High Blood Pressure & Cardiovascular Prevention (2022) 29:57–64
https://doi.org/10.1007/s40292-021-00488-0

ORIGINAL ARTICLE

Inequalities in Undiagnosed Hypertension Among Adult Population in Bangladesh: Evidence from a Nationally Representative Survey

Mohammad Rifat Haider[1] · **Rajat Das Gupta**[2]

Received: 5 October 2021 / Accepted: 3 November 2021 / Published online: 10 November 2021

Abstract

Introduction Bangladesh has experienced a rising trend in hypertension in recent years and women are suffering from this non-communicable disease more than men. About one-fifth of the adult population is suffering from hypertension and almost three-fifth of them are undiagnosed.

Aim This study aims to assess the prevalence and determinants of undiagnosed hypertension and to examine the extent of socioeconomic inequalities in undiagnosed hypertension among adult Bangladeshi population (≥ 18 years).

Methods This study used nationally representative Bangladesh Demographic and Health Survey 2017–18 data. Undiagnosed hypertension was defined as having systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg and was never told by the health professionals to lower/control blood pressure. Multiple logistic regression analysis was performed to assess factors associated with undiagnosed hypertension. Further, socioeconomic inequalities in the prevalence of undiagnosed hypertension were estimated using Concentration Index.

Results Out of total 3196 hypertensive adults, half (50.1%) were undiagnosed. In the adjusted model, older age, overweight/obesity, female gender, richest wealth quintiles had lower odds of being undiagnosed. Overall concentration index showed that poor patients were disproportionately affected by undiagnosed hypertension (Concentration Index: − 0.103, Standard Error (SE) of Concentration Index: 0.024; P value < 0.001). The poor(Q1)-to-rich(Q5) ratio of 1.3 also demonstrates that poorest hypertensive Bangladeshi adults have higher prevalence of undiagnosed hypertension than their richest counterparts.

Conclusion Awareness building program should be targeted towards adults belong to poor wealth quintiles for checking blood pressure regularly. Hypertension should be diagnosed and treated to prevent further complications.

Keywords Undiagnosed hypertension · Inequalities · Bangladesh

1 Introduction

Hypertension is the worldwide leading cause for mortality and disability. It is a risk factor for cardiovascular disease, stroke, and chronic kidney disease [1]. In 2017, around 10.4 million deaths were attributed to hypertension around the world [2]. Majority of the burden of hypertension is concentrated in the low-and-middle income countries, including the South Asian nations [3, 4]. In the South Asian nation of Bangladesh, around 28% of the adult population had hypertension as per the latest Health and Demographic Survey 2017–18 [5]. Ahmed et al. [6] estimated that every three in five Bangladeshi hypertensive adults (59.9%) aged ≥ 35 years were unaware about their blood pressure status, while 55% of women was not aware of their hypertension. Undiagnosed hypertension can lead to major macrovascular events (e.g., coronary artery disease, myocardial infarction, congestive heart failure, stroke, and peripheral vascular disease) and microvascular events (e.g., retinopathy, nephropathy, and neuropathy), which in turn may lead to death [1, 7].

To develop effective interventions to prevent and control hypertension among Bangladeshi adults, updated knowledge on the prevalence and risk factors of undiagnosed hypertension among this age group is necessary. Also, it is necessary to find out the inequitable distribution of hypertension

✉ Mohammad Rifat Haider
haider@uga.edu

[1] Department of Health Policy and Management, College of Public Health, University of Georgia, Wright Hall 301B, 100 Foster Rd, Athens, GA 30602, USA

[2] Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Discovery I, Columbia, SC 29208, USA

among different groups of people within the larger population for targeted preventive efforts. The aim of this study was to the inequalities in undiagnosed hypertension among adults (aged ≥ 18 years) in Bangladesh using the nationally representative sample of Bangladesh Demographic and Health Survey 2017–18 (BDHS 2017–18). Although previous study by Khanam et al. [9] utilized BHDS 2017–18 data to assess the prevalence, risk factors, and inequality of hypertension, the inequalities in undiagnosed hypertension were not assessed. This study will fill up this knowledge gap and inform the policy makers about the inequalities in undiagnosed hypertension using the latest nationally representative survey dataset [8].

2 Methods

2.1 Study Design

The secondary data of BDHS 2017–18 was analyzed in this study. BDHS 2017–18 was a nationally representative survey implemented by Mitra and Associates between October 2017 and October 2018 [9]. This data was analyzed between March 2021 and July 2021. The final report of BDHS 2017–18 was published previously which described the methodology, sample size calculation, data collection tools, and process [9]. A two-staged stratified cluster sampling was followed. At the first stage, a list of enumeration areas (EAs) was identified using 2011 Population and Housing Census of Bangladesh. The EAs were considered as primary sampling unit and on average each EA had 120 households. Total 675 EAs were selected based on probability proportional to their size (urban: 250 EAs; rural: 425 EAs). Then from each EAs, 30 households were randomly selected. Overall, 20,250 households were selected and one-fourth of them were selected randomly for biomarker testing, and anthropometric measurement [8]. Total 14,704 individuals (8013 women and 6691 men) were eligible for biomarker measurement. In this study, the target population was individuals aged ≥ 18 years with hypertension.

2.2 Outcome Variable

The main outcome of interest was hypertension status, which was dichotomized into diagnosed and undiagnosed hypertension. A LIFE SOURCE® UA-767 Plus BP monitor with size adjusted measuring cuffs was used for blood pressure measurement. The blood pressure was measured by two trained health technician (one male and one female) per each study team. The supervisor of the study team supervised the measurement procedure. In addition to that, external quality control team from Mitra and Associates and National Institute of Population Research and Training (NIPORT) monitored the quality of the data [9].

Three measurements were taken in ten minutes intervals between measurements. The first measurement was discarded and the average of the second and third measurements was considered as the final blood pressure. Joint National Committee 7 (JNC7) guideline was used to classify hypertension. Hypertension was defined as a systolic blood pressure (SBP) more than 140 mmHg or diastolic blood pressure (DBP) more than 90 mmHg or using blood pressure lowering medication at the time of the survey irrespective of blood pressure level. If a hypertensive respondent had SBP ≥ 140 mm Hg or DBP ≥ 90 mmHg and was never told by the health professionals to lower/control blood pressure, then he/she was considered as having undiagnosed hypertension [10].

2.3 Independent Variables

The following independent variables were considered: age (18–29, 30–49, 50–69, ≥ 70 years); education (no education, primary, secondary, college and higher education); body mass index (BMI) (underweight/normal, overweight/obese); household wealth index (poorest, poorer, middle, richer, richest); place of residence (rural, city corporation, urban), and division of residence (Dhaka, Barisal, Chattogram, Khulna, Rajshahi, Rangpur, Sylhet, Mymensingh). The information on these variables except BMI was collected using questionnaire.

Lightweight, electronic SECA 878 (with digital display and boards) was used to measure height and weight. BMI was measured by dividing the participants' weight by height squared. The unit of BMI was kilogram/meter^2 (kg/m^2). Asia-specific BMI cut-off was used for categorization. BMI was categorized into: (1) underweight/normal BMI (< 23.0 kg/m^2); (2) overweight/obesity (≥ 23.0 kg/m^2) [11].

Information on household asset such as construction materials, type of sanitation facilities, and water source, use of electricity, health services and other amenities. Then wealth index was calculated using principal component analysis. Finally, the wealth index was categorized into quintiles [9, 12–14].

2.4 Statistical Analysis

At first, descriptive analysis was conducted, and the findings were presented in frequency and percentage. Then bivariate analysis was performed to find out the prevalence of undiagnosed hypertension across the covariates. Chi-square test was performed to find out the differences between the categories. Bivariate logistic regression was conducted to find out the individual association between the covariates and undiagnosed hypertension. Finally, multivariable logistic

regression was fitted for identifying the overall association between the covariates and undiagnosed hypertension. Both crude odds ratio (COR) and adjusted odds ratio (AOR), with 95% confidence interval (CI) were reported. The survey weight of BDHS 2017–18 were adjusted while performing all analyses.

In order to determine the inequalities in undiagnosed hypertension among Bangladeshi adults, concentration index, with standard error (SE) was reported. At first, the households were ranked based on wealth index score. Then, a concentration curve was plotted to measure the distribution of undiagnosed hypertension.

Distribution of undiagnosed hypertension was measured by plotting a concentration curve representing the cumulative proportion of undiagnosed hypertension in Y-axis and cumulative proportions of the population in X-axis. The cumulative proportion of undiagnosed hypertension was plotted in Y-axis, and the cumulative proportions of the population was plotted in X-axis. In case of no inequality (the prevalence of undiagnosed hypertension is same across the wealth quintiles), the concentration curve and the diagonal will coincide. On the other hand, the deviation of concentration curve from the diagonal implies inequalities in the prevalence [15–17].

The concentration index was defined as twice the area between the concentration curve and the diagonal. The concentration index ranges from − 1 to + 1 [16, 18]. If the value is positive, then prevalence of undiagnosed hypertension is higher among the richer wealth quintiles, and a negative value implies more concentration of undiagnosed hypertension among the poorer wealth quintiles. All analyses were performed using STATA V 16.1 [19].

2.5 Ethical Consideration

The institutional review board at ICF (IRB: FWA00000845) and the Bangladesh Medical Research Council (IRB: BMRC/NREC/2016–2019/324) approved the study protocol of BDHS 2017-18. Prior to data collection, informed consent was taken from the participants.

3 Results

In total the weighted data of 3196 hypertensive adults were included in the study. The characteristics of the participants with hypertension and with prevalence of undiagnosed hypertension is presented in Table 1. Majority of the participants were aged between 30 and 49 years, female, were educated up to primary level, were overweight/obese, belonged to the richest wealth quintile, residing in the rural area, and in Dhaka division. The prevalence of undiagnosed hypertension was significantly higher among the 18–29 years old (66.3%, compared to other age categories, $P < 0.001$), males (57.4%, compared to females, $P < 0.001$), participants who received education up to college and higher (56.7%, compared to other education categories, $P = 0.003$), participants with underweight/normal BMI (53.9%, compared to overweight/obese, $P = 0.001$), poorest wealth quintile (57.3%, compared to other quintiles, $P = 0.002$), and residence in Sylhet division (57.8%, compared to residents of other division, $P = 0.009$). Although not statistically significant, the prevalence was higher among those residing in rural area (51.3%, compared to urban residents, $P = 0.092$).

The results from the multivariable logistic regression model, showing factors associated with undiagnosed hypertension among Bangladeshi adults is shown in Table 2. In the final model age, BMI, gender, and wealth index, were found significantly associated with undiagnosed hypertension. Participants aged 30–49 years were 36% less likely to have undiagnosed hypertension (AOR: 0.64; 95% CI 0.47–0.87) compared to 18–29 years. The odds were 70% and 74% less among the individuals aged 50–69 years (AOR: 0.30; 95% CI 0.22–0.41) and ≥ 70 years (AOR: 0.34; 95% CI 0.23–0.50) compared to 18–29 years. Females were 45% less likely to have undiagnosed hypertension than the males (AOR: 0.55; 95% CI 0.46–0.66). Overweight/Obese adults were less likely to have their hypertension undiagnosed (AOR: 0.74; 95% CI 0.62–0.89) compared to those with underweight and normal BMI. The adults who belonged to the richest wealth quintiles had 39% lower odds of having undiagnosed hypertension compared to those who were from the poorest wealth quintile (AOR: 0.61; 95% CI 0.44–0.86). Education, place and division of residence were not associated with undiagnosed hypertension.

The socioeconomic inequalities in undiagnosed hypertension among adults is shown in Table 3. Overall, concentration index showed that a disproportionate prevalence of undiagnosed hypertension towards the poorest quintile (concentration index: − 0.103; SE: 0.024). The poor (Q1)-to-rich (Q5) ratio was 1.3 indicating that the prevalence of undiagnosed hypertension was higher among the poorest individuals. The inequalities in undiagnosed hypertension was higher among 50–69 years old age group (concentration index: − 0.154; SE: 0.040), males (concentration index: − 0.116; SE: 0.035), those who were educated up to secondary education (concentration index: − 0.193; SE: 0.047), overweight/obese individuals (concentration index: − 0.114; SE: 0.030), urban area (concentration index: − 0.102; SE: 0.034), Barisal division (concentration index: − 0.141; SE: 0.062).

Table 1 Characteristics of Bangladeshi adult population with hypertension and with prevalence of undiagnosed hypertension, (n = 3196)

Characteristics	Total		Undiagnosed Hypertension (weighted %)	*P* value
	Frequency (n)	Weighted %		
Age (in years)				< 0.001
18–29	330	10.6	66.3	
30–49	1322	41.5	55.2	
50–69	1107	34.3	40.9	
≥ 70	437	13.6	45.2	
Gender				< 0.001
Male	1222	38.0	57.4	
Female	1974	62.0	45.6	
Education				0.003
No education	987	30.9	47.1	
Primary education	937	29.3	47.7	
Secondary education	804	25.2	53.4	
College and higher	468	14.6	56.7	
Body Mass Index (BMI)				0.001
Underweight/normal	1325	42.0	53.9	
Overweight/obese	1806	58.0	47.5	
Wealth index				0.002
Poorest	458	14.7	57.3	
Poor	505	16.8	54.2	
Middle	594	19.7	50.4	
Richer	674	21.3	48.4	
Richest	965	27.5	45.0	
Place of residence				0.092
Rural	1935	70.4	51.3	
Urban	1261	29.6	47.4	
Division				0.009
Dhaka	365	21.6	45.8	
Barisal	391	6.5	48.4	
Chattogram	460	19.3	47.8	
Khulna	490	13.5	50.4	
Rajshahi	319	6.9	51.8	
Rangpur	413	13.9	55.7	
Sylhet	412	12.5	57.8	
Mymensingh	346	5.9	41.8	
Total	3196	100.0	50.1	

BDHS Bangladesh Demographic and Health Survey

4 Discussion

This study aimed to find out the inequalities in undiagnosed hypertension among adults in Bangladesh. The study found that every one in two Bangladeshi adults had undiagnosed hypertension. Participants aged 30–49 years, 50–69 years, and ≥ 70 years, female gender, being overweight/obese, and belonging to the richest wealth quintiles had lower odds of having undiagnosed hypertension. In most of the categories, the concentration index was significantly in negative direction, which indicates that the inequality is more concentrated in the poor socio-economic group.

Participants aged 30–49 years, 50–69 years, and ≥ 70 years had lower odds of having undiagnosed hypertension. This finding is similar to the results of a previous study done in the context of Nepal [20]. Adults of this age group are in more proximity of the health system than those of younger age group. The risk of non-communicable diseases including cardiovascular disease increases after the age of 35–40 years leading to the more frequent visit of healthcare providers [21]. As a result, the chance of having undiagnosed hypertension decreases with advancing age [6].

Similarly, females were less likely to have undiagnosed hypertension. Females are usually in more proximity of the

Table 2 Factors associated with undiagnosed hypertension among Bangladeshi adult population

Characteristics	Unadjusted models (n = 3196)		Adjusted model (n = 3131)	
	COR	95% CI	AOR	95% CI
Age (in years)				
18–29	1.00	–	1.00	–
30–49	0.63**	0.47–0.83	0.64**	0.47–0.87
50–69	0.35***	0.26–0.46	0.30***	0.22–0.41
≥ 70	0.42***	0.30–0.59	0.34***	0.23–0.50
Gender				
Male	1.00	–	1.00	–
Female	0.62***	0.53–0.73	0.55***	0.46–0.66
Education				
No education	1.00	–	1.00	–
Primary education	1.03	0.84–1.25	0.86	0.70–1.07
Secondary education	1.29*	1.05–1.58	1.03	0.80–1.32
College and higher	1.47**	1.15–1.89	1.07	0.78–1.46
Body Mass Index (BMI)				
Underweight/normal	1.00	–	1.00	–
Overweight/obese	0.77**	0.66–0.90	0.74**	0.62–0.89
Wealth index				
Poorest	1.00	–	1.00	–
Poor	0.88	0.66–1.17	0.83	0.62–1.12
Middle	0.76*	0.57–0.99	0.76	0.56–1.02
Richer	0.70*	0.53–0.93	0.66**	0.49–0.90
Richest	0.61***	0.47–0.80	0.61**	0.44–0.86
Place of residence				
Rural	1.00	–	1.00	–
Urban	0.86	0.71–1.03	0.97	0.78–1.19
Division				
Dhaka	1.00	–	1.00	–
Barisal	1.11	0.80–1.54	1.02	0.74–1.43
Chattogram	1.08	0.79–1.48	1.05	0.73–1.42
Khulna	1.20	0.87–1.66	1.19	0.76–1.46
Rajshahi	1.27	0.89–1.81	1.19	0.86–1.65
Rangpur	1.49*	1.08–2.06	1.35	0.83–1.72
Sylhet	1.62**	1.16–2.26	1.40	0.99–1.98
Mymensingh	0.85	0.59–1.23	0.77	0.53–1.13

AOR adjusted odds ratio, *BDHS* Bangladesh Demographic and Health Survey, *CI* confidence interval, *COR* crude odds ratio

*P < 0.05; **P < 0.001; ***P < 0.001

health system than their male counterparts. Pregnant women during their antenatal visit undergo blood pressure check-up. As a result, they are less likely to have undiagnosed hypertension [20].

Similarly, overweight and obesity is an established risk factor of hypertension and other non-communicable diseases. As a result, overweight and obese adults come in frequent contact with healthcare providers and get their blood pressure measured. As a result, the probability of having undiagnosed hypertension decreases [22, 23].

Participants belonging to households from the richest wealth status had lower likelihood of having undiagnosed hypertension. This is consistent with previous studies conducted in South Asia [20, 24]. Also, we found that the participants from the lower socio-economic group were disproportionately affected by undiagnosed hypertension. This might be due to the greater access of adults from the richest wealth quintiles to the health system [25, 26]. Economic reasons (both direct and indirect medical cost) hinder the individuals from the poorer wealth quintiles from care seeking [27, 28].

We did not find any association between undiagnosed hypertension and educational status, place and division of residence. Previously Ahmed et al. [6] found less educational attainment was associated with undiagnosed hypertension. The discrepancy was mainly due to time and study population as Ahmed et al. utilized data from BDHS 2011 and their target population was adults aged ≥ 35 years. Similarly, the concentration index was almost similar among the urban (− 0.101) and rural area (− 0.102). Also, we did not find any significant differences at the divisional level. The public health promotion program aiming to address undiagnosed hypertension should focus on individuals irrespective of their educational status, place and division of residence.

In Bangladesh, the out-of-pocket expenditure (OOPE) for health remains very high and the proportion is increasing day by day. OOPE in total health expenditure increased from 55.9% in 1997 to 63.3% in 2012, as estimated by national surveys [29]. According to the recent World Bank data, the proportion has risen to 73.87% in 2018 [30]. Khan et al. [31] estimated that around 14.2% households face catastrophic health expenditure (CHE), and the poorest households are disproportionately affected by the CHE. Data from a nationally representative survey showed that presence of a chronic disease (which includes noncommunicable disease) was associated with OOPE in Bangladesh [32].

The higher burden of undiagnosed hypertension among the adult individuals is a big challenge for the health system of Bangladesh. Government of Bangladesh has recently endorsed 'Multisectoral Action Plan for Prevention and Control of Noncommunicable Diseases 2018–2025'. It aims to reduce the premature mortality due to noncommunicable diseases by 25% within 2025 [33]. The high burden of undiagnosed hypertension among Bangladeshi adults needs to be addressed in order to achieve the aforementioned goal. Bangladesh Health Facility Survey 2017 found that in spite of having instruments for blood pressure measurement (i.e., stethoscope, blood pressure apparatus, adult scale) in more than 85% of the facilities, only 10% of them have at least trained staff to provide services related to hypertension. Health facility strengthening with trained staffs must be

Table 3 Socioeconomic inequalities in undiagnosed hypertension among Bangladeshi adult population, (n = 3196)

Variables	Poorest (Q1) (%)	Richest (Q5) (%)	Q1–Q5	Q1:Q5	Concentration index (C)	Standard error (SE)
Total	57.3	45.0	12.3	1.3	− 0.103***	0.024
Age (in years)						
18–29	75.9	62.4	13.5	1.2	− 0.036	0.064
30–49	62.1	51.0	11.1	1.2	− 0.105**	0.035
50–69	51.0	33.5	17.5	1.5	− 0.154***	0.040
≥ 70	50.3	39.5	10.8	1.3	− 0.088	0.063
Gender						
Male	67.5	53.2	14.3	1.3	− 0.116**	0.035
Female	52.5	38.7	13.8	1.4	− 0.109***	0.030
Education						
No education	52.4	37.5	14.9	1.4	− 0.102*	0.043
Primary education	60.8	40.4	20.4	1.5	− 0.149***	0.040
Secondary education	70.0	45.6	24.4	1.5	− 0.193***	0.047
College and higher	77.2	51.9	25.3	1.5	− 0.167**	0.051
Body Mass Index (BMI)						
Underweight/normal	56.9	49.1	7.8	1.2	− 0.036	0.037
Overweight/obese	58.4	44.1	14.3	1.3	− 0.114***	0.030
Place of residence						
Rural	57.7	46.6	11.1	1.2	− 0.101**	0.031
Urban	53.0	43.7	9.3	1.2	− 0.102**	0.034
Division						
Dhaka	53.7	39.4	14.3	1.4	− 0.133*	0.056
Barisal	56.5	44.3	12.2	1.3	− 0.141*	0.062
Chattogram	59.2	46.8	12.4	1.3	− 0.075	0.061
Khulna	60.8	47.9	12.9	1.3	− 0.036	0.059
Rajshahi	64.6	42.0	22.6	1.5	− 0.124	0.070
Rangpur	48.0	53.8	− 5.8	0.9	− 0.005	0.059
Sylhet	65.6	56.6	9	1.2	− 0.111	0.065
Mymensingh	44.5	39.9	4.6	1.1	0.002	0.069

BDHS Bangladesh Demographic and Health Survey

*P < 0.05; **P < 0.001; ***P < 0.001

implemented in order to reduce the burden of undiagnosed hypertension [34].

Even in case of diagnosed hypertension, the control of blood pressure is necessary. For example, Tocci et al. [35] found that approximately one-third of the diagnosed hypertensives in Italy do not have their blood pressure controlled. In Russia, more than half of the diagnosed hypertensives had uncontrolled hypertension. Pre-existing comorbidities including cardiovascular diseases increased the likelihood of having uncontrolled hypertension [36]. Future studies should investigate the determinants of uncontrolled hypertension in Bangladeshi adults using BDHS 2017–18 dataset.

We followed the JNC7 guidelines for the definition of hypertension since the BDHS 2017–18 report followed this guideline to define hypertension [9]. This will help the policy makers to interpret the findings in the context of BDHS 2017–18 report. Future studies should compare the findings with 2017 American College of Cardiology/American Heart Association hypertension guideline, which used a different cut-off for defining hypertension [37].

This study has some key strengths. BDHS 2017–18 utilized a nationally representative sample. Therefore, the findings of the study can be generalized to the target population. The possibility of measurement error was minimized by utilizing standardized questionnaires and calibrated tools. However, the limitations of the study warrant discussion. First, due to cross-sectional nature of the study, the temporal association between the exposure and the outcome could not be established. Blood pressure was measured on the same day, whereas longitudinal measurement is recommended [10]. This might induce white coat hypertension [38]. Also, blood pressure was measured in one arm, whereas the guidelines

recommend measurement in both arms [39]. However, this study depicts the inequity in undiagnosed hypertension concentrated among the adults from the poorest wealth quintile and help us to identify the predictors of undiagnosed hypertension in the study population.

5 Conclusions

Undiagnosed hypertension is common among Bangladeshi adults. Younger adults, males, individuals with underweight/normal BMI, residents from poor socio-economic status are more prone to suffer from hypertension which go undiagnosed. Targeted intervention to check regular blood pressure among the vulnerable group needs to be adopted to treat this insidious disease and prevent further complications and comorbidities.

Declarations

Funding This article received no external funding.

Competing interests The authors declare that they have no competing interests.

Ethical approval The institutional review board at ICF (IRB: FWA00000845) and the Bangladesh Medical Research Council (IRB: BMRC/NREC/2016–2019/324) approved the study protocol of BDHS 2017–18. Prior to data collection, informed consent was taken from the participants.

Consent for publication Not applicable.

Data availability All the datasets of BDHS 2017–18 are publicly available and can be accessed from the following link: https://dhsprogram.com/methodology/survey/survey-display-536.cfm . Following proper instruction by the DHS program, data are available to download.

Authors' contributions MRH had a role in the conception, planning, data acquisition and analysis and writing up of the work, and manuscript development. RDG contributed to literature review, editing, and revision of the final manuscript. All authors have read and approved the final manuscript.

References

1. Lackland DT, Weber MA. Global burden of cardiovascular disease and stroke: hypertension at the core. Can J Cardiol. 2015. https://doi.org/10.1016/j.cjca.2015.01.009.
2. GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study, 2017. Lancet. 2018;392:1923–94. https://doi.org/10.1016/S0140-6736(18)32225-6.
3. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. Lancet. 2017;389:37–55. https://doi.org/10.1016/S0140-6736(16)31919-5.
4. Neupane D, McLachlan CS, Sharma R, Gyawali B, Khanal V, Mishra SR, et al. Prevalence of hypertension in member countries of South Asian Association for Regional Cooperation (SAARC): systematic review and meta-analysis. Medicine (Baltimore). 2014;93: e74. https://doi.org/10.1097/MD.0000000000000074.
5. Das Gupta R, Ananyo Chakraborty P, Belal HM. Association of household wealth and education level with hypertension and diabetes among adults in Bangladesh: a propensity score-based analysis. Trop Med Int Health. 2021. https://doi.org/10.1111/tmi.13625.
6. Ahmed S, Tariqujjaman M, Rahman MA, Hasan MZ, Hasan MM. Inequalities in the prevalence of undiagnosed hypertension among Bangladeshi adults: evidence from a nationwide survey. Int J Equity Health. 2019;18:33. https://doi.org/10.1186/s12939-019-0930-5.
7. Long AN, Dagogo-Jack S. Comorbidities of diabetes and hypertension: mechanisms and approach to target organ protection. J Clin Hypertens (Greenwich). 2011;13:244–51. https://doi.org/10.1111/j.1751-7176.2011.00434.x.
8. National Institute of Population Research and Training (NIPORT). Bangladesh demographic and health survey 2017–18. Dhaka: ICF; 2020.
9. Khanam M, Hasan E, Sarker AR. Prevalence and factors of hypertension among Bangladeshi adults. High Blood Press Cardiovasc Prev. 2021;28(4):393–403. https://doi.org/10.1007/s40292-021-00461-x.
10. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JLJ, et al. The Seventh Report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. JAMA. 2003;289:2560–72. https://doi.org/10.1001/jama.289.19.2560.
11. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363:157–63. https://doi.org/10.1016/S0140-6736(03)15268-3.
12. Jolliffe IT, Cadima J. Principal component analysis: a review and recent developments. Philos Trans R Soc A Math Phys Eng Sci. 2016;374:20150202.
13. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data–or tears: an application to educational enrollments in states of India. Demography. 2001;38:115–32. https://doi.org/10.1353/dem.2001.0003.
14. Kolenikov S, Angeles G. Socioeconomic status measurement with discrete proxy variables: is principal component analysis a reliable answer? Rev Income Wealth. 2009;55:128–65.
15. Wagstaff A, Van Doorslaer E, Paci P. On the measurement of horizontal inequity in the delivery of health care. J Health Econ. 1991;10(2):169–205.
16. Wagstaff A, O'Donnell O, Van Doorslaer E, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington: The World Bank; 2008. p. 220.
17. Kakwani N, Wagstaff A, Van Doorslaer E. Socioeconomic inequalities in health: measurement, computation, and statistical inference. J Econom. 1997;77(1):87–103.
18. Koolman X, Van Doorslaer E. On the interpretation of a concentration index of inequality. Health Econ. 2004;13(7):649–56.
19. StataCorp. Stata statistical software: release 16. College Station: StataCorp LLC; 2019.
20. Haider MR, Das GR. Inequalities in undiagnosed hypertension among adult Nepalese population: evidence from a nationally representative survey. Int J Cardiol Hypertens. 2020;5: 100026. https://doi.org/10.1016/j.ijchy.2020.100026.

21. Gupta R, Misra A, Vikram NK, Kondal D, Sen GS, Agrawal A, et al. Younger age of escalation of cardiovascular risk factors in Asian Indian subjects. BMC Cardiovasc Disord. 2009;9:28. https://doi.org/10.1186/1471-2261-9-28.
22. Julius S, Valentini M, Palatini P. Overweight and hypertension: a 2-way street? Hypertens (Dallas, Tex 1979). 2000;2000(35):807–13. https://doi.org/10.1161/01.hyp.35.3.807.
23. Al-Goblan AS, Al-Alfi MA, Khan MZ. Mechanism linking diabetes mellitus and obesity. Diabetes Metab Syndr Obes. 2014;7:587–91. https://doi.org/10.2147/DMSO.S67400.
24. Gupta R, Kaur M, Islam S, Mohan V, Mony P, Kumar R, et al. Association of household wealth index, educational status, and social capital with hypertension awareness, treatment, and control in South Asia. Am J Hypertens. 2017;30:hpw169. https://doi.org/10.1093/ajh/hpw169.
25. Palafox B, McKee M, Balabanova D, AlHabib KF, Avezum AJ, Bahonar A, et al. Wealth and cardiovascular health: a cross-sectional study of wealth-related inequalities in the awareness, treatment and control of hypertension in high-, middle- and low-income countries. Int J Equity Health. 2016;15:199. https://doi.org/10.1186/s12939-016-0478-6.
26. Orach CG. Health equity: challenges in low income countries. Afr Health Sci. 2009;9:S49–51.
27. Shrestha S, Shrestha A, Koju RP, LoGerfo JP, Karmacharya BM, Sotoodehnia N, et al. Barriers and facilitators to treatment among patients with newly diagnosed hypertension in Nepal. Heart Asia. 2018;10: e011047. https://doi.org/10.1136/heartasia-2018-011047.
28. Uddin MJ, Alam N, Koehlmoos TP, Sarma H, Chowdhury MAH, Alam DS, et al. Consequences of hypertension and chronic obstructive pulmonary disease, healthcare-seeking behaviors of patients, and responses of the health system: a population-based cross-sectional study in Bangladesh. BMC Public Health. 2014;14:547. https://doi.org/10.1186/1471-2458-14-547.
29. Mahumud RA, Sarker AR, Sultana M, Islam Z, Khan J, Morton A. Distribution and determinants of out-of-pocket healthcare expenditures in Bangladesh. J Prev Med Public Health. 2017;50:91–9. https://doi.org/10.3961/jpmph.16.089.
30. The World Bank. Out-of-pocket expenditure (% of current health expenditure)—Bangladesh. https://data.worldbank.org/indicator/SH.XPD.OOPC.CH.ZS?locations=BD. Accessed 7 Nov 2021.
31. Khan JAM, Ahmed S, Evans TG. Catastrophic healthcare expenditure and poverty related to out-of-pocket payments for healthcare in Bangladesh-an estimation of financial risk protection of universal health coverage. Health Policy Plan. 2017;32:1102–10. https://doi.org/10.1093/heapol/czx048.
32. Molla AA, Chi C, Mondaca ALN. Predictors of high out-of-pocket healthcare expenditure: an analysis using Bangladesh household income and expenditure survey, 2010. BMC Health Serv Res. 2017;17:94. https://doi.org/10.1186/s12913-017-2047-0.
33. Non-communicable Disease Control Programme, Directorate General of Health Services (DGHS). Multi-sectoral action plan for prevention and control of non-communicable diseases 2018–2025. Dhaka: DGHS; 2018.
34. National Institute of Population Research and Training (NIPORT) and ICF. Bangladesh health facility survey 2017. Dhaka: NIPORT; 2019.
35. Tocci G, Nati G, Cricelli C, Parretti D, Lapi F, Ferrucci A, Borghi C, Volpe M. Prevalence and control of hypertension in different macro-areas in Italy: analysis of a large database by the general practice. High Blood Press Cardiovasc Prev. 2016;23(4):387–93. https://doi.org/10.1007/s40292-016-0173-0.
36. Kiselev AR, Posnenkova OM, Belova OA, Romanchuk SV, Popova YV, Prokhorov MD, Gridnev VI. Impact of clinical factors on the achievement of target blood pressure in hypertensive patients from Ivanovo region of Russia: data of 2015. High Blood Press Cardiovasc Prev. 2017;24(4):425–35. https://doi.org/10.1007/s40292-017-0227-y.
37. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Himmelfarb CD, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD, Wright JT Jr. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension. 2018;71(6):1269–324. https://doi.org/10.1161/HYP.0000000000000066.
38. Pickering TG, James GD, Boddie C, Harshfield GA, Blank S, Laragh JH. How common is white coat hypertension? JAMA. 1988;259:225–8.
39. Fonseca-Reyes S, Forsyth-MacQuarrie AM, de Alba-García JEG. Simultaneous blood pressure measurement in both arms in hypertensive and nonhypertensive adult patients. Blood Press Monit. 2012;17:149–54. https://doi.org/10.1097/MBP.0b013e32835681e2.