinely during the survey. A digital blood pressure measuring

machine, supplied by WHO with uniform cuff-size with automatic measurement of BP and pulse, was used for measuring blood pressure.

STEP 3 (Biochemical measurements):

For estimation of blood sugar and lipid profile level, each participant was advised to remain nothing per mouth (except plain water) for at least 12 hours before blood collection. Blood and urine samples were collected under strict aseptic precautions. On the first visit of STEP 3, written instructions on fasting state, and appointment date for the blood test were given to each participant and asked to visit maintaining the schedule. Initially, 5 ml of blood was collected by disposable syringe, and plasma and serum were separated by centrifuging within 30 minutes to 1 hour after collection. Followed by 2 ml of this blood was transferred to a fluoride-oxalate vacutainer for serum glucose testing, and 3 ml of the blood was kept in a normal tube and allowed to stand for the separation of plasma (for lipid profile) with proper labeling. The sample for blood glucose was left in the upright position in a vacutainer rack and then centrifuged and separated serum was keep in the cold box (2-8^{0}C) surrounded by ice packs.

The participants were asked to collect 20 ml urine in supplied labeled screw-capped plastic urine pot in the evening before bedtime to submit to the medical technologist on the following day for blood sample collection at the prefixed place. All the collected blood and urine samples of a day were sent to the NIPSOM laboratory within 24 hours of collection. At the central laboratory, the blood and urine samples were received and sent with a laboratory ID number for testing sodium and urine. After the estimation of blood glucose and lipid profile, the remaining serum sample was kept in Cryo vials at -70^{0}C. After the estimation of urinary sodium, and the remaining urine sample was discarded.

Quality control

Quality control procedures included regular field supervision and daily review of collected data. Laboratory instruments were calibrated following the standard procedure and the findings were validated with the same sample findings of another standard national laboratory. The blood and urine samples were tested in the NIPSOM central laboratory dividing the sample into multiple samples and the same samples multiple times to compare the findings and to validate the instruments and procedure. To ensure accurate findings of the biochemical samples; pretesting was done in both urban and rural areas from where samples were sent to the NIPSOM laboratory. Accordingly, samples were received at different time intervals after collection and were tested at different times and the findings were compared.

Data management

Data were entered directly in the ODK software on the PDAs. Data were sent electronically and stored in the ONA database server. The field team uploaded data daily on the server. The stored data were downloaded into Microsoft Excel® format for consistency and validity check at the central office. Each participant had a unique identifier QR-code and personal identification number (PID), which were used for merging data of steps 1, 2, 3. Data were cleaned and analyzed following WHO STEPS recommended guidelines.

Statistical methods

We weighted the data considering selection probabilities of PSU, household, sex, and individuals within the household so that the study results conform to the population of Bangladesh. Calibration was done to replicate population distribution. Prevalence was estimated using the STEPS recommended cut-off values[14]. Data were analyzed using STATA version 15.0, and Epi Info version 3.4 was used as a reference for programming purposes and cross-validation of STATA outputs. Missing data were excluded from the analysis. Economic status was determined by the principal component analysis of the wealth index based on household assets. Descriptive statistics included percentage, and inferential statistics included logistic regression to determine the NCD risk factors. Background characteristics were cross-tabulated with NCD risk factors, and the chi-square test was performed to investigate the significance of the relationships. Outcome measures and differences between groups were calculated at 95% CI and significant at p-value <0.05. To assess the degree of association of the risk factors, we used the adjusted odds ratio (AOR). We tested multicollinearity and adjusted the risk factors through multivariable logistic regression analysis.

Ethics

We obtained the ethical approval of the National Research Ethics Committee (NREC) of Bangladesh. We took informed consent from each participant before data collection. Confidentiality and privacy of the participants and anonymity of data were maintained strictly. We carried out all the activities in conformity with the revised declarations of Helsinki.

RESULTS

Among the target 9900 population, 8185 (82.7%) completed STEP-1 & 2 while 7208 took part in STEP-3. Out of 7208 participants, 7056 gave the blood and 7028 urine sample. The majority of the urban participants were male (51.5%), and the majority of the rural participants were female (51.4%).

Around 33.0% of urban and 47.0% of rural participants had no education or less than primary level education. The majority of the rural (45.7%) and urban (36.9%) participants were homemakers. The 'richest' comprised 28.5% urban and 12.6% rural, and the 'poorest' included 18.1% urban and 17.6% rural population (Table 1).

Table 1. Background characteristics (weighted) of the adult population of Bangladesh (n=8185)

Background characteristics		Urban, %	Rural, %	Both, %
Age	18 – 24	23.6	24.0	23.9
	25 – 39	42.1	39.0	39.7
	40 – 54	19.7	19.7	19.7
	55 – 69	14.6	17.2	16.6
Sex	Male	51.5	48.6	49.3
	Female	48.5	51.4	50.7
Highest level of Education	No education/<primary	32.9	47.0	43.9
	Primary	27.8	32.0	31.1
	Secondary	18.6	10.8	12.6
	More than secondary	20.7	10.1	12.5
Marital status	Never married	14.2	11.8	12.3
	Currently married	80.9	83.2	82.7
	Ever married*	04.8	05.1	05.0
Occupation	Employed	36.7	35.7	35.9
	Businessman	13.3	10.1	10.9
	Student	08.4	05.4	06.1
	Homemaker	36.9	45.7	43.7
	Unemployed	02.3	02.1	02.1
	Others	02.3	01.0	01.3
Economic status (Based on Wealth Index)	Poorest	18.1	17.6	17.7
	Poor	15.5	22.2	20.7
	Average	16.2	24.6	22.7
	Rich	21.7	23.0	22.7
	Richest	28.5	12.6	16.2

%: Weighted percentage; n: Number; *Ever married: Separated/divorced/widow/widowed

Mean serving of fruits and/or vegetables per day was 2.6 (CI: 2.5-2.7), and the mean duration of physical activity per day was 247.9 (CI: 247.8-248.0) minutes. Mean BMI was 22.7 (95% CI: 22.5-22.8) kg/m², and mean waist circumference was 78.6 (95% CI: 78.2-79.1) cm. Both mean SBP [122.6 (95% CI: 122.0-123.1) mmHg] and DBP [80.6 (95% CI: 80.2-81.0) mmHg] was higher in urban population. Both mean fasting blood glucose [5.6 (95% CI: 5.5-5.6) mmol/L] and mean total

cholesterol [4.4 (95% CI: 4.4-4.5) mmol/L] was higher in the richest but mean salt intake per day was [9.1 (95% CI: 9.1-9.1) gm] in the poor population (Table-2).

Table 2. Means (CI) of behavioral, physical and biochemical parameters of the adult population

Means (CI) of behavioral risk factors of NCD					
Attributes		**Mean number of servings of fruits on average per day**	**Mean number of servings of vegetables on average per day**	**Mean number of servings of fruits and/or vegetables on average per day**	**Mean physical activity in minutes of moderate-intensity activity (Min/day) ***
Age	18 – 24	0.4 (0.4-0.5)	2.3 (2.1-2.5)	2.7 (2.5 - 2.9)	213.3 (213.1-213.5)
	25 – 39	0.4 (0.3-0.4)	2.4(2.2-2.5)	2.7(2.6 - 2.9)	272.2 (272.1-272.3)
	40 – 54	0.3 (0.3-0.3)	2.2 (2.1-2.3)	2.5 (2.3 - 2.6)	291.8 (291.6-291.9)
	55 – 69	0.3 (0.2-0.3)	2.1(1.9-2.2)	2.3 (2.1 - 2.5)	187.7 (187.5-187.8)
Sex	Male	0.4 (0.3-0.4)	2.2 (2.0-2.3)	2.5 (2.3 - 2.7)	354.6 (354.5-354.7)
	Female	0.4 (0.3-0.4)	2.4 (2.2-2.5)	2.7 (2.6 - 2.8)	144.8 (144.7-144.8)
Residence	Urban	0.5(0.4-0.5)	1.9(1.8-2.1)	2.4(2.2 - 2.5)	196.7(196.6-196.8)
	Rural	0.3(0.3-0.4)	2.4(2.2-2.5)	2.7 (2.5 - 2.8)	262.7(262.5-262.8)
Overall		0.4 (0.3-0.4)	2.3 (2.2-2.4)	2.6 (2.5 - 2.7)	247.9 (247.8-248.0)
Economic status	Poorest	0.4 (0.4-0.4)	2.1 (2.1-2.1)	2.5 (2.4-2.5)	258.0 (257.9-258.2)
	Poor	0.3 (0.3-0.3)	2.3 (2.2-2.3)	2.6 (2.5-2.6)	264.5 (264.4-254.7)
	Average	0.4 (0.3-0.4)	2.4 (2.4-2.4)	2.8 (2.7-2.8)	260.0 (259.9-260.1)
	Rich	0.4 (0.3-0.4)	2.1 (2.1-2.1)	2.5 (2.4-2.5)	221.5 (221.4-221.6)
	Richest	0.5 (0.5-0.5)	2.3 (2.3-2.3)	2.7 (2.7-2.8)	231.2 (231.1-231.3)
	Overall	0.4 (0.3-0.4)	2.3 (2.2-2.4)	2.6 (2.5-2.7)	247.9 (247.8-248.0)
Means (CI) of physical risk factors of NCD					
Attributes		**BMI (Kg/m²)**	**WC (cm)**	**SBP (mmHg)**	**DBP (mmHg)**
Age	18 – 24	21.6(21.3-22.0)	74.5(73.7-75.3)	113.7 (112.9-114.4)	74.3 (73.7-74.9)
	25 – 39	23.2(23.0-23.4)	79.4(78.8-79.0)	117.1 (116.7-117.6)	78.5 (78.1-78.8)
	40 – 54	23.0(22.8-23.3)	80.4(79.7-81.0)	125.0 (124.2-125.8)	82.2 (81.6-82.7)
	55 – 69	22.3(21.8-22.7)	80.4(79.2-81.7)	130.9 (129.6-132.3)	81.3 (80.6-82.1)
Sex	Male	21.9(21.7-22.0)	79.1 (78.5-79.6)	121.5 (120.9-122.0)	77.9 (77.5-78.3)
	Female	23.5 (23.2-23.7)	78.2 (77.5-78.8)	120.7 (120.2-121.3)	80.8 (80.5-81.2)
Residence	Urban	23.6 (23.3-23.9)	81.4 (80.7-82.1)	122.6(122.0-123.1)	80.6 (80.2-81.0)
	Rural	22.4 (22.2-22.6)	77.8(77.3-78.3)	119.7(119.1-120.2)	78.4 (78.0-78.8)
Overall		22.7 (22.5-22.8)	78.6 (78.2-79.1)	121.1 (120.7-121.5)	79.5 (79.2-79.7)
Economic status	Poorest	22.0 (21.9-22.0)	77.0 (76.9-77.0)	120.4 (119.4-121.3)	79.2 (78.6-79.8)
	Poor	22.5 (22.5-22.5)	78.4 (78.3-78.4)	120.4 (119.5-121.2)	79.1 (78.5-79.7)
	Average	22.5 (22.4-22.5)	78.0 (78.0-78.0)	120.8 (119.9-121.7)	78.9 (78.3-79.5)
	Rich	22.6 (22.5-22.6)	78.6 (78.6-78.7)	120.9 (120.1-121.7)	79.3 (78.7-79.9)
	Richest	23.6 (23.6-23.6)	81.6 (81.5-81.6)	123.0 (122.1-123.9)	80.8 (80.3-81.4)
	Overall	22.7 (22.5-22.8)	78.6 (78.2-79.1)	121.1 (120.7-121.5)	79.5 (79.2-79.7)
Means (CI) of biochemical risk factors of NCD					

Attributes		Fasting blood glucose (mmol/L)	Total cholesterol (mmol/L)	Salt intake**(gm/day)	
Age	18 – 24	5.0 (5.0-5.1)	4.2 (4.1-4.3)	9.1 (8.9-9.3)	
	25 – 39	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
	40 – 54	5.7 (5.6-5.8)	4.6 (4.6-4.7)	9.0 (8.9-9.1)	
	55 – 69	5.6 (5.5-5.6)	4.6 (4.5-4.8)	8.9 (8.8-9.1)	
Sex	Male	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.2)	
	Female	5.4 (5.3-5.5)	4.4 (4.3-4.4)	9.0 (8.9-9.1)	
Residence	Urban	5.8 (5.7-5.8)	4.4 (4.4-4.5)	8.9(8.7-9.0)	
	Rural	5.3 (5.3-5.4)	4.4 (4.3-4.4)	9.0(8.9-9.1)	
Overall		5.4 (5.3-5.5)	4.4 (4.4-4.5)	9.0 (8.9-9.1)	
Economic status	Poorest	5.4 (5.4-5.4)	4.4 (4.3-4.4)	9.0 (8.9-9.0)	
	Poor	5.4 (5.4-5.5)	4.4 (4.4-4.4)	9.1 (9.1-9.1)	
	Average	5.3 (5.3-5.4)	4.4 (4.4-4.5)	8.9 (8.8-8.9)	
	Rich	5.3 (5.2-5.3)	4.4 (4.4-4.4)	9.1 (9.0-9.1)	
	Richest	5.6 (5.5-5.6)	4.5 (4.4-4.5)	9.0 (9.0-9.0)	
	Overall	5.4 (5.3-5.5)	4.4 (4.4-4.5)	9.0 (8.9-9.1)	

CI: Confidence Interval; NCD: Non-communicable diseases; Min: Minute; BMI: Body mass index; WC: West circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure;
*Minutes spent on vigorous-intensity activities per day are multiplied by 2, to derive equivalent minutes of moderate-intensity activities and then summed up to obtain the total physical activity in minutes of moderate-intensity activity per day. ** Calculated using 'Tanaka Equation' (Based on Urinary Na+ concentration)

The prevalence of tobacco consumption was 43.7% and was significantly ($p<0.05$) higher in males (59.6%) and rural (45.2%) population. The prevalence of alcohol consumption was 1.5% and was significantly ($p<0.05$) higher in males (2.9%) and businessman (3.2%). The prevalence of inadequate fruit and vegetable intake was 89.6% and was significantly ($p<0.05$) higher in the elderly (92.3%) and urban (92.1%) population. The prevalence of insufficient physical activity was 12.3% and was significantly ($p<0.05$) higher in the females (14.8%) and urban (14.1%) population (Table 3).

The prevalence of overweight and obesity was 25.9% and was significantly ($p<0.05$) higher in the females (33.7%), urban (34.3%), and 'richest' (34.3%) population. The prevalence of hypertension was 21.0% and was significantly ($p<0.05$) higher in the urban (25.2%) and 'richest' (24.9%) population. The prevalence of diabetes was 8.3% and was significantly ($p<0.05$) higher in the urban (13.2%), elderly (16.3%), and 'richest' (11.9%) population. The prevalence of hypercholesterolemia was 28.4% and was significantly ($p<0.05$) higher in females (29.3%) and urban (32.4%) population (Table 3).

Table 3. Bivariate analysis between NCD risk factors and background characteristics of the adult population of Bangladesh (Chi-square test)

Background characteristics	Current tobacco consumption (in any form) (n=8185)	Current alcohol consumption (in past 30 days) (n=8185)	**Inadequate fruits and/or vegetables intake (n=8185)	***Insufficient physical activity (n=8185)	[a]Overweight/ Obese (n=8013)	[b]Raised BP (Hypertension) (n=8154)	[c]Raised glucose (Diabetes)	[d]Raised total cholesterol
Age	%	%	%	%	%	%	%	%
18 – 24	22.3	2.4	90.5	11.2	15.9	08.8	02.9	20.6
25 – 39	38.7	1.5	87.3	08.8	31.4	20.7	08.1	26.7
40 – 54	59.1	1.0	91.1	11.3	28.8	34.4	12.4	36.4
55 – 69	68.4	0.4	92.3	23.1	23.6	46.9	16.3	39.5
Sex								
Male	59.6	2.9	90.0	09.6	18.3	17.9	08.9	27.4
Female	28.3	0.0	89.3	14.8	33.7	24.1	07.9	29.3
Residence								
Urban	38.8	1.8	92.1	14.1	34.3	25.2	13.2	32.4
Rural	45.2	1.4	88.9	11.7	23.5	19.8	07.1	27.4
Highest level of education								
No education /<Primary	60.2	1.2	92.2	13.0	20.2	22.8	07.3	27.0
Primary	35.6	2.0	87.1	10.4	29.1	19.1	08.5	28.7
Secondary	26.9	1.4	88.9	11.9	29.8	17.8	08.3	29.4
>Secondary	22.8	1.1	88.1	14.0	33.9	22.5	13.1	33.0
Marital status								
Never married	31.6	3.0	90.0	7.7	11.4	09.0	02.2	18.8
Currently married	44.7	1.3	89.3	11.5	27.8	21.2	08.6	28.3
Ever married*	57.3	0.2	94.8	35.6	30.3	47.0	13.6	45.9
Occupation								
Employed	60.0	2.7	89.2	6.8	17.9	16.1	07.0	25.1
Businessman	62.4	3.2	90.3	13.7	26.8	21.2	12.9	38.0
Student	15.4	1.1	91.6	9.8	10.0	9.1	02.0	17.3
Homemaker	29.1	0.0	90.1	14.5	34.5	25.0	08.0	29.2
Unemployed	51.8	2.0	83.7	40.4	24.6	33.5	14.9	29.5
Others	49.9	0.7	84.9	36.2	33.8	53.1	33.2	39.1
Economic status								
Poorest	49.6	2.2	92.2	13.8	19.3	18.8	07.9	26.9
Poor	44.6	0.9	89.7	11.6	26.3	21.2	09.2	26.3
Average	42.9	1.0	89.1	10.6	23.9	19.7	06.2	30.4
Rich	42.8	2.0	90.8	13.7	26.3	21.1	07.9	28.5
Richest	38.6	1.2	85.9	11.5	34.3	24.9	11.9	29.7
Overall	43.7	1.5	89.6	12.3	25.9	21.0	08.3	28.4

%: Percentage; n: Number;
*Ever married: Separated/divorced/widow/widowed
**Participants taking <5 servings fruits and/or vegetables on average per day
*** Participants doing less than 150 minutes of moderate-intensity physical activity per week
[a]Overweight & obese: BMI≥25kg/m^2; [b]Raised blood pressure (BP): Systolic BP≥140 or diastolic BP≥90mm Hg;
[c]Raised blood sugar: ≥7.0 mmol/L or, ≥126 mg/dl; [d]Raised total cholesterol: ≥5.0 mmol/L;
All the differences of findings are statistically significant at the p-value <0.05

The elderly (AOR: 4.5, 95% CI: 4.5–4.5) and ever married (OR: 1.4, 95% CI: 1.4–1.4) were more likely to have the smoking habit. The urban population was more likely to consume alcohol (AOR: 1.2, 95% CI: 1.2–1.2). The females (AOR: 1.7, 95% CI: 1.6–1.7), and unemployed (AOR: 7.8, 95% CI: 7.8–7.9) were more likely to have inadequate physical activity. The females were more likely to have hypertension (AOR: 1.5, 95% CI: 1.5–1.5), and obesity (AOR: 2.0, 95% CI: 2.0–2.0). The urban population was more likely to have insufficient physical activity (AOR: 1.2, 95% CI: 1.2–1.2), obesity (AOR: 1.5, 95% CI: 1.5–1.5), raised BP (AOR: 1.3, 95% CI: 1.3–1.3), diabetes (AOR: 1.6, 95% CI: 1.6–1.6) and hyperglycemia (AOR: 1.1, 95% CI: 1.1–1.1) (Table 4).

Table 4. Logistic regression analysis of the determinants of NCD risk factors in the adult population of Bangladesh

Determinants		Adjusted Odds Ratio (AOR) at 95% Confidence Interval (CI)							
		Current Smoking	Current Alcohol consumption	Insufficient Physical Activity	Inadequate Servings	Raised BP (Hypertension)	Obesity	Raised Glucose (Diabetes)	Raised Total Cholesterol
Age (Years)	18-29	1	1	1	1	1	1	1	1
	30-44	1.7(1.7-1.7)	0.4(0.4-0.4)	0.7(0.7-0.7)	0.7(0.7-0.7)	1.9(1.9-1.9)	2.4(2.4-2.4)	3.3(3.2-3.3)	1.4(1.4-1.4)
	45-59	3.5(3.4-3.5)	0.3(0.3-0.3)	0.9(0.9-0.9)	0.9(0.9-1.0)	6.1(6.1-6.2)	2.5(2.5-2.5)	7.7(7.6-7.7)	2.6(2.6-2.6)
	60-69	4.5(4.5-4.5)	0.1(0.1-0.1)	1.5(1.5-1.5)	1.1(1.1-1.1)	9.2(9.2-9.2)	2.0(2.0-2.0)	8.7(8.6-8.7)	2.7(2.7-2.7)
Gender	Male	1	1	1	1	1	1	1	1
	Female	0.2(0.2-0.2)	0.01(0.01-0.01)	1.7(1.6-1.7)	0.6(0.6-0.6)	1.5(1.5-1.5)	2.0(2.0-2.0)	1.0(1.0-1.0)	1.3(1.3-1.3)
Residence	Rural	1	1	1	1	1	1	1	1
	Urban	0.9(0.9-0.9)	1.2(1.2-1.2)	1.2(1.2-1.2)	1.8(1.8-1.8)	1.3(1.3-1.3)	1.5(1.5-1.5)	1.6(1.6-1.6)	1.1(1.1-1.1)
Highest level of education	No education /<primary	1	1	1	1	1	1	1	1
	Primary	0.5(0.5-0.5)	1.5(1.5-1.5)	1.0(1.0-1.0)	0.6(0.6-0.6)	1.5(1.5-1.5)	1.7(1.7-1.7)	1.7(1.7-1.7)	1.4(1.4-1.4)
	Secondary	0.3(0.3-0.3)	0.9(0.9-1.0)	1.1(1.1-1.1)	0.7(0.7-0.7)	1.5(1.5-1.5)	2.2(2.2-2.2)	1.6(1.6-1.6)	1.6(1.6-1.6)
	>secondary	0.2(0.2-0.2)	0.7(0.7-0.7)	1.5(1.5-1.5)	0.6(0.6-0.6)	2.3(2.3-2.3)	3.7(3.7-3.7)	3.1(3.1-3.1)	2.1(2.1-2.1)
Marital status	Never married	1	1	1	1	1	1	1	1
	Currently married	0.9(0.9-0.9)	1.0(1.0-1.0)	1.9(1.9-1.9)	0.9(0.9-0.9)	1.1(1.1-1.1)	1.7(1.7-1.7)	2.2(2.2-2.2)	1.2(1.2-1.2)
	Ever married	1.4(1.4-1.4)	0.3(0.3-0.3)	5.1(5.1-5.1)	1.7(1.7-1.7)	1.6(1.6-1.6)	1.8(1.8-1.8)	2.9(2.8-2.9)	2.0(2.0-2.0)

Occupation	Employed	1	1	1	1	1	1	1	1
	Business	1.1(1.1-1.1)	1.0(1.0-1.0)	2.5(2.5-2.5)	1.1(1.1-1.1)	1.4(1.4-1.4)	1.7(1.7-1.7)	1.8(1.8-1.8)	1.9(1.9-1.9)
	Student	0.6(0.6-0.6)	0.3(0.3-0.3)	1.8(1.8-1.8)	1.6(1.6-1.6)	1.1(1.1-1.1)	0.6(0.6-0.6)	1.2(1.2-1.2)	0.8(0.8-0.8)
	Homemaker	0.9(0.9-0.9)	1.1(1.0-1.1)	1.4(1.4-1.4)	1.9(1.8-1.9)	1.4(1.4-1.4)	1.5(1.5-1.5)	1.4(1.4-1.4)	1.0(1.0-1.0)
	Unemployed	0.6(0.6-0.6)	1.2(1.2-1.2)	7.8(7.8-7.9)	0.5(0.5-0.6)	1.8(1.8-1.8)	1.6(1.6-1.6)	1.9(1.9-1.9)	1.1(1.1-1.1)
	Others	0.6(0.6-0.6)	1.0(1.0-1.0)	4.2(4.2-4.2)	0.7(0.7-0.7)	2.0(2.0-2.0)	1.3(1.3-1.3)	2.9(2.8-2.9)	1.1(1.1-1.1)
Economic status	1	1	1	1	1	1	1	1	1
	Poor	0.8(0.8-0.8)	0.3(0.3-0.3)	0.8(0.8-0.8)	0.8(0.8-0.8)	1.2(1.2-1.2)	1.6(1.6-1.6)	1.2(1.2-1.2)	1.0(1.0-1.1)
	Average	0.9(0.9-0.9)	0.4(0.4-0.4)	0.7(0.7-0.7)	0.7(0.7-0.8)	1.1(1.1-1.1)	1.3(1.3-1.3)	0.8(0.8-0.8)	1.2(1.2-1.2)
	Rich	0.9(0.9-0.9)	0.9 (0.9-0.9)	0.9 (0.9-1.0)	0.9(0.9-0.9)	1.1(1.1-1.1)	1.4 (1.4-1.4)	0.9(0.9-0.9)	1.0 (1.0-1.0)
	Richest	0.8(0.8-0.8)	0.6(0.6-0.6)	0.8(0.8-0.8)	0.(0.5-0.5)	1.2(1.2-1.2)	1.7(1.7-1.7)	1.1(1.1-1.1)	1.0(1.0-1.1)

AOR: Adjusted Odds Ratio; CI: Confidence Interval; Inadequate Servings: Intake <5 servings` fruits and/or vegetables on average per day; All the findings are statistically significant at the p-value <0.05.

Regarding combined risk factors, 3% (men 1.9%, women 4.0%) population had no risk factor while 70.9% had 1-2 and 26.2% had ≥3 NCD risk factors, which was higher in males (29.6%) than in females (22.8%) (Figure 1).

Figure 1. Summary of combined *risk factors of NCD

DISCUSSION

Based on the analysis of weighted data, this country-wide survey determined the national prevalence of NCD risk factors in three steps including socio-demographic factors; tobacco and salt consumption; fruits and vegetable consumption, and physical activity; overweight and obesity; hypertension; hyperglycemia; and hypercholesterolemia. The prevalence of current tobacco consumption was higher than that observed in the Global Adult Tobacco Survey (GATS)[14]. It was higher in the rural than the urban population but an average 10% reduction was observed in both areas compared to STEPS 2010[15], which reflects the success of anti-tobacco intervention programs. The higher prevalence of tobacco uses in the males (OR=0.2) and elderly imitates the real picture of the South Asia region[16,17] except Bhutan[18].

The prevalence of alcohol consumption was much lower in Bangladesh than in India (1.5% vs. 14.9%)[19], which could be due to cultural and religious differences. Despite some recall bias, the majority of the population consumed <5 servings of vegetables and fruits per day; though it is more than earlier[16] but lower than the neighboring countries[18,20]. Public fear regarding the presence of heavy metals and pesticides in fruits and vegetables[20,21] is not tenuous rather their dietary habit seems to be the driving factor behind it.

The prevalence of insufficient physical activity (12.3%) is a glaring pointer towards a growing epidemic of overweight and obesity in our country. Insufficient physical activity was more in urban than in rural population (14.1% vs. 11.7%), and in females than in males (OR=1.7), which is inconsistent with the previous studies in the low- and middle-income and South Asian countries[22,23,24]. The prevalence of insufficient physical activity has spiked up significantly in comparison with the previous STEPS survey[16]. Despite a little recall bias, it could be argued that males are involved in more laborious activities than females. High income also excites a sedentary lifestyle like smartphone and computer use[25].

In comparison with the 2010 survey, the prevalence of overweight and obesity (25.9%) showed a rising trend with a higher proportion in females than males (33.7% vs. 18.3%)[16]. Shifting towards a sedentary lifestyle in the rural whereas growing health consciousness in the urban population may be the reasons behind it. The prevalence of obesity is comparable to the neighboring[19,26,27], and many developed countries[28]. About one-fourth population had hypertension with significant sex and age differences. The prevalence of hypertension was significantly higher in females (AOR=1.5), elderly (AOR=9.2), urban (AOR=1.3), and unemployed (AOR=1.8) population. Another population-based study reported the prevalence of hypertension as 12-13%[29]. A sedentary lifestyle predisposes hypertension and higher prevalence in females is possibly a bane from the revolutionary success of contraceptive usage among them.

Diabetes mellitus has been steadily creeping into the low- and middle-income countries to reach an epidemic proportion[30]. The current prevalence (8.3%) is a testament to the exponential trend of diabetes as reported in previous systemic reviews[31,32]. With the increasing ages, the prevalence rose steadily and a significant difference was observed in the urban population (OR=1.6). The effect of unplanned urbanization, sedentary lifestyle and altered food habits could make the urban population more vulnerable to hypertension. If an effective strategy is not adopted, all these will pose an ominous potential to trigger a range of cardiovascular disease epidemics in the recent future[33]. Reviews from

surrounding countries indicate that dyslipidemias are slowly increasing in the region[34,35]. About 28.4% had higher serum cholesterol with a greater propensity in urban than rural population (32.4%vs. 27.4%).

The current study found 3% had no, 70.9% had 1-2, and 26.2% had ≥3 NCD risk factors while the previous STEPS survey 2010 found 1.3%, 77.4%, and 28.3%.[16] These discrepancies could be due to the positive impacts of comprehensive NCD prevention and control activities in the country. In 2018, ≥3 risk factors were higher in females than in males (31.5% vs. 21.7%) while it was reversed in 2010 (22.8% Vs. 29.6%). This finding suggests an emphasized NCD risk factors alleviation programme for the females.

Despite few methodological limitations like recall bias with self-reported behavioral data of the participants, challenges of transportation of biological samples maintaining the cold chain, and the inability of the cross-sectional design to infer causal relationships among the risk factors, the study unveiled crucial nationally representative data on NCD risk factors.

Raising public awareness through health education seems to be a vital viable option for modifying the mass dietary habit and tobacco consumption behavior of the people. Bangladesh can adopt several strategies like healthy urban community design making neighborhoods more walkable and encouraging healthy foods in schools and cafeterias for modifying the growing obesogenic environment. Specific intervention programs must be designed based on risk factors and high-risk groups for the early detection and treatment of the major NCDs.

CONCLUSION

Despite diverse challenges, this comprehensive survey aligned with the WHO protocol identified the major NCD risk factors and high-risk groups having three or more risk factors. The study findings recommend individual and collective program interventions with an emphasis on the elderly, females, and urban population. The study will also contribute to devising future comprehensive national action plan to combat the rising NCD burden.

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Author Contributions

BK Riaz and MZ Islam were responsible for the concept and design, analysis and interpretation of data, and writing the manuscript. MM Zaman and MM Rahman participated in the acquisition, analysis, and interpretation of data, and critical revision of the manuscript. ANMS Islam and MA Hossain performed the statistical analysis and participated in preparing the manuscript. F Khanam, KMB Amin, and IN Noor participated in the acquisition and analysis of data. All authors wrote the article, edited, and approved the final draft of the manuscript.

Role of the funding source

As the funder of the study, the Ministry of Health and Family Welfare of Bangladesh had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author (M.Z. Islam) had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Competing interests

The authors declare that they have no competing interests.

Data sharing

Extra data can be accessed via the Dryad data repository at http://datadryad.org/ with the doi:10.5061/dryad.zkh18937f

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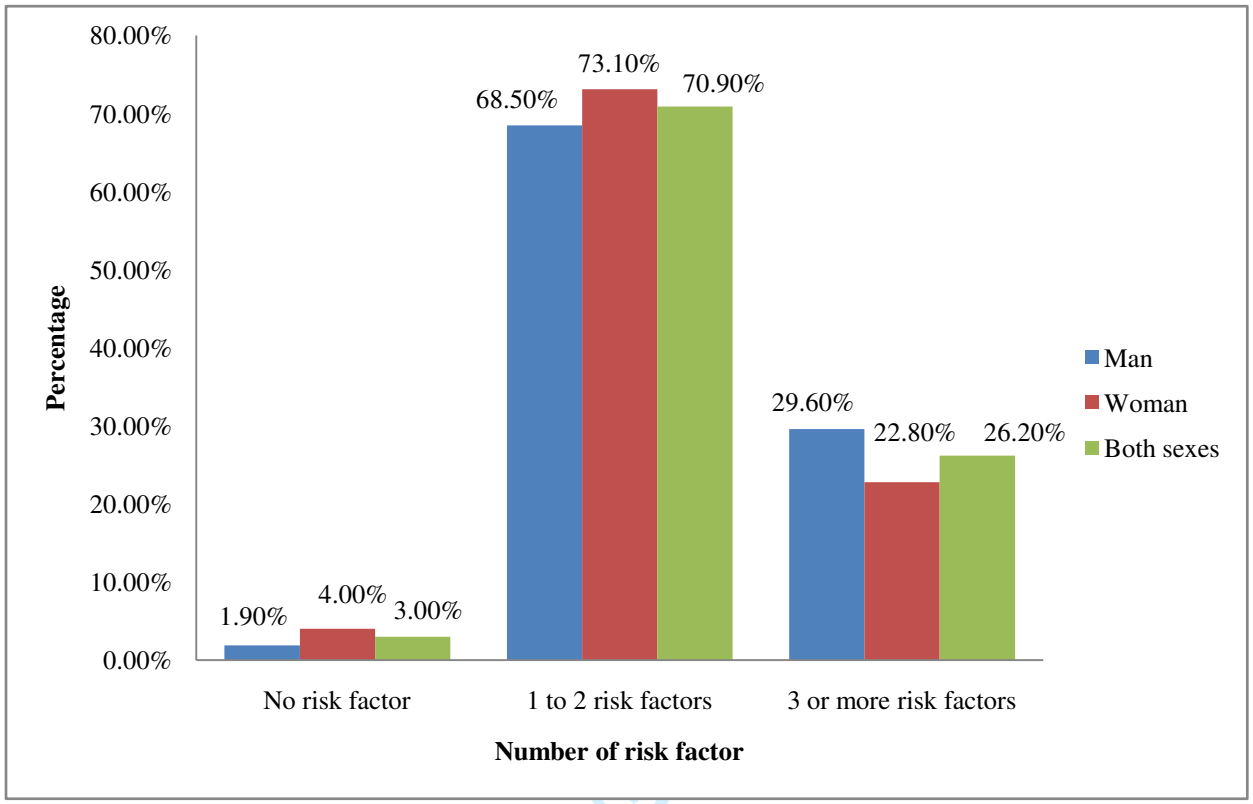

Figure 1. Summary of combined *risk factors of NCD

*Risk factors: Current daily smokers, Less than five servings of fruits and vegetables per day, Insufficient physical activity, Overweight (BMI≥25 Kg/m²), Raised blood pressure and raised total cholesterol.

Risk Factors for Non-Communicable Diseases in Bangladesh: Findings of the Population-based Cross-sectional National Survey 2018

STROBE Checklist

Based on the STROBE cross sectional guidelines.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1, 2
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	5
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for exposed and unexposed groups if applicable. This cross-sectional study used one group of participants. So, there was no separate exposed and unexposed groups.	6,7

Bias	#9	Describe any efforts to address potential sources of bias (Recall bias)	14,15
Study size	#10	Explain how the study size was arrived at (Sample size)	5
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why (In case of age, Wealth index, duration of physical activity, fruit and vegetable intake BMI, blood pressure, blood glucose, serum cholesterol, salt intake, groupings are described under each table as foot notes)	5,7, 9-14
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	8
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions The study didn't require it	
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	8
Statistical methods	#12e	Describe any sensitivity analyses	8
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for exposed and unexposed groups if applicable.	8,9
Participants	#13b	Give reasons for non-participation at each stage	8
Participants	#13c	Consider use of a flow diagram	8
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable. Background characteristics are deployed in the table-1	9
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest (In the table 3)	12

Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable. As a cross-sectional study separate information on exposed and unexposed groups were not required	
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included As a cross-sectional study it was Not required	
Main results	#16b	Report category boundaries when continuous variables were categorized (Table 2)	10,11
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (The study didn't require it)	
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses Logistic regression analysis-Table 4	13,14
Discussion			
Key results	#18	Summarise key results with reference to study objectives	14
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15,16
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	15,16
Generalisability	#21	Discuss the generalisability (external validity) of the study results Nationally representative findings were obtained through analysis of weighted data	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17