VOLUME 02 ISSUE 02 (2023)

AMERICAN JOURNAL OF MEDICAL SCIENCE AND INNOVATION (AJMSI)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Medical Science and Innovation (AJMSI)

Volume 2 Issue 2, Year 2023
ISSN: 2836-8509 (Online)
DOI: https://doi.org/10.54536/ajmsi.v2i2.2135
https://journals.e-palli.com/home/index.php/ajmsi

Socioeconomic Differential of Cardiovascular Diseases Risk Factors in Bangladesh: Findings from a Nationally Representative Survey

Shimlin Jahan Khanam[1*], Md Awal Kabir[2]

Article Information

Received: August 20, 2023
Accepted: September 23, 2023
Published: September 29, 2023

Keywords

Socioeconomy, Cardiovascular Diseases, Risk Factors, Survey Findings

ABSTRACT

Diabetes, hypertension, and overweight/obesity are three major risk factors for cardiovascular diseases (CVD). However, their distributions across socioeconomic status (SES) are debated despite its critical importance to design healthcare system. This study aimed to examine the associations between SES and diabetes, hypertension, and overweight/obesity in Bangladesh. Data was extracted from the 2017/18 Bangladesh Demographic and Health Survey. Diabetes, hypertension, and overweight/obesity were outcome of interest. Three variables wealth quintiles, education, and paid employment were considered as proxy of respondents' SES, as such the major explanatory variables of interest. Age-standardised prevalence of diabetes, hypertension, and overweight/obesity by SES were estimated using direct standardisation. Associations between SES and CVD risk factors were examined using multilevel Poisson regression model with robust variance. The overall age-standardized prevalence of diabetes, hypertension, and overweight/obesity in the sample were 9.82% (95% CI, 9.11-10.58), 27.37% (95% CI, 26.37-28.40) and 40.11% (35% CI, 38.82-41.42), respectively. We found a significant gradient of diabetes, hypertension, and overweight/obesity in Bangladesh with a higher prevalence among the respondents of advantageous wealth quintiles, education, and paid employment. In the fully adjusted models improved wealth quintiles and higher education were found as important predictors of diabetes and overweight/obesity. Prevalence ratio of hypertension and overweight/obesity was found lower among respondents with no education/pre-school or primary education as compared to the respondents with primary education. Diabetes, hypertension, and overweight/obesity are not distributed proportionately by SES in Bangladesh, especially by wealth quintiles and levels of education. Policies and programs to increase awareness on importance of controlling weight and regular screening for diabetes and hypertension are important. Treatment facilities for diabetes and hypertension should also need to be spread up at the community level.

INTRODUCTION

The world is now observing a rapid transition in diseases pattern, where the non-communicable diseases (NCDs) is showing a surge increase from the previous burden of infectious diseases (Dandona *et al.*, 2017). The Cardiovascular disease (CVD), a group of disorders of the heart and blood vessels, is among the highest in this list, that includes but not limited to coronary heart disease, cerebrovascular disease, and rheumatic heart disease (WHO, 2020). Together these lead an estimated 17.9 million deaths each year, which represents over 31% of all global deaths, a number which is projected to grow in future (WHO, 2020), [3]. Over three quarter (80%) of these deaths occur in low- and middle income countries (LMICs), whereas late detection and less access to healthcare services are the major reasons (WHO, 2020). Nearly 37% of these deaths occur in premature age a figure that represents over 82% of the total 17 million premature deaths occur globally (WHO, 2002 & Assembly, 2015)[4]. Importantly, this number is rising rapidly instead of the world's level target through the Sustainable Development Goals (SDGs) to stabilize the premature deaths along with the rate reduced to 2015's level by 2030 (Assembly, 2015). However, this is unlikely that LMICs will achieve this target unless the ongoing burden of CVD has been stabilized (Vos, *et al.* 2020).

In Bangladesh, the CVD is an ongoing concern with an exponential rising of the people suffering from it (Chowdhury, *et al.* 2018). Of the ten major causes of deaths in Bangladesh, the CVD takes the first three, stroke, ischemic heart disease, and Chronic Obstructive Pulmonary Disease (COPD), consecutively as reported by the global diseases burden in 2019 (Vos, *et al.* 2020). However, these three forms of CVDs were the 5th, 4th, 3rd major causes of deaths in 2010 just a 10 years back from now (CDCP, 2014). With time passes, Bangladesh has been observing a change the NCDs' risk factors which is being responsible for CVDs rapid rising though evidence are rare.

Diabetes and hypertension are two most prominent risk factors of the CVD (Khanam, *et al.* 2019 & Islam, *et al.* 2021), whereas overweight/obesity comprises a major risk factor of CVD directly and catalyst for other intermittent risk factors, including the diabetes and hypertension (Koliaki, *et al.* 2019). Previous studies in Bangladesh reported a higher prevalence of diabetes (9.82%) and hypertension (27.36%) (Islam, *et al.* 2021 & Khan, *et al.* 2021) with a rapid rise of overweight/obesity from a

[1] Department of Population Science, Jatiya Kabi Kazi Nazrul Islam University, Mymensingh, Bangladesh
[2] Department of Social Work, Pabna University of Science and Technology, Pabna, Bangladesh
[*] Corresponding author's e-mail: shimlinjahan2208@gmail.com

point of nearly 1 in 5 adults being any of these categories (Safiri, *et al.* 2020). Rapid urbanization, dietary changes, and limited physical activity are main promotors to such rise (Mohiuddin, *et al.* 2019 & Moniruzzaman, *et al.* 2016). Unawareness over these diseases lead development of the CVD and associated adverse consequences, including the premature deaths (Khan, *et al.*, 2021). This is fuelled by community level cognitions in Bangladesh including the NCDs are kind of rich and novel diseases occur among aged and highly educated people. Consequently, the detection, treatment, and control rates are low among the segments of population outside these groups, though they represent a major share of the country's total population (Khan, *et al.*, 2021). Higher burden of the NCDs among educated and higher aged people, that were found in the previous studies of this series (Islam, *et al.* 2021 & Khan, *et al.* 2021) and have been reported from the years (Fottrell, *et al.* 2018 & Jafar, *et al.* 2018), are often consider to justify these cognitions. The country level initiatives are also somehow supportive to these cognitions with being the CVD's treatment facilities are available on a limited basis at the government tertiary level hospital in Bangladesh. Consequently, the private sector is the major provider of the CVD's treatment which is often characterised as expensive, therefore not accessible for the general population of Bangladesh (Sulaiman & Misha, 2016).

Assessment of socioeconomic distribution of diabetes, hypertension, and overweight/obesity has been central to equity debate of the CVD and focus of disease priorities in the health sector in Bangladesh. However, this focus is completely absent in the available literature, though this was found as a significant considerable factor in India, a Bangladeshi neighbouring country (Corsi & Subramanian, 2016).

This study has been conducted to present a comprehensive equity analysis of the socio-economic gradients of the burden of CVD's risk factors in Bangladesh. Nationally representative men and women sample aged 18 and more have been analysed with a focus on diabetes, hypertension, and overweight/obesity.

METHODOLOGY

Data Source

Data originated in the 8th Bangladesh Demographic and Health Survey (BDHS), a nationally representative survey conducted between October 24, 2017, and March 15, 2018. The National Institute of Population Research and Training, as a local body, conducted this survey as part of the Demography and Health Survey Program, USA. The Ministry of Health and Family Welfare of Bangladesh provided supervision. Two-stage stratified survey designed was used in this survey to collect the nationally representative sample. A total of 675 Primary Sampling units (PSUs) was selected at the first stage of sampling. Of which the data collection was undertaken in 672 PSUs (the remaining three PSUs were excluded due to flood), through probability proportional to Enumeration Area's (EA) size. The PSU is the census EA with an average of 120 households that created in 2011 as part of the 2011 Population and Housing Census of Bangladesh. A fixed number of 30 households was selected randomly at the second stage of sampling from each selected PSU. This generated a list of 20,160 households, 19,584 of them households were occupied. One fourth of these selected households, 4,896 in total, were selected for further data collection on non-communicable diseases including diabetes and hypertension. The targeted respondent was men and women aged 18 and older.

Outcomes

The study outcomes were diabetes, hypertension, and overweight/obesity. Diabetes was measured based on the fasting blood glucose (FBGs) level collected using the HemoCue Glucose 201 DM system. According to the World Health Organization (WHO) criteria, FBG level ≥7 or self-reported diabetes medication use, were used to classify respondents with the diabetes. Systolic and diastolic blood pressure (in millilitres of mercury [mmHg]) were considered to classify respondents with hypertension. For this, a digital oscillometric blood pressure measuring device with automatic upper-arm inflation and an automatic pressure release were used. The survey measured blood pressure in three times with an interval of at least 5 minutes, whereas the average of the second and third time was reported. These along with hypertensive medication use/non-use status were used to classify hypertension: (i) systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg, or (ii) taking any prescribed drugs to control blood pressure. The national guidelines for management of hypertension in Bangladesh was followed for this classification (DGHS, 2013) a guideline that is comparable with the 2018 European Society of Hypertension (ESH) and European Society of Cardiology (ESC) HTN guidelines (Williams, *et al.* 2018). The WHO's recommendation for Body Mass Index (BMI) for the Asian population were used to defined overweight and obesity, which is BMI≥23 to <27.5 kg/m2 for overweight and BMI ≥ 27.5 kg/m2 for obesity.

Exposure Variables

The SES was defined based on wealth quintiles, education and working status. Household wealth quintile, an index based on indicators of asset ownership and housing characteristics, developed and reported by the DHS as a unique measure of income and expenditure. The approach has been validated in several countries. The principal component analysis technique was used to construct this index with 5 categories, ranging from the lowest to the highest. Education was categorized in four levels based on the number of years completed: no education/pre-school (0), primary (0-5), secondary (6-10), and higher (11 and more). Respondents' current working classified dichotomously as Yes vs No. We have reclassified these three variables to make a dichotomous group of advantageous and disadvantageous

socioeconomic status an approach that was followed in previous studies in LMICs including Bangladesh [20, 23]. The wealth quintiles were reclassified in such a way where respondents in lowest and lower quintile were classified as disadvantageous group and remaining were classified as advantageous group. Respondents with no education/ preschool education were classified as disadvantageous group and the remaining were classified as advantageous group. Respondents who engaged any forms work to generate money were classified as advantage group.

Covariates

Respondents' age, sex, and place of residence were included as covariates. Where applicable, diabetes, hypertension, and body mass index were also adjusted.

Statistical Analysis

Descriptive statistics was used to describe the characteristics of the respondents. Prevalence of diabetes, hypertension, and overweight/obesity were calculated using direct standardization and reported by SES and other covariates. Multilevel Poisson regression model was used to calculate prevalence ratio (PR) of the diabetes, hypertension, and overweight/obesity for three exposure variables considered adjusting with the confounders. We used Poisson regression because the odds ratio estimated using logistic regression is usually overestimated if the outcome of interest is common, and the study design is cross-sectional (Barros & Hirakata, 2003). Furthermore, in the BDHS, individuals were nested within the household; households were nested within the PSU/cluster. Therefore, our multilevel mixed-effects Poisson regression model accounts for these multiple hierarchies and dependency in data and the problem of overestimation. Both unadjusted and adjusted model were run. In unadjusted models, we considered outcome variables separately with each explanatory variable. In the adjusted models, outcome variables were considered with the explanatory variables and covariates. We considered multistage survey design and sampling weights in all analyses. Analyses were conducted using the Stata software version 15.1.

RESULTS

Table 1 presents the basic characteristics of the total respondents and the respondents who had either diabetes, hypertension, or overweight/obesity at the time of the survey. The BDHS 2017/18 covered 11,949 respondents- a majority of them were aged 18-34 years (45.11%) and female (57.12%). Around 60% of the total respondents had have either primary (30.03%) or secondary (29.62%) level of education. A three-quarter (73.4%) of the total respondents analysed was resided in the rural areas.

The overall prevalence of diabetes was 9.82 (95% CI, 9.11-10.58%), the prevalence of hypertension was 27.37% (95% CI, 26.37-28.40), and the prevalence of overweight/obesity was 40.11 (95% CI, 38.82-41.42). The differences in the rates of diabetes and hypertension across sexes were not quite high as like what was reported for the overweight/obese while the rates were 46.19% and 32.56% among male and female, respectively. The rates of diabetes, hypertension, and overweight/obese were found higher among the currently not working respondents than their counterparts of not currently working.

Socio-Economic Difference of Diabetes, Hypertension, and Overweight/Obesity

Among the socio-economic status (SES) markers, a noticeable difference of diabetes, hypertension, and overweight/obesity was found across household wealth quintile (Table 1). The prevalence of diabetes varied between 5.32% among the poorest to 16.55% among the richest, the rate of hypertension varied between 20.68% among the poorest to 32.89% among the richest, and the rate of overweight/obesity varied between 23.88% among the poorest to 63.66% among the richest. The rates of diabetes, hypertension and overweight/obesity were also found to be increased from the 6.89%, 23.70%, and 28.10%, respectively with the increase grades of education. The occupational gradient of diabetes, hypertension and overweight/obesity were not noticeably different, however, the prevalences were found higher among respondents engaged with an advantage occupation category.

Table 1: Age-standardised prevalence of diabetes, hypertension, and overweight/obesity among Bangladeshi adults, 2017-2018

Characteristics	Overall (N=11949) n[a] (%)	Diabetes % (95% CI)	Hypertension % (95% CI)	Overweight/ obesity % (95% CI)
Average prevalence		9.82 (9.11-10.58)	27.37 (26.37-28.40)	40.11 (38.82-41.42)
Age in years				
18-34	5390 (45.11)	5.12 (4.53-5.70)	12.86 (11.98-13.75)	38.58 (37.28-39.87)
35-39	1371 (11.47)	9.98 (8.41-11.55)	27.44 (25.11-29.78)	49.96 (47.35-52.58)
40-44	1047 (8.76)	11.78 (9.83-13.72)	31.72 (28.91-34.53)	48.15 (45.13-51.17)
45-49	994 (8.32)	12.88 (10.83-14.93)	37.66 (34.69-40.63)	47.71 (44.65-50.77)
50-54	672 (5.62)	16.37 (13.58-19.15)	41.59 (37.88-45.31)	41.30 (37.59-45.01)
55-59	676 (5.66)	15.90 (13.17-18.62)	46.53 (42.81-50.25)	39.88 (36.23-43.54)
60-64	673 (5.64)	15.31 (12.61-18.00)	49.70 (45.96-53.45)	33.09 (29.57-36.61)

≥65	1126 (9.42)	14.85 (12.80-16.90)	56.64 (53.79-59.50)	27.55 (24.97-30.12)
Sex				
Male	5124 (42.88)	8.84 (8.09-9.59)	23.52 (22.42-24.61)	32.56 (31.26-33.86)
Female	6825 (57.12)	9.58 (8.89-10.28)	29.17 (28.17-30.17)	46.19 (45.02-47.36)
Educational status				
No education/preschool	3033 (25.38)	6.89 (5.72-8.05)	23.70 (21.85-25.55)	28.10 (25.71-30.49)
Primary education	3588 (30.03)	9.30 (8.38-10.23)	25.52 (24.21-26.83)	35.22 (33.67-36.77)
Secondary education	3539 (29.62)	11.67 (10.49-12.85)	28.98 (27.45-30.51)	49.03 (47.30-50.75)
Higher education	1789 (14.98)	13.15 (11.40-14.89)	31.07 (28.93-33.20)	57.42 (55.16-59.68)
Working status				
No	4620 (38.66)	11.85 (10.86-12.84)	30.30 (29.00-31.59)	48.43 (46.96-49.90)
Yes	7329 (61.34)	8.10 (7.49-8.72)	24.31 (23.38-25.24)	36.78 (35.67-37.90)
Socio-economic status				
Poorest	2311 (19.34)	5.32 (4.42-6.22)	20.68 (19.17-22.18)	23.88 (22.13-25.63)
Poorer	2354 (19.7)	5.65 (4.71-6.58)	23.38 (21.74-25.01)	28.52 (26.66-30.38)
Middle	2465 (20.63)	7.58 (6.54-8.62)	25.65 (24.02-27.27)	38.38 (36.43-40.33)
Richer	2378 (19.90)	10.36 (9.15-11.56)	28.44 (26.73-30.14)	45.08 (43.10-47.07)
Richest	2441 (20.43)	16.55 (15.19-17.90)	32.89 (31.26-34.53)	63.66 (61.85-65.46)
Place of residence				
Urban	3178 (26.60)	11.85 (10.86-12.84)	28.99 (27.73-30.25)	48.76 (47.28-50.24)
Rural	8771 (73.40)	8.10 (7.49-8.72)	25.00 (24.10-25.90)	36.11 (35.03-37.18)
Administrative division				
Barishal	659 (5.51)	9.23 (7.67-10.81)	28.40 (26.10-30.70)	43.24 (40.46-46.02)
Chattogram	2051 (17.17)	10.86 (9.39-12.33)	29.60 (27.51-31.71)	47.03 (44.62-49.43)
Dhaka	2767 (23.16)	14.99 (13.25-16.73)	24.07 (22.09-26.04)	46.84 (44.41-49.27)
Khulna	1488 (12.45)	8.00 (6/76-9.24)	27.16 (25.18-29.14)	46.53 (44.11-48.94)
Mymensingh	973 (8.15)	7.76 (6.35-9.18)	21.27 (19.22-23.32)	31.32 (28.83-33.82)
Rajshahi	1728 (14.46)	8.16 (6.86-9.48)	26.11 (24.11-28.11)	38.22 (35.83-40.63)
Rangpur	1503 (12.58)	5.61 (4.50-6.72)	28.90 (26.77-31.02)	36.44 (34.03-38.84)
Sylhet	780 (6.53)	9.62 (8.09-11.13)	25.16 (23.08-27.25)	32.99 (30.55-35.43)

Note: All counts are weighted. a Column percentage

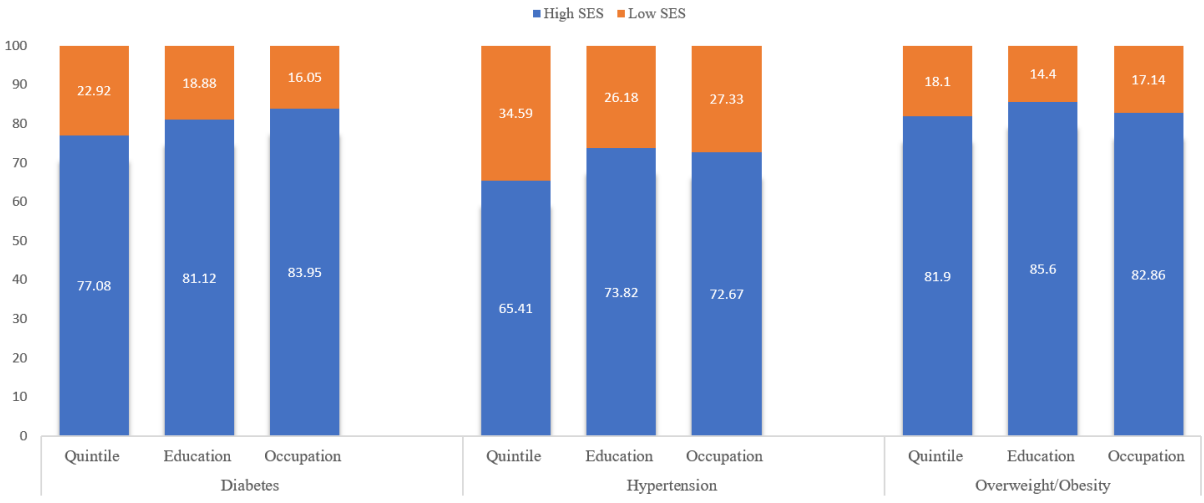

Figure 1: Distribution of Diabetes, Hypertension, and overweight/obesity by socioeconomic status, Bangladesh, 2017/18

We also examined the distribution of the socio-economic markers among the individuals with diabetes, hypertension, and overweight/obesity (Figure 1). The proportion of diabetes, hypertension, overweight/obese were 77%, 65% and 82%, respectively among respondents of high SES. Majority of the high SES and educated people had either diabetes (81%), hypertension (74%), or overweight/obese (86%). A similar result was reported for the respondents with high SES and currently working respondents- around 84% of them had either diabetes, 73% had hypertension, and 83% overweight/obesity.

Multivariable Analyses of Socioeconomic Gradients in CVD Risk Factors

The socioeconomic gradients in CVD risk factors were determined using unadjusted and adjusted multilevel passion regression models. Models were adjusted with potential covariates. Their results are presented in Table 2. The prevalence ratio of diabetes and overweight/obesity were found significantly higher among richer and richest respondents. Respondents' education levels were not found associated with diabetes and hypertension, however, prevalence ratios of overweight/obesity were found lower among respondents with no education/preschool (PR, 0.68, 95% CI, 0.63-0.74) and primary education (PR, 0.86, 95% CI, 0.80-0.91) as compared to the respondents with secondary education. Respondents' current working status was found negatively associated with diabetes (PR, 0.81, 95% CI, 0.69-0.94).

Table 2: Associations between socio-economic status and diabetes, hypertension and overweight/obesity among Bangladeshi adults

Characteristics	Diabetes Prevalence Ratio± 95% CI		Hypertension Prevalence Ratio± 95% CI		Overweight/Obesity Prevalence Ratio± 95% CI	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Wealth quintile						
Poorest	0.70 (0.54-0.90)***	0.81 (0.62-1.04)	0.89 (0.79-0.99)**	0.96 (0.85-1.07)	0.62 (0.56-0.69)***	0.68 (0.61-0.76)***
Poorer	0.77 (0.60-0.99)**	0.83 (0.65-1.07)	0.93 (0.84-1.04)	0.99 (0.89-1.10)	0.74 (0.67-0.81)***	0.76 (0.69-0.84)***
Middle	1.00	1.00	1.00	1.00	1.00	1.00
Richer	1.38 (1.13-1.69)***	1.29 (1.05-1.59)**	1.08 (0.97-1.20)	1.04 (0.93-1.15)	1.19 (1.09-1.30)***	1.16 (1.07-1.27)***
Richest	2.24 (1.86-2.70)***	1.78 (1.45-2.19)***	1.26 (1.14-1.39)***	1.03 (0.92-1.14)	1.65 (1.54-1.77)***	1.52 (1.41-1.65)***
Respondents' education						
No education, preschool	1.13 (0.96-1.34)	0.86 (0.72-1.04)	1.58 (1.45-1.72)***	0.97 (0.89-1.06)	0.61 (0.56-0.66)***	0.68 (0.63-0.74)***

Primary education	1.13 (0.95-1.33)	1.07 (0.92-1.26)	1.15 (1.05-1.26)***	0.96 (0.88-1.04)	0.78 (0.73-0.84)***	0.86 (0.80-0.91)***
Secondary education	1.00	1.00	1.00	1.00	1.00	1.00
Higher	0.97 (0.81-1.17)	0.92 (0.77-1.11)	0.96 (0.86-1.07)	1.01 (0.91-1.12)	1.08 (1.01-1.15)**	1.01 (0.95-1.08)
Paid employment						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.82 (0.73-0.92)***	0.81 (0.69-0.94)***	0.82 (0.77-0.87)***	0.94 (0.88-1.02)	0.84 (0.80-0.89)***	1.01 (0.96-1.07)

*Note: *** p<0.01, ** p<0.05*

Unadjusted Models

Models are adjusted for age, sex, place of residence and place of residence Beside these, age of the respondents was found as most important predictor of diabetes, hypertensive, and overweight/obese with a general increase of the likelihoods with increasing years (Supplementary table 1). We reported a similar trend in our subgroup analysis for diabetes, hypertension and overweight/obese across age and specific to the wealth quintiles (Supplementary Figures S1 to S3).

We also explored prevalence ratios of diabetes, hypertension, and overweight/obesity across respondents' place of region (Supplementary table 2). Prevalence ratio of diabetes was found higher among richer and richest respondents resided in the Dhaka division. In Khulna division, prevalence ratio of diabetes was found higher among the poorer and richest respondents as compared to the respondents with middle wealth quintile. Prevalence of diabetes was also found lower among no educated/ pre-school respondents in the Rajshahi division and higher educated respondents in Sylhet division.

DISCUSSION

Our analysis provides strong evidence of socio-economic gradients of CVDs' risks factors, diabetes, hypertension, and overweight/obesity, in Bangladesh where the key determinants were wealth quintile and education. Prevalence ratio of diabetes were found higher among middle to richest wealth quintile. We also reported a gradual increase in the prevalence ratio of being overweight/obesity among poorest to richest quintile. Prevalence ratios of hypertension and overweight/ obesity were found lower among no education/preschool and primary educated respondents as compared to the secondary educated respondents. In addition, we reported around 18% (95% CI, 0.73-0.92) likelihood of diabetes among respondents reported they were formally employed than the respondents who were not formally employed.

We reported a higher SES gradient of diabetes, hypertension, and overweight/obesity whereas the previous studies in Bangladesh reported their rising prevalence regardless of the SES (Islam, *et al.* 2021, Khan, *et al.* 2021). The likelihoods were even higher for specific regions, including Dhaka and Khulna. This calls for policies and programs to ensure universal availability of the NCDs treatments. However, current governmental level NCDs focus is opposite, governmental NCDs treatment facility is yet to available in the urban areas only, on tertiary health facilities (e.g district hospitals, medical colleges) on limited basis, therefore, not accessible for all (DAO, 2020) . Therefore, the private health facilities is major provider of NCDs treatment in Bangladesh (Khan, *et al.*, 2021), which is also located in the urban areas and treatment available there is expensive (NIPORT, 2017). Consequently, NCDs services provides by private health facilities could not be accessible for lower SES population and population from rural areas, though they cover over 70% of the country's total population (NIPORT, 2017). This leads detection of NCDs at its optimal stage which increase the risk of pre-mature mortality as well as difficulties in control due to concurrent comorbidities.

Challenges are also exit in awareing people about the diabetes, hypertension and risk of becoming overweight/

obesity in Bangladesh. Studies in Bangladesh have been reported poor awareness over these in all segments of the population, however, higher among who are not higher educated, resided in rural areas, and belongs to poor wealth quintile (Islam, *et al.* 2021 & Khan, *et al.* 2021). Those findings reflect the social level taboos on NCDs in Bangladesh, such as, urban educated and late aged population are mainly in the risk of developing the NCDs. However, this study reports primary educated people than their higher educated counterpart is even in the higher risk of becoming overweight/obesity (the most important risk factor of developing NCDs) and diabetic. Hypertension prevalence is also higher among respondents of no/preschool education than respondents of higher education, though the relevant likelihoods did not bring significant level once other socio-demographic factors adjusted. Lower to moderate aged population are even more prone to these risk factors, contributing NCDs are becoming popularized among young and middle-aged population day by day. This is addition to the well documented higher likelihood of NCDs among the higher aged population. The underlaying reasons of such association are increasing urbanization, westernized lifestyle, including excess dietary sodium intake, and physical inactivity (Mills, *et al.* 2016). This calls for awareness building programs on NCDs for all population, regardless of their SES and age. However, this is still limited in Bangladesh, mostly in the urban centres and small in scale (DAO, 2020), though their effectiveness has been questioned Wakefield, (2010). Consequently, use of poor quality of drugs or the use of traditional medicines to control NCDs are common, contributing to the lower control of NCDs in Bangladesh among those who are treated (Khan, *et al.* 2021). Therefore, awareness building programs on the importance of monitoring and controlling NCDs as well as body weight should be considered in future policies and programs. Technology based programs, such as use of social media and mobile phone text messaging, could be cost effective intervention to control NCDs in Bangladesh, therefore, should be adopted in future policies and programs.

The present study has several strengths. The main strengths are the analyses of nationally representative population-based survey data and the consideration of diabetes, hypertension, and overweight/obesity. Their distributions were accessed across all major makers used to measure socio-economic status, including wealth quintile, education, occupation and place of residence. Therefore, the findings provide a comprehensive picture of three major CVDs' risk factors, as such, would be helpful for developing evidence-based policies and programs. However, the major limitation of this study There is no option in the BDHS to distinguish between type-1 and type-2 diabetes, as such we did not consider this issue in this study. Dietary intake, smoking status, lifestyle behaviours, and level of physical exercise are important factors of becoming diabetic, hypertensive, and overweight/obese, therefore, essential to be included in the model. However, this was not done because of the lack of data.

CONCLUSIONS

We found a significant gradient of diabetes, hypertension, and overweight/obesity in Bangladesh with a very higher prevalence among the respondents of advantage wealth quintile, education, occupation, and place of residence. However, wealth quintile and education were found important predictors of becoming diabetic, hypertensive, and overweighted/obese. These suggest need for policies and programs on NCDs management in Bangladesh regardless SES and place of residence. However, higher focus should be given increased aged people with improved SES in respect to wealth quintile and education.

Declaration of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors thank the MEASURE DHS for granting access to the 2017/18 BDHS data.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' Contributions

Khanam SJ designed the study, performed the data analysis, and wrote the first draft of this manuscript. Kabir MA critically reviewed and edited the previous versions of this manuscript. All authors approved this final version of the manuscript.

Data Availability

The datasets used and analysed in this study are available from the Measure DHS website: https://dhsprogram.com/data/available-datasets.cfm

REFERENCES

Al Kibria, G. M., *et al.*, (2021). Clustering of hypertension, diabetes and overweight/obesity according to socioeconomic status among Bangladeshi adults. *Journal of biosocial science, 53*(2), 157-166.

Assembly, G., Sustainable development goals. SDGs Transform Our World, 2015. 2030.

Barros, A. J. and V. N. Hirakata (2003). Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC medical research methodology, 3*(1), 21.

Bangladesh., D.a.o., Prevention of Diabetes and its complications. (2020). Diabetes association of Bangladesh, Dhaka, Bangladesh,.

Centres for Disease Control and Prevention, Global Health- Bangladesh 2014, Centres for Disease Control and Prevention: New York, USA.

Chowdhury, M. Z. I., *et al.*, (2018). Prevalence of cardiovascular disease among Bangladeshi adult population: a systematic review and meta-analysis of the studies. *Vascular health and risk management, 14,* 165.

Corsi, D.J. and S. Subramanian, Socioeconomic gradients and distribution of diabetes, hypertension, and obesity in India. *JAMA network open, 2019. 2*(4), e190411-e190411.

Dandona, L., Dandona, R., Kumar, G. A., Shukla, D. K., Paul, V. K., Balakrishnan, K., ... & Thakur, J. S. (2017). Nations within a nation: variations in epidemiological transition across the states of India, 1990–2016 in the Global Burden of Disease Study. *The Lancet, 390*(10111), 2437-2460.

Directorate General of Health Services of the Ministry of Health and Family Affairs of Bangladesh, Natioanal Guidelines for Management of Hypertension in Bangladesh (2013), World Health Organization Geneva, Switzarland

Fottrell, E., *et al.*, (2018). Distribution of diabetes, hypertension and non-communicable disease risk factors among adults in rural Bangladesh: a cross-sectional survey. *BMJ global health, 3*(6), e000787

Islam, S. M. S., *et al.*, (2021). Cardiovascular diseases risk prediction in patients with diabetes: Posthoc analysis from a matched case-control study in Bangladesh. *Journal of Diabetes & Metabolic Disorders,* 1-9.

Islam, R., *et al.*, (2021). Prevalence of diabetes and prediabetes among Bangladeshi adults and associated factors: Evidence from the Demographic and Health Survey, 2017-18. *medRxiv.*

Jafar, T. H., *et al.*, (2018). Determinants of uncontrolled hypertension in rural communities in South Asia—Bangladesh, Pakistan, and Sri Lanka. *American journal of hypertension, 31*(11),1205-1214.

Khanam, F., *et al.*, (2019). Prevalence and risk factors of cardiovascular diseases among Bangladeshi adults: findings from a cross-sectional study. *Journal of epidemiology and global health, 9*(3), 176.

Khan, M. N., Islam, Rakibul I., Chowdhury, Oldroyd, J., Hossain, M. B., (2021). Awareness, treatment and control of diabetes in Bangladesh: evidence from the nationally representative surveys. *medRxiv.*

Khan, M. N., Islam, Rakibul I., Chowdhury, Enayet K., Hossain, M. B., (2021). Prevalence, awareness, treatment and control of hypertension in Bangladesh: Findings from national Demographic and Health Survey, 2017-18. *medRxiv.*

Koliaki, C., S. Liatis, and A. Kokkinos,(2019). Obesity and cardiovascular disease: revisiting an old relationship. *Metabolism, 92*, 98-107.

Mills, K. T., *et al.*, (2016). Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. *Circulation, 134*(6), 441-450.

Mohiuddin, A., (2019). Diabetes fact: Bangladesh perspective. *International Journal of Diabetes Research, 2*(1), 14-20.

Moniruzzaman, M., *et al.*, (2016). Physical activity levels in Bangladeshi adults: results from STEPS survey 2010. *public health, 137*, 131-138.

National Institute of Population Research and Training (NIPORT) and ICF, Bangladesh Health Facility Survey 2017. 2019: Dhaka, Bangladesh: NIPORT, ACPR, and ICF.

Safiri, S., *et al.*, (2020). Global, regional and national burden of osteoarthritis 1990-2017: a systematic analysis of the global burden of disease study 2017. *Annals of the rheumatic diseases, 79*(6), 819-828.

Sulaiman, M. and F. Misha, Comparative cost-benefit analysis of programs for the ultra-poor in Bangladesh. Dhaka, Bangladesh: Copenhagen Consensus Center and BRAC Research and Evaluation Department, 2016.

Vos, T., *et al.*, (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204-1222.

Wakefield, M. A., B. Loken, and R. C. Hornik,(2010). Use of mass media campaigns to change health behaviour. *The Lancet, 376*(9748), 1261-1271.

Williams, B., *et al.*,(2019). 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Kardiologia polska, 77*(2), 71-159.

World Health Organization (WHO), (2020). Cardiovascular Diseases 2020, World Health Organization Geneva, Swetzarland

World Health Organization(WHO),(2020), Cardiovascular Diseases (CVDs). 2020, World Health Organiozation Geneva, Switzarland

Supplementary Table and Figures

Table 3: Age distribution of the survey respondents by household wealth quintile, Bangladesh Demographic and Health Survey, 2017/18

Age (years)	Poorest		Poorer		Middle		Richer		Richest	
	Number	%	Number	%	Number	%	Number	%	Number	%
18-34	972	42.06	1014	43.08	1109	44.99	1165	49.02	1130	46.27
35-39	290	12.56	276	11.73	278	11.28	219	9.20	307	12.59
40-44	216	9.34	227	9.66	204	8.29	208	8.77	191	7.83
45-49	178	7.70	199	8.45	206	8.36	194	8.18	216	8.85
50-54	127	5.50	144	6.11	145	5.90	132	5.57	123	5.03

55-59	138	5.99	127	5.39	144	5.86	118	4.96	149	6.09
60-64	140	6.07	152	6.44	134	5.43	131	5.49	117	4.81
≥65	249	10.79	215	9.13	244	9.89	244	9.89	208	8.53

Table 4: Mutually adjusted prevalence ratios and 95% confidence intervals from Multilevel poison regression analyses across respondents place of residence

Characteristics	Barishal	Chattogram	Dhaka	Khulna	Mymensingh	Rajshahi	Rangpur	Sylhet
Diabetes								
Wealth quintile (ref: middle)								
Poorest	0.83 (0.49-1.40)	0.72 (0.32-1.59)	0.93 (0.49-1.77)	0.86 (0.34-2.23)	0.61 (0.35-1.05)	0.96 (0.48-1.92)	0.50 (0.27-0.93)**	1.13 (0.54-2.40)
Poorer	0.75 (0.44-1.28)	0.70 (0.37-1.34)	1.11 (0.56-2.18)	2.14 (1.21-3.81)***	0.68 (0.39-1.19)	0.54 (0.28-1.02)	0.46 (0.22-0.96)**	0.59 (0.27-1.32)
Richer	0.81 (0.46-1.42)	1.15 (0.70-1.89)	1.71 (1.11-2.65)**	1.73 (0.90-3.34)	1.08 (0.42-2.78)	1.22 (0.68-2.20)	1.07 (0.56-2.05)	0.85 (0.42-1.72)
Richest	0.94 (0.52-1.73)	1.50 (0.99-2.29)	2.61 (1.63-4.16)***	2.72 (1.41-5.29)***	1.30 (0.73-2.33)	1.15 (0.56-2.35)	0.99 (0.52-1.89)	2.12 (1.03-4.37)**
Respondents' education (ref: secondary education)								
No education, preschool	1.21 (0.62-2.35)	0.66 (0.41-1.06)	1.10 (0.76-1.59)	1.06 (0.70-1.62)	1.32 (0.66-2.63)	0.46 (0.27-0.79)***	0.66 (0.33-1.30)	0.93 (0.53-1.63)
Primary education	1.42 (0.87-2.30)	0.88 (0.62-1.23)	1.29 (0.95-1.75)	1.23 (0.84-1.79)	1.15 (0.63-2.10)	0.85 (0.50-1.44)	0.93 (0.52-1.68)	1.18 (0.76-1.82)
Higher	2.03 (1.18-3.49)	0.88 (0.64-1.22)	0.98 (0.66-1.43)	0.70 (0.42-1.19)	0.74 (0.35-1.54)	0.93 (0.53-1.65)	1.11 (0.57-2.15)	0.53 (0.29-0.97)**

Paid employment (ref: no)	0.86 (0.57-1.28)	0.83 (0.58-1.18)	0.72 (0.53-0.99)	1.05 (0.68-1.62)	0.91 (0.55-1.51)	0.51 (0.32-0.79)***	1.32 (0.82-2.13)	0.89 (0.60-1.34)
Hypertension								
Wealth quintile (ref: middle)								
Poorest	0.73 (0.59-0.90)***	1.15 (0.81-1.64)	1.09 (0.72-1.67)	0.90 (0.64-1.25)	0.85 (0.61-1.18)	0.93 (0.71-1.23)	0.95 (0.79-1.15)	0.78 (0.56-1.10)
Poorer	0.92 (0.71-1.19)	1.01 (0.76-1.35)	0.95 (0.63-1.41)	1.05 (0.85-1.30)	1.13 (0.81-1.56)	0.90 (0.73-1.12)	1.03 (0.82-1.30)	0.82 (0.57-1.18)
Richer	1.10 (0.89-1.36)	1.22 (0.94-1.60)	0.97 (0.73-1.29)	1.25 (1.01-1.58)**	1.12 (0.80-1.57)	0.72 (0.53-0.97)**	1.12 (0.86-1.45)	0.92 (0.68-1.27)
Richest	0.92 (0.67-1.27)	1.05 (0.85-1.30)	0.91 (0.68-1.23)	1.15 (0.89-1.48)	1.25 (0.87-1.79)	0.96 (0.75-1.24)	1.34 (0.98-1.84)	1.02 (0.79-1.32)
Respondents' education (ref: secondary education)								
No education, preschool	0.86 (0.65-1.13)	0.94 (0.78-1.14)	0.73 (0.58-0.93)**	1.08 (0.86-1.35)	1.06 (0.76-1.48)	0.97 (0.77-1.21)	1.27 (0.97-1.66)	1.25 (0.94-1.67)
Primary education	0.90 (0.72-1.12)	0.99 (0.82-1.21)	0.86 (0.70-1.07)	0.99 (0.78-1.26)	1.14 (0.88-1.49)	0.85 (0.68-1.05)	1.11 (0.87-1.42)	1.18 (0.89-1.57)
Higher	0.77 (0.58-1.03)	1.14 (0.90-1.43)	0.90 (0.68-1.20)	1.03 (0.81-1.32)	1.43 (1.01-2.04)**	1.03 (0.79-1.35)	0.94 (0.72-1.21)	1.04 (0.77-1.40)
Paid employment (ref: no)	1.04 (0.84-1.28)	0.97 (0.81-1.16)	1.02 (0.85-1.23)	0.84 (0.68-1.03)	0.90 (0.72-1.12)	0.94 (0.75-1.19)	0.90 (0.76-1.07)	0.88 (0.68-1.14)

Overweight/obesity								
Wealth quintile (ref: middle)								
Poorest	0.78 (0.58-1.03)	0.70 (0.54-0.90)**	0.68 (0.44-1.03)	0.70 (0.54-0.92)**	0.47 (0.33-0.68)**	0.89 (0.70-1.14)	0.56 (0.44-0.71)***	0.85 (0.60-1.22)
Poorer	0.84 (0.63-1.12)	0.78 (0.59-1.03)	0.69 (0.51-0.93)**	0.77 (0.63-0.93)**	0.79 (0.57-1.09)	0.82 (0.67-1.00)**	0.73 (0.58-0.93)***	0.84 (0.61-1.16)
Richer	1.21 (0.94-1.57)	1.11 (0.94-1.31)	1.22 (0.97-1.53)	1.15 (0.99-1.33)	1.30 (0.94-1.80)	1.17 (0.92-1.49)	1.12 (0.85-1.47)	1.25 (0.91-1.74)**
Richest	1.40 (1.13-1.75)***	1.54 (1.33-1.79)**	1.43 (1.15-1.77)	1.50 (1.29-1.74)**	1.70 (1.30-2.22)***	1.76 (1.43-2.16)**	1.48 (1.13-1.93)***	2.18 (1.66-2.87)***
Respondents' education (ref: secondary education)								
No education, preschool	0.73 (0.55-0.96)**	0.64 (0.53-0.79)**	0.70 (0.60-0.81)***	0.76 (0.62-0.95)**	0.60 (0.44-0.81)***	0.79 (0.61-1.00)**	0.68 (0.52-0.90)***	0.48 (0.38-0.62)***
Primary education	0.79 (0.68-0.93)***	0.86 (0.75-0.98)**	0.89 (0.76-1.05)**	0.79 (0.68-0.92)**	0.70 (0.58-0.86)**	0.81 (0.68-0.97)**	1.09 (0.92-1.29)	0.83 (0.69-0.99)**
Higher	1.17 (0.98-1.39)	0.85 (0.74-0.97)**	1.15 (1.01-1.32)**	1.04 (0.90-1.21)	1.08 (0.87-1.35)	0.93 (0.77-1.13)	0.99 (0.81-1.21)	0.73 (0.60-0.91)**
Paid employment (ref: no)	1.18 (1.02-1.36)**	0.96 (0.85-1.09)	0.89 (0.79-1.00)**	1.14 (1.01-1.30)**	1.08 (0.88-1.32)	1.05 (0.90-1.24)	1.11 (0.94-1.31)	1.06 (0.86-1.30)

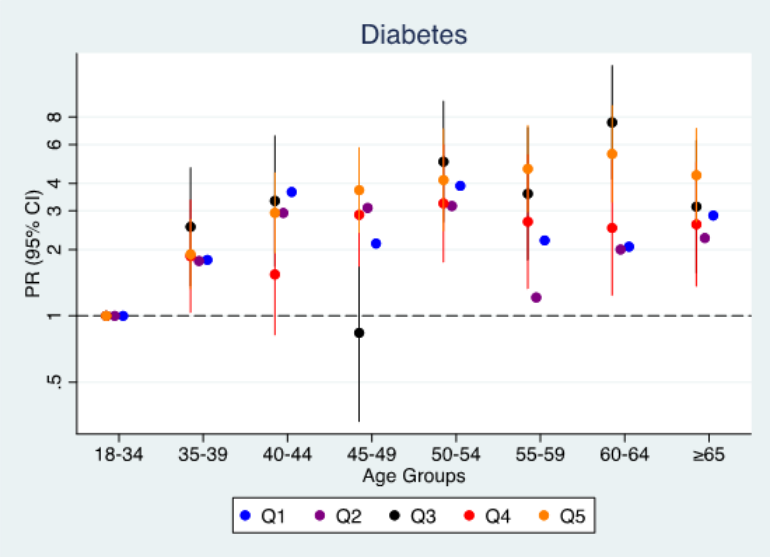

Figure 2: Adjusted prevalence ratio of Hypertension by age for quintiles of household wealth, BDHS, 2017/18
Note: Adjusted prevalence calculated from logistic regression model where the factors adjusted were age, sex, occupation, body mass index, residence, region and status of Diabetes

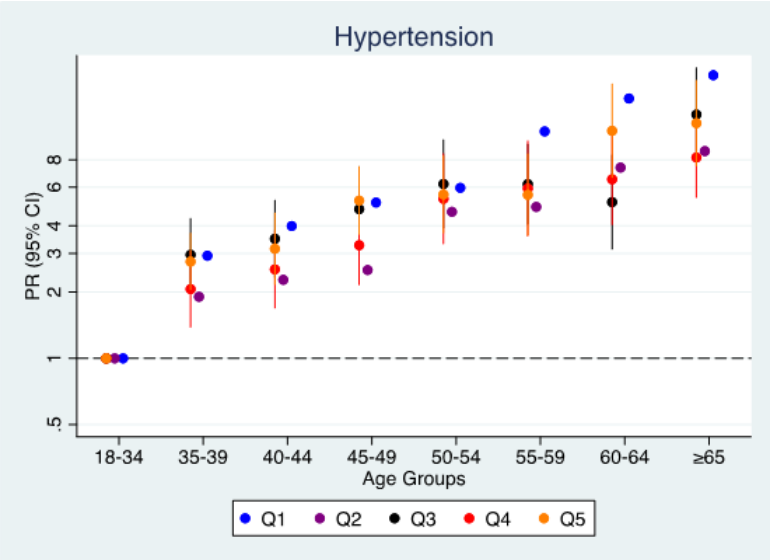

Figure 3: Adjusted prevalence ratio of Obesity by age for quintiles of household wealth, BDHS, 2017/18
Note: Adjusted prevalence calculated from logistic regression model where the factors adjusted were age, sex, occupation, residence, and region