Journal of Biosocial Science (2021), 53: 2, 157–166
doi:10.1017/S0021932020000085

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Clustering of hypertension, diabetes and overweight/obesity according to socioeconomic status among Bangladeshi adults

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(Received 30 September 2019; revised 07 January 2020; accepted 08 January 2020; first published online 09 March 2020)

Abstract

The prevalences of hypertension, diabetes and overweight/obesity are increasing in most developing countries, including Bangladesh. Although earlier studies have investigated the factors associated with these three conditions, little is known about whether socioeconomic status is associated with their co-existence. This cross-sectional study analysed data from the 2011 Bangladesh Demographic and Health Survey. An individual was considered hypertensive, diabetic and overweight/obese if their systolic/diastolic blood pressure, fasting plasma glucose concentration, and body mass index were ≥130/80 mmHg, ≥7 mmol/l and ≥23 kg/m^2, respectively. Furthermore, individuals who reported taking anti-hypertensive and anti-diabetic drugs were also considered as hypertensive and diabetic, respectively. Two socioeconomic variables were investigated: education level and household wealth quintile. Descriptive analyses and multilevel logistic regression were conducted. Among the 7932 respondents (50.5% female) aged ≥35 years, the prevalences of hypertension, diabetes, overweight/obesity, any one condition and the co-existence of the three conditions were 48.0%, 11.0%, 25.3%, 60.9% and 3.6%, respectively. In adjusted analysis, individuals with secondary (adjusted odds ratio [AOR]: 1.8, 95% confidence interval [CI]: 1.2–2.8) and college or above (AOR: 3.6; 95% CI: 2.2–5.7) education levels had higher odds of the co-existence of all three conditions compared with those with no formal education. Similarly, compared with the poorest wealth quintile, the richer (AOR: 4.6; 95% CI: 2.2–9.4) and richest (AOR: 11.8; 95% CI: 5.8–24.1) wealth quintiles had higher odds of co-existence of these three conditions. Education and wealth quintile also showed significant relationships with each of the three conditions separately. In conclusion, in Bangladesh, hypertension, diabetes and overweight/obesity are associated with indicators of higher socioeconomic status. These findings highlight the importance of developing healthy lifestyle interventions (e.g. physical exercise and dietary modification) targeting individuals of higher socioeconomic status to minimize the burden of these non-communicable diseases.

Keywords: Hypertension; Diabetes; Overweight/Obesity

Introduction

Hypertension, diabetes and overweight/obesity are leading causes of death and disability worldwide (Dhillon *et al.*, 2013; Forouzanfar *et al.*, 2015; Riaz *et al.*, 2018). Although the prevalence of these three conditions is static in developed countries, it is increasing in most developing countries. Due to ongoing epidemiologic and demographic transitions, developing countries are also experiencing a double disease burden, with a simultaneous high prevalence of communicable and

non-communicable diseases (Bygbjerg, 2012; Abdullah, 2015; Kulkarni *et al.*, 2017). Moreover, very few nationally representative studies have estimated the prevalence or determinants of these conditions in developing countries (NIPORT *et al.*, 2013).

With an estimated population of 160 million within an area of 147,570 km^2, Bangladesh is a developing country showing a high prevalence of both types of disease with limited recent data to elucidate the disease trends and relavant risk factors (Bureau of Statistics, 2017; Central Intelligence Agency, 2017). The Bangladesh Demographic and Health Survey (BDHS) 2011, the most recent nationally representative survey to investigate these conditions in this country, found that the prevalences of diabetes, hypertension and overweight/obesity were 48%, 11% and 24%, respectively (NIPORT *et al.*, 2013; Chowdhury *et al.*, 2015; Biswas *et al.*, 2017a; Kibria *et al.*, 2018a).

Earlier studies have suggested that these conditions are clustered, or have shared associated factors, in most developing countries, including Bangladesh (NIPORT *et al.*, 2013; Chowdhury *et al.*, 2018; Kibria *et al.*, 2018b). For instance, the prevalence rates of each of these conditions are higher among people of higher socioeconomic status (i.e. people with higher education and wealth status) (NIPORT *et al.*, 2013). Following more-sedentary lifestyles with fewer manually intensive tasks, as well as consuming more-calorigenic foods, could be responsible for this increase in chronic disease prevalence (Biswas *et al.*, 2017a). However, few studies have investigated how socioeconomic factors impact these three conditions jointly. Investigating the association of these conditions with socioeconomic status may help to identify population groups that are at an elevated risk for these conditions, who would benefit from prevention and control strategies.

This study attempted to address this knowledge gap and identify associations between socioeconomic factors and the three chronic conditions in Bangladeshi adults. The study hypothesized that people of higher socioeconomic status would be more positively associated with hypertension, diabetes, overweight/obesity, the presence of any one of these three conditions, and the co-existence of the three conditions, compared with individuals of lower socioeconomic status.

Methods

Data source

A secondary analysis was conducted using data from the 2011 BDHS. The BDHS is a cross-sectional survey implemented by Mitra and Associates, with ICF International providing technical assistance. The institutional review boards of ICF International and the Bangladesh Medical Research Council approved the survey protocol. This survey was conducted from July 2011 to January 2012. It aimed to estimate the prevalence of hypertension and diabetes among Bangladeshi adults aged 35 years or older. In addition, the body mass index (BMI) of participants was measured (NIPORT *et al.*, 2013).

The survey covered both the rural and urban regions of the seven administrative divisions of the country. It used a two-stage cluster sampling design: 600 primary sampling units (PSUs) were selected (207 from urban regions and 393 from rural regions), then 17,964 households were selected from the PSUs. Using the simple randomization technique, one-third of these households were selected. Men and women aged at least 35 years residing in these households were eligible for inclusion in the survey to estimate hypertension, diabetes and nutritional status. Verbal informed consent was obtained from all participants. The present study included a total of 7932 respondents. The findings, survey design, sample size calculation and data collection methods are available elsewhere (NIPORT *et al.*, 2013).

Outcome measures

Blood pressure was measured in the BDHS by using a LIFE SOURCE® UA-767 Plus monitor. Three measurements were taken 10 minutes apart. Within those 10-minute intervals, other data were recorded. Small, medium and large cuff sizes were used. The means of the second and third pressure measurements were used to report the final blood pressure level (NIPORT *et al.*, 2013).

https://doi.org/10.1017/S0021932020000085 Published online by Cambridge University Press

In the present study, a respondent was classified as hypertensive using the 2017 American College of Cardiology/American Heart Association (ACC/AHA) recommended cut-offs (Whelton *et al.*, 2018). A person was classified as hypertensive if s/he fulfilled one of the three following criteria: systolic blood pressure (SBP) ≥130 mmHg, diastolic blood pressure (DBP) ≥80 mmHg or the participant reported that h/she was taking an anti-hypertensive drug during the survey period.

Blood sugar level was measured using a HemoCue 201+ blood analyser. Participants with a fasting plasma glucose of ≥7.0 mmol/l, or those who were taking anti-diabetic drugs to control their blood sugar levels, were considered to be diabetic (NIPORT *et al.*, 2013).

BMI was calculated by dividing weight (kg) by height squared (m^2). Participants' weight was measured twice using digital weighing scales, while their height was measured three times with a standard clinical height scale, and the averages of these measurements were used (Biswas *et al.*, 2017a). The Asian-specific recommended cut-off BMI of ≥23 kg/m^2 was used to classify a person as overweight/obese (Ni Mhurchu *et al.*, 2004).

Socieconomic and other variables

The effects of two socioeconomic factors were investigated: education level and household wealth. Education level was categorized as: no formal education, primary (1–5 school years), secondary (6–10 school years) and college or above (≥11 school years). The BDHS 2011 participants also reported their household belongings, including basic household construction materials, and the survey employed principal component analysis to obtain a wealth index score from those compoents that was then stratified into quintiles: poorest, poorer, middle, richer and richest (NIPORT *et al.*, 2013).

Other potential confounding factors were selected based on the published literature and data structure. Age was categorized as 35–44, 45–54, 55–64 and ≥65 years. Sex (male or female) was also reported. Place of residence was classified as rural or urban, with those living in a municipal or city corporation during the survey period considered as urban residents. Bangladesh had seven administrative divisions during the period of the survey, and the administrative division of residence for each participant was also recorded (NIPORT *et al.*, 2013).

Statistical analysis

The overall sociodemographic characteristics of the participants were reported, as well as these characteristics by the presence of diabetes, hypertension and overweight/obesity, any one of these three conditions and the co-existence of these three conditions. Mean and standard errors (SE) were used to report continuous variables, and categorical variables were reported with numbers and percentages. Then, the prevalences of the three conditions were estimated separately as well as for any one condition and the co-existence of these conditions, and each prevalence was stratified by socioeconomic status. Lastly, multilevel logistic regression analysis was conducted to report the odds ratios (ORs) and 95% confidence interval (CI) for the associations between the socioeconomic factors and disease statuses; both unadjusted and adjusted ORs (AOR) were calculated. Covariates with a significance level of <0.2 from the unadjusted logistic regression analysis were incorporated into the multivariable models (Maldonado & Greenland, 1993).

To report all the estimates, the provided sample weights were used and the hierarchical structure (i.e. multistage cluster-sampling design) of the dataset was accounted (NIPORT *et al.*, 2013). Multicollinearity was assessed using the variance inflation factor (VIF). All analysis were conducted using Stata 14.0 (Stata Corporation, 2015). To adjust for the cluster sampling design of survey, the *svy* command in Stata was used.

Results

Table 1 shows the distribution of the study sample by hypertension, diabetes, overweight/obesity, only one condition, and the co-existence of all three conditions for the 7932 study

https://doi.org/10.1017/S0021932020000085 Published online by Cambridge University Press

Table 1. Background characteristics of the study participants by hypertension, diabetes and overweight/obesity and co-existence, 2011 BDHS

Variable		Hypertension ($N = 3767$)	Diabetes ($N = 826$)	Overweight/obesity ($N = 1921$)	Any 1 condition ($N = 4639$)	All 3 conditions ($N = 265$)	Overall ($N = 7932$)
SBP mmHg, Mean (SE)		132.9 (0.4)	122.7 (1.1)	125.1 (0.8)	128.4 (0.5)	133.6 (1.9)	119.4 (0.1)
DBP, mmHg, Mean (SE)		86.9 (0.2)	79.8 (0.6)	84.1 (0.6)	84.4 (0.3)	87.4 (1.5)	78.5 (0.3)
FPG, mmol/L, Mean (SE)		8.9 (0.3)	8.5 (0.1)	9.4 (0.4)	9.0 (0.3)	8.9 (0.3)	5.9 (0.1)
BMI, kg/m^2, Mean (SE)		21.9 (0.1)	22.7 (0.3)	25.9 (0.1)	22.3 (0.1)	26.7 (0.2)	20.9 (0.1)
Age (in years)	35–44	1211 (32.1)	244 (29.5)	872 (45.4)	1629 (35.1)	78 (29.5)	2882 (36.3)
	45–54	1079 (28.6)	234 (28.3)	575 (29.9)	1309 (28.2)	86 (32.6)	2286 (28.8)
	55–64	683 (18.1)	189 (22.9)	273 (14.2)	812 (17.5)	63 (23.6)	1355 (17.1)
	≥65	795 (21.1)	159 (19.2)	200 (10.4)	889 (19.2)	38 (14.4)	1409 (17.8)
Sex	Male	1606 (42.6)	397 (48.1)	774 (40.3)	2050 (44.2)	97 (36.5)	3925 (49.5)
	Female	2161 (57.4)	429 (51.9)	1147 (59.7)	2589 (55.8)	168 (63.5)	4007 (50.5)
Hypertension	No	—	324 (39.3)	633 (33.0)	871 (18.8)	—	4072 (52.0)
	Yes	—	502 (60.7)	1286 (67.0)	3767 (81.2)	—	3767 (48.0)
Diabetes	No	3127 (86.2)	—	1491 (80.9)	3647 (81.5)	—	6702 (89.0)
	Yes	502 (13.8)	—	351 (19.1)	826 (18.5)	—	826 (11.0)
Overweight/obesity	No	2326 (64.4)	448 (56.1)	—	2554 (57.1)	—	5671 (74.7)
	Yes	1286 (35.6)	351 (43.9)	—	1921 (42.9)	—	1921 (25.3)
All 3 conditions	No	3221 (92.4)	534 (66.9)	1577 (85.6)	4056 (93.9)	—	7033 (96.4)
	Yes	265 (7.6)	265 (33.1)	265 (14.4)	265 (6.1)	—	265 (3.6)
Education	No education	2378 (63.1)	451 (54.6)	1092 (56.9)	2873 (61.9)	131 (49.6)	4990 (62.9)
	Primary	623 (16.5)	155 (18.7)	295 (15.3)	771 (16.6)	45 (17.0)	1460 (18.4)
	Secondary	463 (12.3)	116 (14.1)	278 (14.5)	602 (13.0)	39 (14.9)	982 (12.4)
	≥College	303 (8.0)	104 (12.6)	257 (13.4)	394 (8.5)	49 (18.5)	500 (6.3)

(*Continued*)

Table 1. (*Continued*)

Variable		Hypertension ($N = 3767$)	Diabetes ($N = 826$)	Overweight/obesity ($N = 1921$)	Any 1 condition ($N = 4639$)	All 3 conditions ($N = 265$)	Overall ($N = 7932$)
Wealth quintile	Poorest	582 (15.5)	107 (13.0)	127 (6.6)	689 (14.8)	11 (4.0)	1529 (19.3)
	Poorer	621 (16.5)	104 (12.6)	176 (9.2)	744 (16.0)	11 (4.3)	1513 (19.1)
	Middle	703 (18.7)	114 (13.8)	278 (14.5)	863 (18.6)	22 (8.2)	1567 (19.8)
	Richer	834 (22.1)	178 (21.5)	494 (25.7)	1038 (22.4)	63 (23.9)	1631 (20.6)
	Richest	1027 (27.3)	323 (39.2)	846 (44.1)	1306 (28.2)	158 (59.6)	1693 (21.3)
Place of residence	Urban	1061 (28.2)	283 (34.2)	758 (39.5)	1329 (28.7)	123 (46.3)	1892 (23.8)
	Rural	2706 (71.8)	543 (65.8)	1163 (60.5)	3310 (71.3)	142 (53.7)	6040 (76.2)
Division of residence	Barisal	208 (5.5)	53 (6.5)	84 (4.4)	263 (5.7)	11 (4.2)	469 (5.9)
	Chittagong	570 (15.1)	178 (21.5)	354 (18.5)	750 (16.2)	62 (23.5)	1339 (16.9)
	Dhaka	1285 (34.1)	277 (33.5)	648 (33.7)	1543 (33.3)	96 (36.4)	2563 (32.3)
	Khulna	566 (15.0)	72 (8.8)	287 (14.9)	671 (14.5)	29 (10.8)	1024 (12.9)
	Rajshahi	486 (12.9)	116 (14.0)	280 (14.6)	627 (13.5)	39 (14.8)	1155 (14.6)
	Rangpur	474 (12.6)	78 (9.5)	168 (8.7)	556 (12.0)	15 (5.6)	926 (11.7)
	Sylhet	178 (4.7)	52 (6.2)	100 (5.2)	230 (4.9)	12 (4.7)	456 (5.8)

DBP: Diastolic blood pressure, FPG: fasting plasma glucose, BMI: body mass index, SE: Standard Error.
Numbers and column percentage unless otherwise specified. Numbers may not add up to total because of missing values and/or rounding.

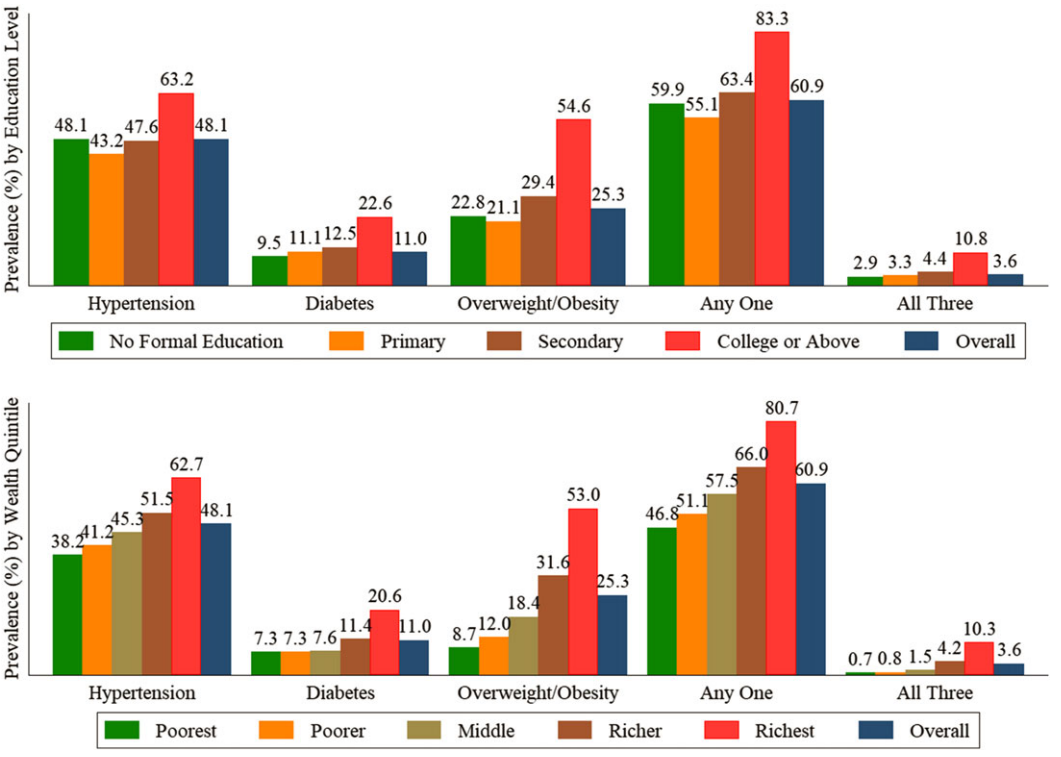

Figure 1. Prevalence (%) of hypertension, diabetes, overweight/obesity, and their co-existence by education level and household wealth quintile.

participants. The overall prevalences of hypertension, diabetes and overweight/obesity, any one of these three conditions and the co-existence of all three conditions were 48.0%, 11.0%, 25.3%, 60.9% and 3.6%, respectively. The mean SBP of the participants was 119.4 (SE: 0.1) mmHg, and the mean DBP was 78.5 (SE: 0.3) mmHg. About 50.5% of the participants were female; the proportion of female participants with all three conditions was higher than males. More than three-quarters of the participants (76.2%) were from rural areas and about one-third (32.3%) were living in Dhaka divisions. The proportions of people with higher education level and wealth quintiles were higher among people with hypertension, diabetes, overweight/obesity, any one condition and co-existing conditions than the overall sample.

Figure 1 summarizes the prevalences of the three conditions by education levels and wealth quintiles, as well as the overall prevalences., The prevalence of each condition was higher among people with college education compared with those with no formal education. For instance, the prevalences of the co-existence of the three conditions were 2.9%, 3.3%, 4.4% and 10.8% among people with no formal education, primary, secondary and college education levels, respectively. A similar increment in prevalence was observed for wealth status.

Table 2 shows the multiple regession analysis of the association of the prevalences of hypertension, diabetes, overweight/obesity, either of these conditions, and their co-existence with socioeconomic factors. Both education level and household wealth quintile had significant relationships with hypertension, diabetes, overweight/obesity, either of these conditions, and their co-existence. Compared with people with no formal education, the odds of hypertension (AOR: 1.7; 95% CI: 1.3–2.1) and diabetes (AOR: 1.7; 95% CI:1.3–2.3) were about 2 times higher among people with

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Table 2. Adjusted Odds Ratios (95% Confidence Intervals) of association of socioeconomic factors with hypertension, diabetes, overweight/obesity, and the co-existence of all three conditions, 2011 BDHS

Variable	Hypertension[a]	Diabetes[b]	Overweight/ obesity[c]	Any one condition[d]	All three conditions[e]
Education level					
No education (Ref.)					
Primary	1.0 (0.9, 1.2)	1.2 (0.9, 1.4)	1.3** (1.1, 1.5)	1.0 (0.9, 1.2)	1.4 (0.9, 2.0)
Secondary	1.2 (1.0, 1.4)	1.2 (0.9, 1.6)	1.8*** (1.4, 2.2)	1.4*** (1.2, 1.7)	1.8** (1.2, 2.8)
College or above	1.7*** (1.3, 2.1)	1.7*** (1.3, 2.3)	3.4*** (2.6, 4.3)	2.9*** (2.2, 3.9)	3.6*** (2.2, 5.7)
Wealth quintile					
Poorest (Ref.)					
Poorer	1.1 (0.9, 1.3)	0.9 (0.7, 1.2)	1.3* (1.0, 1.7)	1.1 (1.0, 1.3)	1.2 (0.5, 2.9)
Middle	1.3** (1.1, 1.6)	0.9 (0.7, 1.2)	2.1*** (1.7, 2.7)	1.5*** (1.3, 1.7)	1.8 (0.8, 3.9)
Richer	1.4*** (1.2, 1.6)	1.2 (0.9, 1.5)	4.0*** (3.1, 5.0)	1.9*** (1.6, 2.3)	4.6*** (2.2, 9.4)
Richest	1.8*** (1.4, 2.2)	2.2*** (1.7, 3.0)	8.3*** (6.6, 10.6)	4.0*** (3.2, 4.8)	11.8*** (5.8, 24.1)

See Methods section for definitions of hypertension, diabetes and overweight/obesity.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
[a]Adjusted for age, sex, diabetes, overweight/obesity, place of residence and division of residence.
[b]Adjusted for age, sex, overweight/obesity, place of residence and division of residence.
[c]Adjusted for age, sex, place of residence and division of residence.
[d]Adjusted for age, sex, place of residence and division of residence.
[e]Adjusted for age, sex, place of residence and division of residence.

college or above education level. Similar relationships were observed for wealth status. Overweight/obesity had dose–response relationships with education level and wealth quintile (i.e. the higher the education level and wealth quintile, the higher the odds of overweight/obesity). Regarding the co-existence of all three conditions, secondary education level (AOR: 1.8, 95% CI: 1.2–2.8), college or above education level (AOR: 3.6; 95% CI: 2.2–5.7), richer wealth quintile (AOR: 4.6; 95% CI: 2.2–9.4) and richest wealth quintile (AOR: 11.8; 95% CI: 5.8–24.1) had significant positive associations.

Discussion

This study found that Bangladeshi adults with higher education levels and in higher household wealth quintiles had significantly higher prevalences and odds of diabetes, hypertension, overweight/obesity, the presence of any of these three conditions and the co-existence of the three conditions than those of lower education level and in lower household wealth quintiles. This finding supports the study hypothesis that hypertension, diabetes, overweight/obesity, and their co-existance, are associated with the higher socioeconomic status. Several earlier studies conducted in Bangladesh have had similar findings, which adds credence to these conclusions (Biswas *et al.*, 2017a; Chowdhury *et al.*, 2018; Chowdhury *et al.*, 2015, 2016; Harshfield *et al.*, 2015; Kibria *et al.*, 2018b).

Earlier studies have revealed that all three studied conditions interact with each other and share many common associated factors (Harshfield *et al.*, 2015; Chowdhury *et al.*, 2018; Kibria *et al.*, 2018b). These conditions also have multiple genetic and lifestyle-related aetiological factors (Celermajer *et al.*, 1994; August & Oparil, 1999; Barroso *et al.*, 2012; Bhurosy & Jeewon, 2014). As mentioned earlier, people in the developing world of higher socioeconomic status usually follow more-sedentary lifestyles or engage in fewer labour-intensive tasks, which may

https://doi.org/10.1017/S0021932020000085 Published online by Cambridge University Press

contribute to the clustering of these chronic conditions among wealthier individuals (Bhurosy & Jeewon, 2014; Nepal *et al.*, 2018). As a large proportion of people of higher socioeconomic status could have either hypertension, diabetes, overweight/obesity or a combination of these diseases, this study signifies the importance of adopting more public health awareness programmes for this group of people. Although the study did not investigate disease awareness or lifestyle characteristics of the study participants, healthy lifestyle (e.g. increasing physical exercise) and dietary interventions (e.g. calorie consumption reduction or salt restriction) may be beneficial for these individuals (Bhurosy & Jeewon, 2014; Whelton *et al.*, 2018). These findings contradict studies conducted in developed countries, where people of higher socioeconomic status usually have lower prevalences of these conditions (Dorans *et al.*, 2018).

The findings of the present study indicate that a common prevention strategy, especially targeting people of higher socioeconomic status, may be beneficial to prevent or reduce the burden of these conditions in Bangladesh (Biswas *et al.*, 2017a; Kibria *et al.*, 2018b). Moreover, implementing national awareness and control programmes to screen people with elevated risk of these conditions could be helpful for countries like Bangladesh. Earlier reports have revealed that the monitoring and supervision of previously implemented programmes to screen and manage the at-risk population were inadequate (Biswas *et al.*, 2016, 2017b). In addition, regular monitoring of the temporal trends in these conditions is required to adopt prevention and control strategies successfully.

In addition to socioeconomic status, several other factors could be associated with hypertension, diabetes and overweight/obesity prevalence, such as age, sex and place of residence (Chowdhury *et al.*, 2015, 2016; Biswas *et al.*, 2017a). Addressing these associated factors or determinants is also essential to reduce the burden of these conditions, as well as the complications resulting from them.

This study has several notable strengths. First, it covered rural and urban regions in all administrative divisions of Bangladesh, which make the findings nationally representative and generalizable to residents all over the country. Secondly, the survey used standardized and validated methods to record blood pressure and other measures, which increases the authenticity of these findings. The sample size was large and the response rate was high (NIPORT *et al.*, 2013). The limitations of the study also warrant discussion. As the data were cross-sectional, and due to the lack of temporality, the findings may not be causal. Although the survey was nationally representative, the data were collected nearly 8 years ago (NIPORT *et al.*, 2013), and the findings may not reflect the presnt situation in the country. The results do not reflect clinical diagnosis of hypertension and diabetes as the measurements were taken only 1 day in this survey. Due to the lack of adequate data, several other confounders, such as dietary habits, were not adjusted for. The efficacy or skill level of the survey staff recording the measures may impact the accuracy of the findings (Harshfield *et al.*, 2015). The survey also only included individuals aged 35 years and over. However, these limitations illustrate the need for more-recent and better quality of data on these topics targeting the Bangladeshi population.

In conclusion, this study shows an association of socioeconomic status with the three chronic conditions hypertension, diabetes and overweight/obesity in the Bangladesh population. Clustering of these conditions among people of higher socioeconomic status highlights the importance of implementing national awareness and control programmes targeting the wealthiest and most highly educated individuals. Finally, given the lack of recent nationally representative data on these critical health conditions, this study recommends conducting high-quality surveys to obtain the most recent trends and identify intervenable risk factors.

Acknowledgment. The abstract of this article was presented at the 2019 American Public Health Association (APHA) Annual Meeting and Expo.

Funding. Ms. Christina Stennet was funded by NIH/NIA (T32 AG000262).

Conflicts of Interest. The authors declare that they have no conflicts of interest.

Ethical Approval. The Institutional Review Boards of the ICF International and Bangladesh Medical Research Council provided ethical approval. They approved the 2011 BDHS protocol, questionnaires, and verbal consent forms. Respondents provided informed verbal informed consent to participate in the 2011 BDHS. The electronic approval to use the dataset was obtained in September 2019.

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Cite this article: Kibria GMA, Hashan MR, Hossain MM, Zaman SB, and Stennett CA (2021). Clustering of hypertension, diabetes and overweight/obesity according to socioeconomic status among Bangladeshi adults. *Journal of Biosocial Science* **53**, 157–166. https://doi.org/10.1017/S0021932020000085