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Age and sex differences in factors associated with hypertension among an urban poor population in Bangladesh

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ABSTRACT

This study explores the differences in factors associated with hypertension between younger and older subjects in an urban slum community in Bangladesh. We analyzed the data of 1,008 men and 1,001 women obtained from a cross-sectional survey conducted between October 2015 and April 2016. Multivariable logistic regression models were stratified by age (18 to 44 and 45 to 64 years) in men and women separately. The multivariable model included age (continuous) and the following categorical variables simultaneously: education duration, marital status, tobacco smoking, smokeless tobacco use, total physical activity, body mass index (BMI), waist circumference, and the blood levels of glycated hemoglobin (HbA1c), triglycerides, high- and low-density lipoprotein (HDL and LDL) cholesterol. Hypertension was defined as the presence of either blood pressure ≥140/90 mmHg or the use of antihypertensive medication. The prevalence of hypertension was 13.0% (younger men), 14.6% (younger women), 35.6% (older men), and 38.7% (older women). In younger men, higher waist circumference and increased LDL cholesterol levels were significantly associated with hypertension. In older men, physical activity was the only significant factor that was inversely associated with hypertension. In younger women, higher BMI, increased HbA1c, triglycerides, and LDL cholesterol levels were associated with hypertension. In older women, a higher HbA1c was the only factor significantly associated with hypertension. These findings suggest that public health interventions to prevent hypertension may require different approaches according to sex and age groups within the poor urban population in Bangladesh.

Keywords: hypertension, risk factors, age groups, obesity, urban poor

Abbreviations:
HbA1c: glycated hemoglobin
BMI: body mass index
HDL: high-density lipoprotein

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LDL: low-density lipoprotein
NCD: non-communicable disease
STEPS: STEPwise approach to Surveillance
WHO: World Health Organization
SBP: systolic blood pressure
DBP: diastolic blood pressure
MET: metabolic equivalent
OR: odds ratio
CI: confidence interval

INTRODUCTION

The burden of hypertension is increasing in low- and middle-income countries, including Bangladesh, a lower-middle-income country in South Asia.[1,2] Previous nationwide epidemiological surveys in Bangladesh reported that the prevalence of hypertension ranged from 17.9% to 21.0% (18.5 to 20.7% in men, 17.3 to 25.0% in women),[3-5] and that low levels of physical activity, raised blood glucose, increased age, body mass index (BMI), and waist circumference were independently associated with hypertension.[6-9] Other community-based cross-sectional studies also showed that increased age and BMI were associated with hypertension in rural areas.[10] The same studies show that, in urban areas, increased age, a larger waist circumference, tobacco smoking, and extra salt intake were associated with hypertension.[11]

The urban poor population in Bangladesh is expanding rapidly.[12] This population is assumed to be at high risk of noncommunicable diseases (NCDs), due to the urbanized lifestyle in adulthood and possible childhood undernutrition.[13,14] Since the data and information on the prevalence of NCD risk factors among the urban poor population are still scarce, we conducted a cross-sectional epidemiological study on NCD risk factors[15] and a qualitative study on perception and attitude towards these risk factors[16] among adult men and women in a slum community in Dhaka, Bangladesh.[17] Our epidemiological study showed that the prevalence of hypertension was 18.6% in men and 20.7% in women, comparable to the previous nationwide surveys. The study was predominantly conducted using the standard procedures of the STEPwise approach to Surveillance (STEPS) of the World Health Organization (WHO),[18] as well as measurements of glycated hemoglobin (HbA1c) and blood lipid profile, which were not included in the previous studies.

It is widely known that the prevalence of hypertension increases with age in both men and women. The prevalence of hypertension in men is known to be higher than that in women up to their 40s; however, differences between the sexes decrease and even reverse after their 50s or the age of menopause.[19,20] It is widely known that the prevalence of other cardiovascular risk factors, including abdominal obesity, raised blood glucose, and dyslipidemia, increases with age, particularly in women over 50 years.[21,22]

Several studies, including those conducted in South Asian countries, have reported that risk factors such as abdominal obesity and dyslipidemia were more prominently associated with hypertension in the younger than the older age groups.[23-25] These findings suggest that the influence of these factors may vary among the different age groups. However, how the association of various potential risk factors for hypertension varies by age has not yet been studied in Bangladesh.

This study aimed to explore the differences in factors associated with hypertension between younger and older groups of men and women in an urban poor community in Bangladesh.

METHODS

Data source

We used data obtained from a cross-sectional epidemiological study on NCD risk factors, conducted from October 2015 to April 2016,[15] which targeted men and women aged 18 to 64 years in an urban slum community in Dhaka, Bangladesh. Details about the epidemiological study have been described elsewhere.[15] The study sample was selected in two stages. The first stage included a census-like baseline survey that targeted all households in the study's area. In the second stage, participants were selected using a stratified random sampling method. Four strata were determined according to sex and housing level (male or female, lower-middle-wealth or low-wealth households). We randomly selected 1,000 households for men and women in each housing level group at the beginning of the study. A total of 4,000 households were selected. We recruited one adult aged 18 to 64 years from each selected household using the Kish Grid. Out of 4,000 households, 3,560 were visited until the number of participants with complete data reached 2,000. Among the total visited households, 576 had no eligible persons while 435 declined to participate or were unavailable. Finally, out of 2,551 subjects who completed home interviews, 2,009 underwent physical and biochemical measurements.[15-17] In addition to the measurements included in the standard WHO procedures,[18] we added measurements of HbA1c,[26] triglycerides, total, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) cholesterol levels, which were not included in previous population-based studies in Bangladesh. Excluding the subjects with missing values in the variables used for the analyses, data from 1,008 men and 1,001 women were subjected to the following statistical analyses.

Variables

In this study, hypertension is defined as systolic blood pressure (SBP) ≥140 mmHg or diastolic blood pressure (DBP) ≥90 mmHg or by taking any antihypertensive medication.[27] BMI, calculated as body weight in kilograms divided by height in meters squared, was categorized into four groups: <18.5, 18.5–24.9, 25–27.4, and ≥27.5 kg/m^2. However, the groups of <18.5 and 18.5–24.9 were merged into one category (BMI <25 kg/m^2) due to the insignificant number of individuals in the group of <18.5.[28] Waist circumference was categorized into three groups (<80, 80–89, ≥90 cm). HbA1c was categorized into three groups (<5.7, 5.7–6.4, and ≥6.5%).[29] Triglycerides were categorized into three groups (<150, 150–199, and ≥200 mg/dL).[30] HDL cholesterol was categorized into two groups (<40 and ≥40 mg/dL for men; <50 and ≥50 mg/dL for women).[30] LDL cholesterol was categorized into three groups (<100, 100–129, ≥130 mg/dL).[30] The total amount of physical activity was categorized into three groups ranging from low to high (<600, 600–2999, and ≥3000 metabolic equivalent minutes (MET-minutes) per week) in men of both age groups.[31] In women, we collapsed the higher two groups of physical activity because of the small sample size of women with ≥3000 MET-minutes per week. Education duration was categorized into five groups (none, 1–4, 5–7, 8–9, and ≥10 years) in men from both age groups. Regarding women's education duration, the higher three groups (5–7, 8–9, ≥10) collapsed into a single group (≥5 years) as the number of women in these categories was small.

Statistical Analysis

All analysis was stratified by two age groups (18 to 44 and 45 to 64 years) and then separated into men and women. We chose 45 years of age as the cutoff for the stratification according to previous studies on the median age of menopause of women in Bangladesh[32] and other Asian countries.[33] The associations of the following factors with hypertension were assessed using multivariable logistic regression and expressed as odds ratios (ORs) and 95% confidence intervals

(95% CIs): age, years of education, marital status, tobacco smoking, smokeless tobacco use, physical activity, BMI, and waist circumference, as well as blood levels of HbA1c, triglycerides, LDL, and HDL cholesterols. These variables were simultaneously entered into multivariable models. Age was included as a continuous variable and the other variables were entered as categorical variables. Marital status was excluded from the multivariable model in older men, as only two men were single, and only one of them had hypertension. Tobacco smoking was excluded from the multivariable model in women, as no women reported tobacco smoking habits. The lowest category was used as the reference for all variables. The statistical significance of the interaction of age groups with each categorical variable was tested in a multivariable model that simultaneously entered these terms using the likelihood ratio test.

Sensitivity analysis was performed after excluding 137 individuals (42 men and 95 women) who reported taking medication for hypertension. In all of the analyses, P-values of <0.05 indicated statistical significance.

All data analysis was performed using Stata for Windows, version Stata/IC 12.1, Stata Corp, College Station, TX, USA).

Ethics Approval

The survey was approved by the Bioethics Review Committee of Nagoya University School of Medicine, Japan (approval no. 2014-0021) and the Institutional Review Boards of Bangabandhu Sheikh Mujib Medical University and National Heart Foundation Hospital and Research Institute, Bangladesh.

RESULTS

The median education duration was six and two years and four and zero years in younger and older men and women respectively. The overall mean BMI for men was 21.7 kg/m^2 and 21.9 kg/m^2, and 24.2 kg/m^2 and 24.1 kg/m^2 for women. The mean waist circumferences for each group were 78.9 cm, 82.9 cm and 81.1 cm, 84.8 cm for younger and older men and women respectively. The mean HbA1c levels for the groups were 5.8%, 6.2% and 5.8%, 6.6% for younger and older men and women respectively. The mean LDL cholesterol levels in the groups were 96.0, 99.8 mg/dL and 97.0, 106.5 mg/dL for younger and older men and women respectively.

The prevalence of hypertension in younger and older men and women were 13%, 35.6% and 14.6%, 38.7% respectively. The prevalence of hypertension for men with a BMI ≥27.5 kg/m^2 was 37.7% and 58.8% in the younger and older age group respectively. Similarly, for younger and older women with a BMI ≥27.5 kg/m^2, the prevalence was 29.4% and 48.9% (Tables 1 and 2) respectively. The age-adjusted ORs (95% CIs) of BMI ≥27.5 kg/m^2 compared to the category with <25 kg/m^2 were 5.33 (2.82–10.07) for younger men and 3.58 (1.26–10.15) for older men, whereas it was 3.57 (2.19–5.81) and 2.14 (1.07–4.28) for younger and older women respectively. The associations in men and women were significantly attenuated in the multivariable models: the ORs (95% CIs) were 1.48 (0.63–3.47) and 1.82 (0.48–6.84) for younger and older men and 1.99 (1.00–4.00) and 1.65 (0.65–4.20) for younger and older women respectively. However, the attenuation was caused by the adjustment for waist circumference. The ORs (95% CIs) of the BMI category ≥27.5 kg/m^2 in the multivariable model without waist circumference were 2.89 (1.38–6.05) and 2.24 (0.70–7.10) for younger and older men respectively (data not shown in Tables). They were 3.03 (1.80–5.09) and 1.77 (0.83–3.76) for younger and older women. The prevalence of hypertension in the group with a waist circumference ≥90 cm was 34.1%, 50.7% and 29.4%, 42.9% for younger and older men and women respectively. The multivariable-adjusted

ORs of the waist circumference category ≥90 cm compared to <80 cm were 5.12 (2.19–11.94), 2.29 (0.83–6.34) and 1.88 (0.88–4.03), 1.20 (0.48–3.03) in younger and older men and women respectively. Analysis of the data revealed that neither BMI nor waist circumference was significantly associated with hypertension in older men and women.

An HbA1c ≥6.5% was associated with hypertension in both younger and older women (multivariable-adjusted ORs and 95% CIs: 2.11 [1.20–3.69] and 2.71 [1.31–5.60], respectively). LDL cholesterol ≥130 mg/dL was associated with hypertension in younger men and women (2.20 [1.14–4.26] and 2.49 [1.34–4.61], respectively). Triglycerides ≥200 mg/dL were significantly associated with hypertension only in younger women (multivariable-adjusted OR and 95% CI: 1.82 [1.06–3.11]). Physical activity ≥3,000 MET-minutes per week was inversely associated with hypertension in older but not in younger men (multivariable-adjusted ORs [95% CIs]: 0.39 [0.16–0.89] and 1.36 [0.72–2.56], respectively) (physical activity (MET-minutes per week)-age interaction p = 0.008 in men).

Similar results were observed in the sensitivity analysis, which excluded subjects taking antihypertensive medication (data not shown).

Table 1 Odds ratio and the 95% confidence intervals of hypertension association with various risk factors, Bangladesh in men, 2016

Age groups	18–44 years hypertension (n) / total (N) = 99/761			45–64 years hypertension (n) / total (N) = 88/247		
	n/N (%)	Age-adjusted model	Multivariable model	n/N (%)	Age-adjusted model	Multivariable model
Education, years						
None	11/138 (8.0)	ref	ref	38/117 (32.5)	ref	ref
1–4	12/106 (11.3)	1.86 (0.77–4.48)	1.39 (0.53–3.59)	15/39 (38.5)	1.60 (0.72–3.51)	0.91 (0.37–2.25)
5–7	22/176 (12.5)	2.03 (0.93–4.42)	1.20 (0.51–2.82)	11/36 (30.6)	1.11 (0.48–2.58)	0.79 (0.31–2.01)
8–9	25/157 (15.9)	3.10 (1.43–6.74)	1.54 (0.65–3.66)	10/31 (32.3)	1.19 (0.49–2.84)	0.70 (0.26–1.86)
≥10	29/184 (15.8)	4.13 (1.88–9.06)	1.66 (0.67–4.11)	14/24 (58.3)	4.20 (1.62–10.87)	2.15 (0.72–6.42)
Marital status						
Single	16/155 (10.3)	ref	ref	1/2 (50.0)	-	-
Married	83/606 (13.7)	0.52 (0.25–1.08)	1.98 (0.88–4.44)	87/245 (35.5)	-	-
Tobacco smoking						
Non-smoker	61/383 (15.9)	ref	ref	52/123 (42.3)	ref	ref
Current smoker	38/378 (10.1)	0.49 (0.31–0.76)	0.83 (0.50–1.38)	36/124 (29.0)	0.57 (0.33–0.98)	0.76 (0.41–1.39)
Smokeless tobacco						
Non-user	93/680 (13.7)	ref	ref	65/176 (36.9)	ref	ref
Current user	6/81 (7.4)	0.34 (0.14–0.83)	0.46 (0.17–1.19)	23/71 (32.4)	0.82 (0.45–1.49)	0.85 (0.43–1.70)
Physical activity, MET-minutes per week						
<600	28/190 (14.7)	ref	ref	33/61 (54.1)	ref	ref
600–2999	39/246 (15.9)	1.19 (0.69–2.03)	1.29 (0.71–2.32)	33/87 (37.9)	0.61 (0.30–1.22)	0.52 (0.24–1.11)
≥3000	32/325 (10.2)	0.66 (0.38–1.15)	1.36 (0.72–2.56)	22/99 (22.2)	0.30 (0.14–0.63)	0.27 (0.12–0.59)
HbA1c, %						
<5.7	38/417 (9.1)	ref	ref	25/88 (28.4)	ref	ref
5.7–6.4	40/251 (15.9)	1.66 (1.02–2.69)	1.19 (0.69–2.03)	36/100 (36.0)	1.23 (0.65–2.32)	0.93 (0.45–1.92)
≥6.5	21/93 (22.6)	2.23 (1.21–4.10)	1.85 (0.91–3.75)	27/59 (45.8)	1.90 (0.93–3.85)	1.34 (0.58–3.05)
Triglycerides, mg/dL						
<150	29/393 (7.4)	ref	ref	35/124 (28.2)	ref	ref
150–199	17/131 (13.0)	1.57 (0.82–3.00)	0.74 (0.35–1.53)	20/38 (52.6)	3.13 (1.44–6.78)	2.56 (1.01–6.42)
≥200	53/237 (22.4)	3.21 (1.96–5.25)	1.47 (0.81–2.69)	33/85 (38.8)	1.69 (0.92–3.09)	1.30 (0.60–2.82)

HDL cholesterol, mg/dL						
<40	79/562 (14.1)	ref	ref	62/177 (35.0)	ref	ref
≥40	20/199 (10.1)	1.46 (0.86–2.48)	0.79 (0.42–1.47)	26/70 (37.1)	0.98 (0.54–1.77)	0.70 (0.34–1.44)
LDL cholesterol, mg/dL						
<100	38/442 (8.6)	ref	ref	37/125 (29.6)	ref	ref
100–129	40/230 (17.4)	2.03 (1.25–3.30)	1.81 (1.06–3.10)	40/93 (43.01)	1.77 (0.99–3.14)	1.28 (0.66–2.48)
≥130	21/89 (23.6)	2.85 (1.56–5.21)	2.20 (1.14–4.26)	11/29 (37.9)	1.56 (0.66–3.69)	0.93 (0.35–2.48)
Body mass index, kg/m^2						
<25	53/612 (8.7)	ref	ref	66/201 (32.8)	ref	ref
25–27.4	26/96 (27.1)	3.43 (2.00–5.87)	1.28 (0.65–2.50)	12/29 (41.4)	1.67 (0.73–3.78)	0.89 (0.31–2.50)
≥27.5	20/53 (37.7)	5.33 (2.82–10.07)	1.48 (0.63–3.47)	10/17 (58.8)	3.58 (1.26–10.15)	1.82 (0.48–6.84)
Waist circumference, cm						
<80	19/417 (4.6)	ref	ref	19/95 (20.0)	ref	ref
80–89	34/209 (16.3)	2.80 (1.41–5.58)	2.81 (1.41–5.59)	33/81 (40.7)	2.17 (0.95–4.96)	2.24 (0.97–5.14)
≥90	46/135 (34.1)	5.94 (2.83–12.47)	5.12 (2.19–11.94)	36/71 (50.7)	2.53 (1.05–6.08)	2.29 (0.83–6.34)

ref: reference category
MET: metabolic equivalent
HbA1c: glycated hemoglobin
HDL: high-density lipoprotein
LDL: low-density lipoprotein
Multivariable model includes age, years of education, marital status, tobacco smoking, smokeless tobacco, physical activity, and blood levels of HbA1c, triglycerides, HDL cholesterol, LDL cholesterol, waist circumference and body mass index. Marital status was not included in the multivariable model in older men as only two men were single. All the variables except age were included as categorical variables.

Table 2 Odds ratios and the 95% confidence intervals of hypertension association with various risk factors in women, Bangladesh, 2016

Age groups	18–44 years hypertension (n) / total (N) = 110/753			45–64 years hypertension (n) / total (N) = 96/248		
	n/N (%)	Age-adjusted model	Multivariable model	n/N (%)	Age-adjusted model	Multivariable model
Education, years						
None	43/217 (19.8)	ref	ref	77/180 (42.8)	ref	ref
1–4	17/164 (10.4)	0.66 (0.35–1.23)	0.51 (0.26–0.99)	11/35 (31.4)	0.68 (0.31–1.48)	0.61 (0.26–1.42)
≥5	50/372 (13.4)	1.09 (0.67–1.77)	0.64 (0.38–1.07)	8 /33 (24.2)	0.49 (0.20–1.16)	0.47 (0.18–1.20)
Marital status						
Single	8/53 (15.1)	ref	ref	32/78 (41.0)	ref	ref
Married	102/700 (14.6)	1.37 (0.60–3.08)	1.05 (0.44–2.50)	64/170 (37.7)	1.01 (0.57–1.80)	1.46 (0.78–2.71)
Smokeless tobacco						
Non-user	91/628 (14.5)	ref	ref	55/144 (38.2)	ref	ref
Current user	19/125 (15.2)	1.66 (0.38–1.17)	1.01 (0.55–1.86)	41/104 (39.4)	0.98 (0.58–1.66)	1.08 (0.60–1.95)
Physical activity, MET-minutes per week						
<600	72/516 (14.0)	ref	ref	62/161 (38.5)	ref	ref
≥600	38 /237 (16.0)	0.99 (0.63–1.54)	0.90 (0.56–1.44)	34 /87 (39.1)	0.97 (0.57–1.67)	1.40 (0.75–2.61)
HbA1c %						
<5.7	44/405 (10.9)	ref	ref	20/75 (26.7)	ref	ref
5.7–6.4	34/223 (15.3)	1.21 (0.73–1.99)	1.02 (0.60–1.73)	34/86 (39.5)	1.69 (0.85–3.33)	1.54 (0.75–3.14)
≥6.5	32/125 (25.6)	2.44 (1.44–4.14)	2.11 (1.20–3.69)	42/87 (48.3)	2.40 (1.23–4.71)	2.71 (1.31–5.60)
Triglycerides, mg/dL						
<150	57/515 (11.1)	ref	ref	29/100 (29.0)	ref	ref
150–199	19/110 (17.3)	1.30 (0.72–2.35)	0.94 (0.50–1.78)	25/52 (48.1)	2.29 (1.13–4.62)	2.00 (0.92–4.35)

≥200	34/128 (26.6)	2.16 (1.31–3.56)	1.82 (1.06–3.11)	42/96 (43.8)	1.82 (1.00–3.32)	1.21 (0.62–2.37)
HDL cholesterol, mg/dL						
<50	94/624 (15.1)	ref	ref	87/209 (41.6)	ref	ref
≥50	16/129 (12.4)	1.26 (0.70–2.26)	0.89 (0.70–2.26)	9/39 (23.1)	2.52 (1.13–5.65)	2.20 (0.88–5.48)
LDL cholesterol, mg/dL						
<100	47/436 (10.8)	ref	ref	40/108 (37.0)	ref	ref
100–129	40/230 (17.4)	1.54 (0.96–2.46)	1.48 (0.91–2.41)	39/98 (39.8)	1.09 (0.61–1.93)	0.61 (0.26–1.42)
≥130	23/87 (26.4)	2.53 (1.40–4.56)	2.49 (1.34–4.61)	17/42 (40.5)	1.14 (0.54–2.38)	0.47 (0.18–1.20)
Body mass index, kg/m^2						
<25	39/447 (8.7)	ref	ref	56/161 (37.8)	ref	ref
25–27.4	24/146 (16.4)	1.80 (1.03–3.17)	1.24 (0.64–2.41)	18/42 (42.9)	1.46 (0.72–2.96)	1.24 (0.55–2.80)
≥27.5	47/160 (29.4)	3.57 (2.19–5.81)	1.99 (1.00–4.00)	22/45 (48.9)	2.14 (1.07–4.28)	1.65 (0.65–4.20)
Waist circumference, cm						
<80	26/339 (7.7)	ref	ref	20/74 (27.0)	ref	ref
80–89	31/234 (13.3)	1.53 (0.87–2.70)	1.08 (0.57–2.05)	43/97 (44.3)	2.05 (1.06–3.97)	1.61 (0.77–3.36)
≥90	53/180 (29.4)	3.68 (2.17–6.26)	1.88 (0.88–4.03)	33/77 (42.9)	2.03 (1.01–4.06)	1.20 (0.48–3.03)

ref: reference category
MET: metabolic equivalent
HbA1c: glycated hemoglobin
HDL: high-density lipoprotein
LDL: low-density lipoprotein
Multivariable model includes age, years of education, marital status, smokeless tobacco, physical activity, and blood levels of HbA1c, triglycerides, HDL cholesterol, LDL cholesterol, waist circumference and body mass index.
Tobacco smoking was not included as there were no smoking women. All the variables except age were included as categorical variables.

DISCUSSION

This study examined factors associated with hypertension stratified by age groups and in men and women separately in an urban poor community in Bangladesh. To the best of our knowledge, this is the first study to investigate the association of such perspectives in the urban poor population in Bangladesh. In younger men, the group with a waist circumference of ≥90 cm was associated with hypertension as compared to a waist circumference of <80 cm. Similarly, in younger women, the group with a BMI of ≥27.5 kg/m^2 was associated with hypertension as compared to a BMI of <25 kg/m^2. However, neither BMI nor waist circumference was significantly associated with hypertension in older men and women. Physical activity and HbA1c were the only factors associated with hypertension in older men and women, respectively. Increased LDL cholesterol in younger men and increased LDL cholesterol, triglycerides, and HbA1c in younger women were also associated with hypertension.

Obesity is a widely recognized risk factor for hypertension.[2] Our findings showed that for younger men, waist circumference would be a better indicator of obesity in terms of hypertension, while, in younger women, BMI would indicate it better. However, neither high waist circumference nor high BMI was significantly associated with hypertension in older men and women. This might be partly due to a general increase in arterial stiffness in the older groups, regardless of the degree of obesity.[34,35] Weaker associations between obesity and hypertension in older compared to younger groups have been reported previously in South Asian countries, Japan, and the United States.[23-25]

Dyslipidemia (LDL cholesterol in younger men and LDL cholesterol and triglycerides in younger women) were associated with hypertension in both younger men and women. This finding is consistent with a report among Japanese men under 40 years[36] and a hospital-based study in Bangladesh.[37] Dyslipidemia is reported to impair endothelial function[36,38] which leads to a disruption of nitric oxide production and blood pressure regulation.

We found that raised blood glucose measured by an HbA1c ≥6.5% was associated with hypertension in both younger and older women. Raised blood glucose is known to increase the risk of hypertension, as it increases circulating blood volume, advances arteriosclerosis, and heightens the reactions of the sympathetic nerve systems through increased insulin secretion as a reaction to the increased insulin resistance.[39] The association between raised fasting blood glucose and hypertension was previously reported in Bangladesh as well.[9] Our findings, similar to a previous cohort study in Japan,[40] showed that the association between raised blood glucose and hypertension was more prominent in the older than in the younger age groups, perhaps due to a longer duration of raised blood glucose in the older age groups.[41] We found that HbA1c was associated with hypertension in women only after including various factors in the multivariable model. It was reported that the risks of endothelial dysfunction, hypertension, and the increase of insulin resistance are higher in women with raised blood glucose than in men with a similar condition.[42-45] Similar to our findings, cross-sectional studies in India and Pakistan[46,47] and a cohort study in Iran[48] have reported an association of raised blood glucose and hypertension only in women.

An inverse association between physical activity and hypertension has been widely reported,[2] including in studies from Bangladesh.[6,7] However, our study showed that there was an inverse association between physical activity and hypertension only in men of the older age group. This may be because younger men in this urban poor community were likely to undergo vigorous physical labor, such as being *riksha* drivers,[16] which would not contribute to a decrease in blood pressure.[49] No association between increased physical activity and hypertension in women was identified due to their small sample size with high levels of physical activity. This is likely as women in urban Bangladesh mostly lead a relatively sedentary lifestyle due to socio-cultural constraints.[16]

Our study is the first to examine the association of HbA1c, blood lipids, and hypertension as stratified by sex and age among an urban poor population in Bangladesh, who are at high risk of NCDs. The findings of this study could serve as a basis for NCD control programs for similar populations.[50]

LIMITATIONS

This study has a few limitations. First, due to the nature of a cross-sectional study, causal relationships could not be identified, although it would be unlikely from the pathophysiological point of view that hypertension causes obesity. Also, it would be unlikely for people with hypertension to become physically inactive because typically, their symptomless characteristics do not limit physical activities. Furthermore, physical activity was already regarded as a healthy NCD preventive lifestyle in our previous study in the same area.[16] Therefore, we speculated that these factors could be related to the development of hypertension. However, the associations of dyslipidemia or diabetes with hypertension may be a result of confounding factors, including the residual confounding of obesity.[38]

This study targeted a slum community in an urban setting; therefore, the findings may not be generalizable to other settings in Bangladesh. Although our multivariable models included several lifestyle factors, such as tobacco smoking and physical activity, residual confounding caused by diet, alcohol consumption, and other unknown factors cannot be excluded. Finally, our initial choice of 45 years as the cutoff when deciding age stratification was to see possible effect modification due to menopause in women; however, information regarding the age of menopause was not available. Future studies on the effect of menopausal status on hypertension should be conducted.

CONCLUSION

In conclusion, this study found that waist circumference in younger men and BMI in younger women; increased LDL cholesterol in younger men and increased LDL cholesterol and triglycerides in younger women; and a higher HbA1c was associated with hypertension in women of all ages. Physical activity was inversely associated with hypertension in older men. This suggests that public health interventions to prevent hypertension may require different approaches according to sex and age groupings in the poor urban population in Bangladesh.

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CONFLICTS OF INTEREST

All authors declare no competing interests.

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