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The new 2017 ACC/AHA guideline for classification of hypertension: changes in prevalence of hypertension among adults in Bangladesh

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Abstract

We analyzed the Bangladesh Demographic and Health Survey 2011 data to examine absolute differences in hypertension prevalence according to the hypertension definition of the “2017 American College of Cardiology/American Heart Association (2017 ACC/AHA) Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults” and “Seventh Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC7)” 2003 guidelines. Among 7839 participants ≥35 years, the JNC7 and 2017 ACC/AHA classified 25.7% (95% confidence interval (CI): 24.5–27.0%) and 48.0% (95% CI: 46.4–49.7%) people hypertensive, respectively. The JNC7 prevalence was 19.4% (95% CI: 18.0–21.0%) among males and 31.9% (95% CI: 30.1–33.6%) among females. The prevalence was 41.4% (95% CI: 39.4–43.5%) among males and 54.5% (95% CI: 52.4–56.4%) among females as per the 2017 ACC/AHA guideline. From JNC7 to 2017 ACC/AHA, the overall difference in prevalence was 22.3% (95% CI: 19.8–24.8%). Males and females had similar differences, 22.0% (95% CI: 18.3–25.7%) and 22.6% (95% CI: 19.4–26.0%), respectively. As per the 2017 ACC/AHA guideline, >50% prevalence was observed among people with body mass index ≥25 kg/m^2, college-level education, co-morbid diabetes, richest wealth quintile, females, age ≥55 years, urban residence, or living in Khulna, Rangpur or Dhaka divisions; the absolute difference was >20% in most categories. We found a substantial increase in the prevalence of hypertension

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Availability of data and material

Data may be made available upon request to the ICF International, Maryland, USA.

due to change in blood pressure thresholds as per the 2017 ACC/AHA guideline. We recommend conducting more comprehensive population-based studies to estimate the recent burden of hypertension in Bangladesh. Future studies should estimate similar prevalence in other countries.

Background

In recent decades, low- and middle-income countries in South Asia and Africa have experienced an epidemiologic transition with an increasing burden of chronic diseases and slower reduction of infectious diseases [1–3]. Uncontrolled hypertension is the primary global risk factor for cardiovascular and kidney diseases [4]. Although prevalence and risk factors for this condition have been well studied in developed countries, little is known about its burden in many developing countries, including Bangladesh [1–3].The sixth Bangladesh Demographic and Health Survey 2011 (2011 BDHS) was the first and only nationwide BDHS that estimated the overall prevalence of hypertension in the country [5]. Among survey respondents aged 35 years and older, the estimated prevalence of hypertension was 25.7%. Similarly, “The Non-Communicable Disease Risk Factor Survey Bangladesh 2010” conducted by the World Health Organization (WHO) found an overall hypertension prevalence of 17.9% among respondents aged 25 years and older [6]. However, these estimates of the prevalence of hypertension in Bangladesh, along with the current global estimates, were based on the “1999 World Health Organization-International Society of Hypertension Guidelines (WHO-ISH) for the Management of Hypertension” or the “Seventh Report of Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7)” guideline of 2003 [6–9].

The “2017 American College of Cardiology/American Heart Association (2017 ACC/AHA) Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults” recently recommended a new categorization for blood pressure levels. The former two guidelines defined hypertension as a systolic blood pressure (SBP) of ≥140 mm Hg and/or a diastolic blood pressure (DBP) of ≥90 mm Hg [8, 9]. The new 2017 ACC/AHA guideline has updated the definition of hypertension as an SBP of ≥130 mm Hg and/or a DBP of ≥80 mm Hg, reducing SBP and DBP by 10 mm Hg each. Additionally, the guideline issued new blood pressure levels for elevated blood pressure (previously defined as prehypertension as per the JNC7 guideline), and stage-1 and stage-2 hypertension (Supplemental Table 1) [10]. Recommendations for treatment initiation were also modified in this guideline, as making positive lifestyle changes and initiating treatment earlier in disease development may help prevent cardiovascular disease progression and reduce the risks and complications of hypertension [10–13].

The 2017 ACC/AHA guideline highlights the importance of having newer prevalence estimates for hypertension in Bangladesh. As the prevalence of hypertension varies according to sex and background characteristics, it is also essential to investigate the prevalence according to background characteristics of the respondents to have the new prevalence estimates according to these characteristics [10]. Muntner and colleagues estimated the changes in hypertension prevalence according to the new definition among adults in the United States (US). The authors analyzed the US National Health and Nutrition

Examination Survey (NHANES) data and found the overall prevalence of hypertension increased by 14.7% using the new definition compared to the JNC7 definition [14].In the present study, we conducted a similar secondary analysis on the 2011 BDHS to determine the changes in prevalence of hypertension in Bangladesh according to the 2017 ACC/AHA and JNC7 guidelines for both sexes and socio-demographic characteristics [5].

Methods

Ethical approval

The Institutional Review Boards (IRB) of the ICF International and Bangladesh Medical Research Council approved the 2011 BDHS protocol, questionnaires, and verbal consent forms. The IRB of the University of Maryland, Baltimore determined that secondary analysis of this deidentified dataset meets the definition of non-human subject research and exempted this study from IRB oversight. Each respondent provided informed verbal consent to participate in the 2011 BDHS.

Data source

Mitra and Associates implemented the 2011 BDHS from July 2011 to January 2012. The 2011 BDHS was designed to make the sample nationally representative with an aim to represent all urban and rural non-institutionalized populations residing in all administrative divisions within this country. In addition to the previous objectives related to the estimation of maternal and child health indicators, the 2011 BDHS also specifically aimed to measure blood pressure and blood glucose for men and women ages 35 years and older [5].

For the sampling frame, a list of enumeration areas (EAs) was prepared from the 2011 Population and Housing Census [15]. The primary sampling unit was an EA. Similar to the previous five BDHS, a two-stage stratified sample of households was used in the 2011 BDHS. In total, 207 clusters in urban areas and 393 in rural areas were selected in the first phase to obtain 600 EAs with a probability relative to the size of the EAs. To have a sampling frame for the households' selection, households were listed in these EAs in the second stage. Bangladesh had seven administrative divisions during the period of survey. Each EA contained a systematic sample of 30 households for providing consistent estimates of main demographic and health indicators separately for urban and rural areas in all these divisions. A total of 18,000 residential households were selected with this design. One-third of the households were randomly selected for measurement of blood pressure and diabetes. All women and men 35 years or older in these selected households were eligible to receive blood pressure and blood glucose measurements. Of the 4311 women and 4524 men that were eligible to participate in the survey, 92% of the females and 86% of the males had their blood pressure measured. The details of this population-based survey, including survey design, methodologies, sample size calculation, and findings are available elsewhere [5].

Measures

The WHO-recommended "LIFE SOURCE® UA-767" Plus Blood Pressure Monitor model was used to measure the blood pressure of participants in the 2011 BDHS. The device had separate cuffs of small, medium and large sizes to measure the blood pressure. One trained

technician measured systolic and diastolic blood pressure three times with an interval of ten minutes between measurements for each participant. Additionally, participants were asked if they were taking any prescribed anti-hypertensive drugs to lower blood pressure level. Four quality control teams ensured the quality of data collection. The average of the last two measures was used to document the final blood pressure value [5].

Statistical analyses

First, we reported background characteristics of the survey participants. Supplemental Table 2 shows the list of study variables along with their definitions and the categories used to describe the survey participants. These variables were selected based on published reports and the structure of the 2011 BDHS. In exploratory data analysis, we assessed the normality of quantitative variables and reported median values with inter-quartile range (IQR) for the variables with skewed distributions. The 2011 BDHS employed principal component analysis to obtain household wealth status of the survey participants [16, 17].

We reported the relative frequency distributions of the two blood pressure levels, along with the proportion of participants who were already taking prescribed antihypertensive agents. Then, we investigated the prevalence of stages of hypertension according to the two guidelines. We also obtained the proportions of “isolated” systolic (i.e., only the SBP above the threshold level) and diastolic (i.e., only the DBP above the threshold level) hypertension along with the participants who were already taking prescribed antihypertensive drugs and had a controlled (i.e., below the thresholds for blood pressure of hypertension) blood pressure. The absolute differences in estimated prevalence were reported separately. Finally, we calculated the difference in the overall proportion of hypertension with selected background characteristics according to the hypertension definition of the JNC7 and 2017 ACC/AHA guidelines. All prevalence estimates and differences are reported with 95% confidence intervals (CI).

We considered the hierarchical structure of the dataset to estimate the weighted prevalence and differences in the sample. Stata 14.0 (Stata Corp, College Station, TX) was used to analyze the data of this study [18]. The “svy” command was used to calculate these weighted frequency distributions.

Results

Background characteristics of the study participants are presented in Table 1. Of the total 7839 respondents included in the analysis, the JNC7 and 2017 ACC/AHA guidelines found 2016 and 3767 people hypertensive, respectively. The median SBP was similar among the hypertensive people according to both JNC7 (121, IQR: 116–127) and 2017 ACC/AHA (123, IQR: 121–125) guidelines. The median DBP (75, IQR: 72–78) of the hypertensive people of the 2017ACC/AHA guideline was lower than the DBP (82, IQR: 80–85) of hypertensive people of the JNC7 guideline. The median age of the respondents was 49 years (IQR: 41–60), and the proportions of males and females were equally distributed, 49.5% (n = 3876) and 50.5% (n = 3963), respectively. In both guidelines, a majority of hypertensive participants were females. About 11.0% (n = 826) of the respondents had a fasting blood sugar measurement at or above the threshold of diabetic levels (fasting plasma glucose ≥7.0

mmol/L or taking prescribed antidiabetic drugs). The majority of the respondents had no formal education, 63.1% (n = 4945). More than three-fourths of the respondents were from rural areas, 76.7% (n = 6009).The other background characteristics were similar among the hypertensive people according to both guidelines.

According to the 2017 ACC/AHA guideline, 23.2% and 42.1% of the studied population had blood pressure measurements at or above the level of hypertension for the SBP and DBP, respectively, compared to 13.9% and 15.4%, respectively, as per the JNC7 guideline (Table 2). An additional 10.7% of the respondents were on prescribed anti-hypertensive agents. The relative frequency distribution of the blood pressure levels was similar among males and females; however, the proportion of all female participants who were taking anti-hypertensive drugs (14.3%) was more than two times as high as male respondents (7.1%).

Table 3 presents the comparison of blood pressure categories according to older and newer classifications. Comparing prevalence according to sex, similar to the JNC7, the new 2017 ACC/AHA guidelines found more females hypertensive than males in all blood pressure categories. The crude prevalence of hypertension according to the 2017 ACC/AHA hypertension was 41.4% (39.4–43.5%) and 54.5% (95% CI: 52.4–56.4%) among males and females, respectively. Overall, the new guideline classified a large proportion of people as having isolated diastolic hypertension, 20.4% (95% CI: 19.3–21.5%), in contrast to the former JNC7 guideline, 7.1% (95% CI: 6.1–9.2%). However, the proportion of people with isolated systolic hypertension or controlled blood pressure with antihypertensive medications was similar as per both guidelines.

Based on the 2017 ACC/AHA guideline, the overall prevalence of “elevated blood pressure”, “stage-1” and “stage-2” hypertension was 5.0% (95% CI: 4.5–5.6%), 27.1% (95% CI: 26.0–28.3%), and 20.9% (95% CI: 19.8–22.1%), respectively. The crude prevalence of hypertension according to the JNC7 and 2017 ACC/AHA guidelines were 25.7% (95% CI: 24.5–27.0%) and 48.0% (95% CI: 46.4–49.7%), respectively. A large proportion of individuals who were previously considered “pre-hypertensive” are now categorized as hypertensive due to lowering the blood pressure cutoffs for the definition of stage-1 hypertension with the new 2017 ACC/AHA guidelines. The overall difference in hypertension prevalence was 22.3% (95% CI: 19.8–24.8%). Males and females had similar changes, 22.0% (95% CI: 18.3–25.7%) and 22.6% (95% CI: 19.4–26.0%), respectively. The overall change for isolated systolic hypertension was insignificant, −1.9% (95% CI: −5.0 to 1.1%); however, this difference was substantial for the isolated diastolic hypertension, 13.3% (95% CI: 10.4–16.2%) and stage-2 hypertension, 13.4% (95% CI: 10.6–16.3%). Figure 1 summarizes the prevalence of hypertension according to two guidelines. Supplemental Table 3 summarizes blood pressure levels according to antihypertensive drug use.

Table 4 compares the hypertension prevalence between the two guidelines for selected background characteristics. Under the new 2017 ACC/AHA guideline, the highest proportion of individuals with hypertension were those with a body mass index (BMI) ≥ 30kg/m^2 (84.6%; 95% CI: 75.4–93.8%), followed by people with BMI 25–29.9 kg/m^2, (70.2%; 95% CI: 65.4–74.6%). Based on the new guideline, an increase in prevalence to

50% or greater was observed among females, people aged ≥ 55 years, people with comorbid diabetes, and those with a college education or higher, richest household wealth status, urban residence, or people living in Khulna, Rangpur and Dhaka divisions. The absolute differences in prevalence estimates were more than 20% in most of the categories of background characteristics. Supplemental Table 4 compares the prevalence of hypertension according to JNC7 and 2017 ACC/AHA guidelines with these demographic characteristics (with 95% CI) by treatment status of hypertension.

Discussion

We found that more than half of the adults in this country have higher than “normal” (≥120/80 mm of Hg) blood pressure based on the 2017 ACC/AHA hypertension definition; 22.3% of people previously known as “pre-hypertensive” will now be classified as hypertensive. Additionally, under the new guidelines, we observed a small reduction in prevalence of isolated systolic hypertension. This is mainly due to the large proportion of people who not only had isolated systolic hypertension according to the JNC7 guideline, but who also had a “pre-hypertensive” level of DBP. The decreased threshold for DBP level in the 2017 ACC/AHA guideline has now classified these isolated systolic hypertensive persons as combined systolic and diastolic hypertensive. We also found a higher prevalence of hypertension among overweight people (i.e., BMI ≥ 25 kg/m^2), females, individuals with diabetes, tertiary education (i.e., college level or above), richest household wealth status, people living in urban areas or in some administrative divisions. Although these sub-groups had the highest hypertension proportions in the former JNC7 guideline, the hypertension prevalence under this former guideline did not exceed 50% for any group.

Despite having two socioeconomically and demographically different groups, the observed absolute increase in prevalence of hypertension that we found in Bangladesh parallels the rise in prevalence observed in the United States [14]. Another study compared the “2014 Joint National Committee 8 (JNC8)” report and 2017 ACC/AHA guidelines to estimate the difference in hypertension prevalence in the United States and China among the 45–75 years age group. Although that study aimed to estimate the “relative increase” in prevalence, they found an overall absolute increase of 13.3% and 17.0% in the United States and China, respectively [19, 20]. Based on these results, we expect to observe a similar rise in prevalence in other countries.

It is also important to estimate the proportion of people who would require anti-hypertensive medications as per the new evidence-based guideline. Although we found a substantial proportion of people as hypertensive, all hypertensive people would not require anti-hypertensive therapy; among the patients with stage-1 hypertension, those who have cardiovascular diseases or ≥10% of 10-year atherosclerotic cardiovascular disease (ASCVD) risk would require pharmacologic treatment as per the 2017 ACC/AHA guideline [10]. Unlike Muntner et al., we were not able to estimate the proportion of people who require antihypertensive drugs due to limitations of the 2011 BDHS dataset [5]. In their study, the authors observed only a minimal absolute increase in the proportion of adults who would require medications (~2%) [14]. Future studies should investigate the proportion of people who would require anti-hypertensive medications as well as the proportion of people who

have a higher risk of ASCVD. Additionally, all hypertensive people would require at least modification of lifestyles and dietary habits as per the new guideline [10]. Our findings are also essential in the context that “at least” half of the people would require non-pharmacologic interventions. Public health programs need to address that to increase awareness of hypertension for modification of dietary habits and lifestyles to lower blood pressure levels as well as minimizing the negative complications associated with hypertension.

Results of the present study are important from the policy perspective in this country as well as in other countries. It is understandable that the new hypertension definition would make a large proportion of people “hypertensive” [10], and it has long been documented that hypertension and other non-communicable diseases are becoming ‘epidemics’ in low and middle-income countries due to the epidemiologic and demographic transitions in these nations [21–25]. Studies found an overall lower level of awareness and control of hypertension in Bangladesh; these lower awareness and control in addition to the findings of the present study signify the importance of implementing national awareness and control programs to prevent incidence and complications of hypertension in this country. However, a recent analysis conducted by Biswas and colleagues found that the planning, implementation, and monitoring of the government-initiated non-communicable disease programs or policies in Bangladesh were inadequate to make them successful [26].

According to the previously followed JNC7 guideline, the estimated age-adjusted global prevalence of hypertension was 24.1% among males and 20.1% among females in 2015 [1]. Noting the importance of controlling hypertension, in 2013, the World Health Assembly set a target (Global Target 6) to reduce the prevalence of hypertension by 25% within the year 2025 compared to its 2010 level [27]. As those estimates and targets were based on the previously recommended guidelines, we recommend a revision of the “Global Targets 6 and 9” along with the global incidence or prevalence estimation. In addition, the 2017 ACC/AHA guideline sheds light on the importance of conducting similar analyses in other countries to examine the implications of the new hypertension definition as well as increasing awareness to control it.

The strengths and limitations of the present article also merit discussion. We performed a wide range of analyses to estimate the changes in prevalence; we reported the relative frequency distribution for both SBPs and DBPs in the survey population, and estimated the newly defined prevalence of isolated systolic, isolated diastolic, stage-1 and stage-2 hypertension. However, the analyzed survey was cross-sectional and blood pressure was recorded for one day; longitudinal measurement of blood pressure is required for a precise diagnosis of hypertension [28]. Although all staff members were highly trained and this survey used a standardized automated method, efficacy or skill level of the survey staff to measure blood pressure levels may cause some error in measurements [29]. This survey covered rural and urban areas in all divisions of this country; this large coverage along with a high response rate of this population-based survey made the sample nationally representative. The 2011 BDHS used validated research instruments which have been widely used in developing countries. However, this survey relied on verbal reports for a certain number of variables, including age and the elements of the principal component analysis,

which may cause some more mis-classification to estimate the prevalence according to age group or other background characteristics. In addition, this survey may not report the most recent estimates of hypertension, as it concluded in January 2012, nearly 6 years before this analysis. We mentioned earlier about one limitation that we were unable to estimate the proportion of patients who would require blood pressure lowering medication. Based on these limitations, this study illustrates the need for more population-based nationally representative surveys to estimate the recent burden and risk factors for this condition.

Conclusions

Our results demonstrate that the new 2017 ACC/AHA definition significantly changed the estimated prevalence of hypertension in Bangladesh compared to the JNC7 guideline. Future studies should consider assessing changes in hypertension prevalence in other countries to help estimate its global burden. Since the availability of recent hypertension data from Bangladesh is limited, we also propose a more comprehensive nation-wide survey to estimate the prevalence and proportion of people who would require anti-hypertensive medications in this country.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Summary table

What is known?

- The prevalence of hypertension is 25.7% among adults in Bangladesh.

What this study adds?

- The new estimates show that nearly half of the adults have hypertension (48.0%) in Bangladesh.
- Non-pharmacologic interventions to modify blood pressure level are recommended for at least half of the adults as per the 2017 ACC/AHA guideline.
- Global targets for prevention and control of hypertension should be modified.

Research implications

- Estimating “new” prevalence of hypertension in other countries is also required.
- Require estimating the proportion of people who would require anti-hypertensive medications in all countries including Bangladesh.

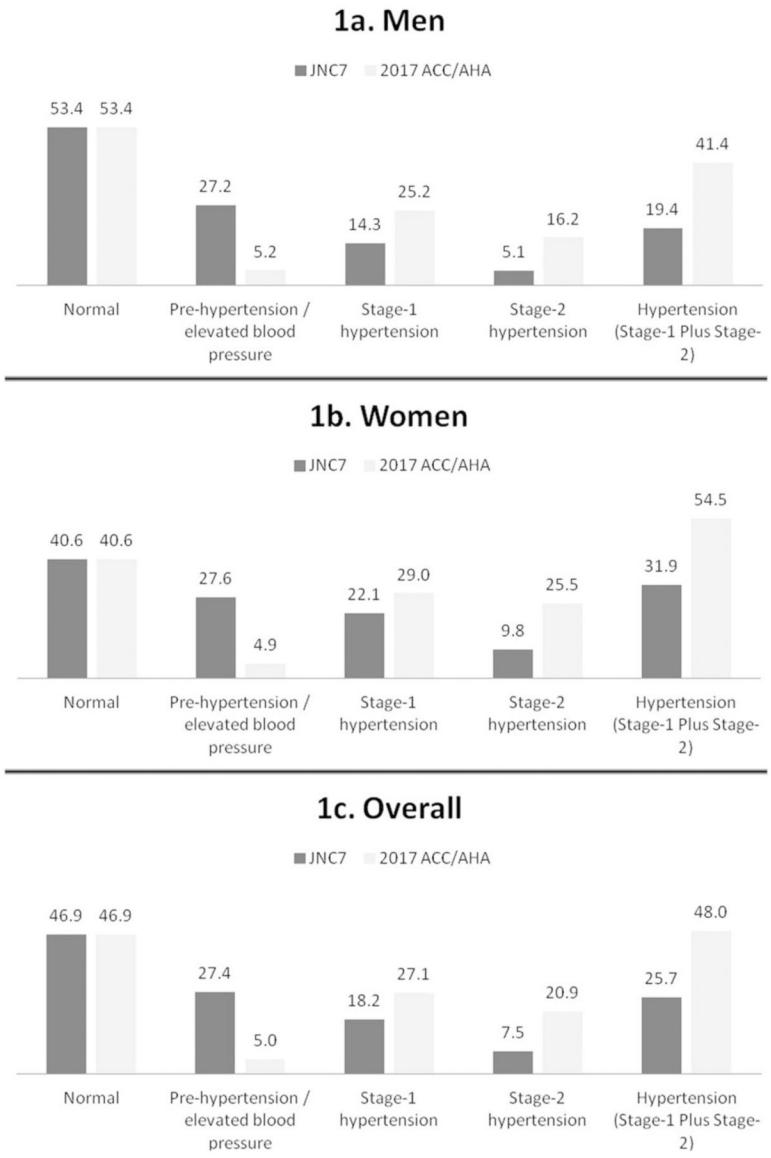

Fig. 1.
Prevalence of hypertension among males and females according to guidelines

Table 1

Background Characteristics of the study population, median (IQR), or *n* (%)[a]

Characteristics	Overall, *N* = 7839	Respondents with hypertension under guidelines	
		JNC7 (*n* = 2016)	2017 ACC/AHA (*n* = 3767)
Systolic blood pressure, mm Hg, median (IQR)	115 (105–129)	121 (116–127)	123 (121–125)
Diastolic blood pressure, mm Hg, median (IQR)	77 [70–85]	82 [80–85]	75 [72–78]
Age (years)			
Median (IQR)	49 [41–60]	48 [40–58]	55 [45–66]
35–44	2850 (36.3)	487 (24.1)	1,210 (32.1)
45–54	2266 (28.9)	566 (28.1)	1,079 (28.6)
55–64	1333 (17.0)	402 (20.0)	683 (18.1)
≥65	1390 (17.7)	560 (27.8)	794 (21.1)
Sex			
Male	3876 (49.5)	1,605 (42.6)	1,605 (42.6)
Female	3963 (50.5)	1,802 (57.8)	2,161 (57.4)
Body mass index (kg/m^2)			
Median (IQR)	20.1 (18.0–22.8)	20.8 (18.5–23.2)	19.8 (18.1–19.8)
<18.5	1687 (31.0)	313 (22.3)	594 (23.3)
18.5–24.9	3177 (58.5)	828 (59.0)	1,539 (60.5)
25–29.9	499 (9.2)	214 (15.3)	351 (13.8)
≥30	73 (1.3)	47 (3.4)	61 (2.4)
Diabetes			
No	6700 (89.0)	1625 (83.5)	3127 (86.2)
Yes	826 (11.0)	320 (16.5)	502 (13.8)
Education			
No formal education	4945 (63.1)	1,289 (63.9)	2,378 (63.1)
Primary	1443 (18.4)	324 (16.1)	623 (16.5)
Secondary	972 (12.4)	228 (11.3)	463 (12.3)
Tertiary	479 (6.1)	174 (8.6)	303 (8.0)
Household wealth status			
Poorest	1524 (19.4)	286 (14.2)	582 (15.4)
Poorer	1508 (19.2)	326 (16.2)	621 (16.5)
Middle	1551 (19.8)	346 (17.2)	703 (18.7)
Richer	1619 (20.7)	447 (22.2)	834 (22.1)
Richest	1637(20.9)	611 (30.3)	1,026 (27.3)
Place of residence			
Urban	1830 (23.3)	597 (29.6)	1061 (28.2)
Rural	6009 (76.7)	1419 (70.4)	2705 (71.8)
Region			
Barisal	464 (5.9)	115 (5.7)	208 (5.5)
Chittagong	1334 (17.0)	293 (14.5)	569 (15.1)
Dhaka	2514 (32.1)	680 (33.7)	1285 (34.1)

Characteristics	Overall, *N* = 7839	Respondents with hypertension under guidelines	
		JNC7 (*n* = 2016)	2017 ACC/AHA (*n* = 3767)
Khulna	1020 (13.0)	308 (15.3)	566 (15.0)
Rajshahi	1135 (14.5)	269 (13.3)	486 (12.9)
Rangpur	922 (11.8)	259 (12.9)	474 (12.6)
Sylhet	449 (5.7)	92 (4.6)	178 (4.7)

[a]Column percentage; numbers may not add up to total due to missing values

IQR inter-quartile range, *JNC* Joint National Committee, *ACC/AHA* American College of Cardiology/American Heart Association

Table 2

Relative frequency distribution of blood pressure levels (95% confidence interval)

Blood pressure level, mm of Hg		Male	Female	Overall
Systolic blood pressure	≤99	16.0 (14.5, 17.5)	13.3 (12.0, 14.8)	14.6 (13.5, 15.8)
	100–109	25.1 (23.4, 26.9)	19.9 (18.5, 21.4)	22.5 (21.3, 23.7)
	110–119	24.6 (23.1, 26.3)	22.0 (20.5, 23.6)	23.3 (22.2, 24.5)
	120–129	16.2 (14.8, 17.6)	16.6 (15.3, 18.0)	16.4 (15.4, 17.4)
	130–139	**8.0 (7.0, 9.1)**	**10.6 (9.6, 11.8)**	**9.3 (8.6, 10.1)**
	140–149	**3.8 (3.2, 4.5)**	**6.3 (5.5, 7.2)**	**5.1 (4.5, 5.7)**
	150–159	**2.8 (2.2, 3.6)**	**3.9 (3.3, 4.6)**	**3.4 (2.9, 3.9)**
	≥160	**3.5 (2.9, 4.3)**	**7.2 (6.4, 8.1)**	**5.4 (4.8, 6.0)**
Diastolic blood pressure	≤69	26.5 (24.7, 28.4)	19.3 (17.7, 21.1)	22.9 (21.5, 24.3)
	70–79	36.8 (35.1, 38.6)	32.8 (31.0, 34.6)	34.8 (33.5, 36.1)
	80–89	**24.5 (22.9, 26.2)**	**29.2 (27.5, 30.9)**	**26.9 (25.6, 28.1)**
	90–99	**9.2 (8.2, 10.3)**	**13.1 (11.8, 14.4)**	**11.1 (10.3, 12.0)**
	≥100	**3.0 (2.4, 3.6)**	**5.7 (4.9, 6.5)**	**4.3 (3.9, 4.8)**
Proportion of participants who were taking anti-hypertensive drugs		**7.1 (6.2, 8.2)**	**14.3 (13.0, 15.7)**	**10.7 (9.9, 11.7)**

Bold values indicate hypertension according to 2017 ACC/AHA guidelines

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Table 3

Comparison of hypertension prevalence among males and females by stage and guideline (95% confidence interval (CI))

Categories	JNC7	2017 ACC/AHA	Difference (95% CI)
Male			
Normal	53.4 (51.3, 55.5)	53.4 (51.3, 55.5)	
Isolated systolic hypertension	4.0 (3.4, 4.8)	3.1 (2.6, 3.8)	−0.9 (−5.3, 3.5)
Isolated diastolic hypertension	6.1 (5.3, 7.0)	20.6 (19.1, 22.0)	14.5 (10.4, 18.7)
Both systolic and diastolic hypertension	6.1 (5.2, 7.0)	15.0 (13.6, 16.5)	8.9 (4.7, 13.1)
Controlled patients on medication	3.2 (2.7, 4.0)	2.8 (2.2, 3.4)	−0.4 (−4.0, 4.0)
Pre-hypertension[a]/elevated blood pressure[a]	27.2 (25.6, 28.8)	5.2 (4.5, 6.0)	−22.0 (−18.3, −25.7)
Stage-1 hypertension	14.3 (13.1, 15.7)	25.2 (23.7, 26.8)	10.9 (6.9, 14.9)
Stage-2 hypertension	5.1 (4.4, 5.9)	16.2 (14.9, 17.6)	11.1 (6.9, 15.3)
Crude (stage-1 plus stage-2) hypertension	19.4 (18.0, 21.0)	41.4 (39.4, 43.5)	22.0 (18.3, 25.7)
Female			
Normal	40.6 (38.5, 42.7)	40.6 (38.5, 42.7)	
Isolated systolic hypertension	6.8 (6.0, 7.8)	3.9 (3.3, 4.7)	−2.9 (−7.2, 1.4)
Isolated diastolic hypertension	8.1 (7.1, 9.2)	20.3 (18.7, 21.9)	12.2 (8.1, 16.3)
Both systolic and diastolic hypertension	10.6 (9.6, 11.8)	24.2 (22.6, 25.8)	13.6 (10.7, 16.4)
Controlled patients on medication	6.3 (5.5, 7.3)	6.1 (5.3, 7.1)	−0.2 (−4.1, 4.4)
Pre-hypertension[a]/elevated blood pressure[a]	27.6 (26.0, 29.2)	4.9 (4.2, 5.7)	−22.6 (−19.4, −26.0)
Stage-1 hypertension	22.1 (20.6, 23.7)	29.0 (27.3, 30.7)	6.9 (3.1, 10.7)
Stage-2 hypertension	9.8 (8.8, 10.8)	25.5 (23.9, 27.2)	15.8 (11.8, 19.7)
Crude (stage-1 plus stage-2) hypertension	31.9 (30.1, 33.6)	54.5 (52.4, 56.4)	22.6 (19.4, 26.0)
Overall			
Normal	46.9 (45.3, 48.6)	46.9 (45.3, 48.6)	
Isolated systolic hypertension	5.4 (4.9, 6.1)	3.5 (3.1, 4.0)	−1.9 (−5.0, 1.1)
Isolated diastolic hypertension	7.1 (6.4, 7.8)	20.4 (19.3, 21.5)	13.3 (10.4, 16.2)
Both systolic and diastolic hypertension	8.4 (7.7, 9.2)	19.6 (18.5, 20.9)	11.2 (8.3, 14.2)
Controlled patients on medication	4.8 (4.2, 5.4)	4.5 (3.9, 5.1)	−0.3 (−3.4, 2.7)
Pre-hypertension[a]/elevated blood pressure[a]	27.4 (26.2, 28.5)	5.0 (4.5, 5.6)	−22.3 (−19.8, −24.8)
Stage-1 hypertension	18.2 (17.2, 19.4)	27.1 (26.0, 28.3)	8.9 (6.1, 11.6)

Categories	JNC7	2017 ACC/AHA	Difference (95% CI)
Stage-2 hypertension	7.5 (6.8, 8.2)	20.9 (19.8, 22.1)	13.4 (10.6, 16.3)
Crude (stage-1 plus stage-2) hypertension	25.7 (24.5, 27.0)	48.0 (46.4, 49.7)	22.3 (19.8, 24.8)

JNC Joint National Committee, *ACC/AHA* American College of Cardiology/American Heart Association

[a]Pre-hypertension and elevated blood pressure according to the JNC7 and 2017 ACC/AHA guidelines, respectively

Table 4

Absolute differences in prevalence of hypertension according to JNC7 to 2017 ACC/AHA guidelines with demographic characteristics (with 95% confidence interval)

Traits	JNC7	2017 ACC/AHA	Difference
Age (in years)			
35–44	17.1 (15.5, 18.8)	42.5 (40.2, 44.8)	25.4 (21.1, 29.8)
45–54	25.0 (22.9, 27.3)	47.6 (45.0, 50.2)	22.6 (18.0, 27.2)
55–64	30.2 (27.4, 33.1)	51.2 (47.9, 54.6)	21.0 (15.2, 26.9)
≥65	40.3 (37.4, 43.3)	57.2 (54.1, 60.2)	16.9 (11.5, 22.2)
Sex			
Male	19.4 (18.0, 21.0)	41.4 (39.4, 43.5)	22.0 (18.3, 25.7)
Female	31.9 (30.1, 33.6)	54.5 (52.4, 56.6)	22.6 (19.4, 26.0)
Body mass index (kg/m^2)			
<18.5	18.6 (16.5, 20.9)	35.2 (32.6, 37.9)	16.6 (10.9, 22.4)
18.5–24.9	26.1 (24.4, 27.9)	48.4 (46.3, 50.6)	22.3 (18.5, 26.3)
25–29.9	42.9 (38.4, 47.6)	70.2 (65.4, 74.6)	27.3 (19.1, 35.5)
≥30	67.3 (53.9, 80.7)	84.6 (75.4, 93.8)	17.3 (1.1, 33.6)
Diabetes			
No	24.3 (23.0, 25.6)	46.7 (44.9, 48.5)	22.4 (19.7, 25.1)
Yes	38.8 (34.9, 42.7)	60.7 (56.7, 64.7)	22.0 (15.2, 28.8)
Education			
No formal education	26.1 (24.5, 27.6)	48.1 (46.1, 50.1)	22.0 (18.9, 25.2)
Primary	22.5 (20.1, 25.0)	43.2 (40.2, 46.3)	20.7 (14.7, 26.7)
Secondary	23.5 (20.6, 26.7)	47.6 (44.2, 51.1)	24.1(17.0, 31.3)
Tertiary	36.4 (31.9, 41.1)	63.2 (58.3, 67.9)	26.8 (17.8, 35.8)
Household wealth status			
Poorest	18.8 (14.3, 23.3)	38.2 (34.3, 42.1)	19.4 (13.4, 25.4)
Poorer	21.6 (17.1, 26.1)	41.2 (37.3, 45.0)	19.6 (13.6, 25.5)
Middle	22.3 (19.9, 24.9)	45.3 (42.4, 48.3)	23.0 (17.3, 28.8)
Richer	27.6 (25.2, 30.1)	51.5 (48.5, 54.5)	23.9 (18.5, 29.3%)
Richest	37.3 (34.7, 40.0)	62.7 (59.8, 65.5)	25.4 (20.6, 30.3)

Traits	JNC7	2017 ACC/AHA	Difference
Place of residence			
Urban	32.6 (30.2, 35.1)	58.0 (55.3, 60.6)	25.4 (20.6, 30.2)
Rural	23.6 (22.2, 25.1)	45.0 (43.0, 47.0)	21.4 (18.5, 24.3)
Region			
Barisal	24.7 (21.7, 27.9)	44.8 (41.0, 48.7)	20.1 (9.8, 30.5)
Chittagong	22.0 (19.3, 25.0)	42.7 (39.6, 45.9)	20.7 (14.5, 27.0)
Dhaka	27.1 (24.4, 29.8)	51.1 (47.5, 54.8)	24.0 (19.7, 28.4)
Khulna	30.2 (26.7, 33.9)	55.5 (51.2, 59.7)	25.3 (18.7, 31.9)
Rajshahi	23.7 (20.9, 26.7)	42.8 (38.8, 47.0)	19.1 (12.5, 25.9)
Rangpur	28.2 (25.0, 31.6)	51.4 (46.6, 56.1)	23.2 (16.1, 30.3)
Sylhet	20.5 (17.0, 24.4)	39.6 (35.2, 44.2)	19.1 (8.2, 30.1)