



# Potential US Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline

**BACKGROUND:** The 2017 American College of Cardiology/American Heart Association (ACC/AHA) Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults provides recommendations for the definition of hypertension, systolic and diastolic blood pressure (BP) thresholds for initiation of antihypertensive medication, and BP target goals.

**OBJECTIVES:** This study sought to determine the prevalence of hypertension, implications of recommendations for antihypertensive medication, and prevalence of BP above the treatment goal among US adults using criteria from the 2017 ACC/AHA guideline and the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7).

**METHODS:** The authors analyzed data from the 2011 to 2014 National Health and Nutrition Examination Survey (N = 9623). BP was measured 3 times following a standardized protocol and averaged. Results were weighted to produce US population estimates.

**RESULTS:** According to the 2017 ACC/AHA and JNC7 guidelines, the crude prevalence of hypertension among US adults was 45.6% (95% confidence interval [CI]: 43.6% to 47.6%) and 31.9% (95% CI: 30.1% to 33.7%), respectively, and antihypertensive medication was recommended for 36.2% (95% CI: 34.2% to 38.2%) and 34.3% (95% CI: 32.5% to 36.2%) of US adults, respectively. Nonpharmacological intervention is advised for the 9.4% of US adults with hypertension who are not recommended for antihypertensive medication according to the 2017 ACC/AHA guideline. Among US adults taking antihypertensive medication, 53.4% (95% CI: 49.9% to 56.8%) and 39.0% (95% CI: 36.4% to 41.6%) had BP above the treatment goal according to the 2017 ACC/AHA and JNC7 guidelines, respectively.

**CONCLUSIONS:** Compared with the JNC7 guideline, the 2017 ACC/AHA guideline results in a substantial increase in the prevalence of hypertension, a small increase in the percentage of US adults recommended for antihypertensive medication, and more intensive BP lowering for many adults taking antihypertensive medication.

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## Clinical Perspective

### What Is New?

- Using cardiovascular risk in conjunction with blood pressure levels is an efficient approach to direct pharmacological antihypertensive treatment to those who are likely to benefit most.
- Many US adults are recommended more intensive antihypertensive medication according to the 2017 ACC/AHA Hypertension Guideline.

### What Are the Clinical Implications?

- Implementation of the 2017 ACC/AHA Hypertension Guideline has the potential to increase the prevalence of hypertension and use of antihypertensive medication among US adults. This should translate into a reduction in cardiovascular disease events.

The American College of Cardiology/American Heart Association (ACC/AHA) Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults provides comprehensive information on the prevention and treatment of hypertension.<sup>1</sup> This guideline updated the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC7), which was published in 2003.<sup>2</sup> Compared with the JNC7 guideline, the 2017 ACC/AHA guideline recommends using lower systolic blood pressure (SBP) and diastolic blood pressure (DBP) levels to define hypertension (Table 1). All adults recommended for antihypertensive medication by JNC7 are also recommended for antihypertensive medication by the 2017 ACC/AHA guideline. Additionally, adults with high cardiovascular disease (CVD) risk with SBP of 130 to 139 mm Hg or DBP of 80 to 89 mm Hg and adults ≥65 years of age with SBP of 130 to 139 mm Hg are recommended for antihypertensive medication by the 2017 ACC/AHA guideline. The 2017 ACC/AHA guideline recommends treating SBP/DBP to <130/80 mm Hg for all adults taking antihypertensive medication. This is lower than the goal recommended by JNC7, with the exception of adults with diabetes or chronic kidney disease, where the treatment goal has not changed. Each of the recommendations in the 2017 ACC/AHA guideline was based on systematic evaluations by an evidence review team and/or members of the guideline writing committee.<sup>1</sup>

The purpose of the current analysis was to estimate the percentage and number of US adults with hypertension and the percentage recommended for pharmacological antihypertensive treatment according to the 2017 ACC/AHA guideline, as compared with the

**Table 1. BP Levels Used to Define Hypertension, Recommend Antihypertensive Medication, and Treatment Goal According to the 2017 ACC/AHA Guideline, the JNC7 Guideline, and the JNC8 Panel Member Report**

	2017 ACC/AHA	JNC7	JNC8 Panel Member Report
Guideline definition of hypertension			
SBP, mm Hg			
General population	≥130	≥140	≥140
≥60 yrs of age without diabetes or CKD	*	*	≥150
DBP, mm Hg			
General population	≥80	≥90	≥90
Guideline-recommended antihypertensive medication			
SBP, mm Hg			
General population	≥140	≥140	≥140
Diabetes or CKD	≥130	≥130	≥140
High cardiovascular disease risk†	≥130	*	*
Age ≥65 yrs	≥130	*	*
≥60 yrs of age without diabetes or CKD	*	*	≥150
DBP, mm Hg			
General population	≥90	≥90	≥90
Diabetes or CKD	≥80	≥80	*
High cardiovascular disease risk†	≥80	*	*
Guideline treatment goal among those taking antihypertensive medication			
SBP, mm Hg			
General population	<130	<140	<140
Diabetes or CKD	<130	<130	<140
Age ≥65 yrs	<130	*	*
≥60 yrs of age without diabetes or CKD	*	*	<150
DBP, mm Hg			
General population	<80	<90	<90
Diabetes or CKD	<80	<80	*

SBP and DBP levels should be based on multiple measurements taken at 2 or more visits. In the National Health and Nutrition Examination Survey, BP was measured 3 times at a single visit. In the top section, adults with SBP or DBP above the levels listed and those taking antihypertensive medication are considered to have hypertension. In the middle section, adults with SBP or DBP above the levels listed and those taking antihypertensive medication are recommended for antihypertensive medication. In the bottom section, to achieve treatment goals, both the SBP and DBP goals have to be met.

\*No specific BP threshold is provided in the guideline for this population. The other thresholds listed from the guideline should be applied, as appropriate.

†High cardiovascular risk is defined as a history of cardiovascular disease or 10-year predicted cardiovascular disease risk ≥10% using the Pooled Cohort risk equations.

ACC/AHA = American College of Cardiology/American Heart Association; BP = blood pressure; CKD = chronic kidney disease; DBP = diastolic blood pressure; JNC7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure; JNC8 = Eighth Joint National Committee; SBP = systolic blood pressure.

JNC7 guideline. Additionally, we estimated the percentage and number of US adults taking antihypertensive medication with blood pressure (BP) levels above goal using targets from each guideline. US adults taking antihypertensive medication with BP levels above goal according to the 2017 ACC/AHA guideline are recommended for more intensive antihypertensive treatment. To accomplish these goals, we analyzed data from the US National Health and Nutrition Examination Survey (NHANES). As a secondary goal, we contrasted prevalence estimates from the 2017 ACC/AHA guideline with those obtained using the 2014 report from the panel members appointed to the Eighth Joint National Committee (JNC8 panel member report).<sup>3</sup>

## METHODS

NHANES is conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention with the goal of monitoring the health status of the US general population.<sup>4</sup> Since 1999, NHANES has been conducted in 2-year cycles. For each cycle, potential participants are identified through stratified, multistage probability sampling of the noninstitutionalized US population. Using sampling weights, nationally representative estimates for the noninstitutionalized US population can be generated and NHANES cycles can be combined to provide more stable prevalence estimates when needed. For the current analysis, we pooled data from the 2011 to 2012 and 2013 to 2014 NHANES cycles. The current analysis was restricted to adult participants, 20 years of age and older ( $n = 10907$ ). Participants who did not have 3 SBP and DBP measurements obtained during their study visit ( $n = 704$ ) or who were missing data on self-reported antihypertensive medication ( $n = 13$ ) were excluded. Also, participants missing data on variables (age, sex, race, smoking, total and HDL cholesterol, and diabetes) used to calculate 10-year predicted CVD risk according to the Pooled Cohort risk equations ( $n = 567$ ) were excluded. After these exclusions were applied, data from 9623 participants were available for the current analyses. The protocols for NHANES 2011 to 2012 and 2013 to 2014 were approved by the National Center for Health Statistics of the Centers for Disease Control and Prevention Institutional Review Board. Written informed consent was obtained from each participant.

## Data Collection

NHANES data were collected through the administration of standardized questionnaires and a medical evaluation at a mobile examination clinic. Covariates included in this analysis and their method of ascertainment are described in [online-only Data Supplement Table 1](#).

## BP Measurement and Antihypertensive Medication Use

BP was measured by a trained physician using a mercury sphygmomanometer and an appropriately sized cuff. Cuff sizes were selected after measurement of each participant's mid-right arm circumference. Readings were obtained after

5 min of seated rest. Three BP measurements were obtained at 30-s intervals. The mean of the 3 measurements was used to define SBP and DBP. Quality control included quarterly recertification with retraining as needed, and annual retraining of all physicians. Certification required video test recognition of Korotkoff sounds and performing measurements on volunteers. Participants who responded affirmatively to both of the questions, "Have you ever been told by a doctor or other healthcare professional that you had hypertension, also called high blood pressure?" and "Are you now taking prescribed medication for high blood pressure?" were considered to be taking antihypertensive medication.

## CVD Risk

History of CVD was defined by self-report of a prior diagnosis of myocardial infarction, coronary heart disease, stroke, or heart failure. Among those without a history of CVD, 10-year predicted CVD risk was calculated using the Pooled Cohort risk equations.<sup>5</sup> Participants were categorized into 1 of 5 mutually exclusive groups including history of CVD and no history of CVD with 10-year predicted CVD risk <5%, 5% to <10%, 10% to <20%, and  $\geq 20\%$ . High CVD risk was defined as having a history of CVD or a 10-year predicted CVD risk  $\geq 10\%$ .

## Definitions of Hypertension, Recommendations for Antihypertensive Medication, and BP Treatment Goals

The 2017 ACC/AHA and JNC7 guideline and JNC8 panel member report definitions of hypertension, criteria for recommending antihypertensive medication, and recommended BP goals for adults taking antihypertensive medication are provided in Table 1.

## Statistical Analysis

We calculated the distribution of the population across 5 groups including those not taking antihypertensive medication with SBP/DBP <120/<80 mm Hg, 120 to 129/<80 mm Hg, 130 to 139/80 to 89 mm Hg, and  $\geq 140/90$  mm Hg, and those taking antihypertensive medication. These levels represent the BP stages in the 2017 ACC/AHA guideline ([online-only Data Supplement Table 2](#)). Participants with SBP and DBP in 2 categories (eg, SBP <120 mm Hg and DBP between 80 and 89 mm Hg) were designated into the higher category. We calculated the demographic and clinical characteristics of US adults in each of these groups. Next, we calculated the percentage and number of US adults with hypertension and recommended for antihypertensive medication according to the 2017 ACC/AHA guideline, the JNC7 guideline, and the 2017 ACC/AHA guideline but not the JNC7 guideline. Also, we calculated the percentage and number of US adults taking antihypertensive medication with BP above goal according to the 2017 ACC/AHA guideline, JNC7 guideline, and the 2017 ACC/AHA guideline but not the JNC7 guideline. These calculations were done for the overall population and within subgroups defined by age, sex, race/ethnicity, and CVD risk categories. Demographic and clinical characteristics of US adults with hypertension and, separately, taking

antihypertensive medication with BP above goal according to the 2017 ACC/AHA guideline, JNC7 guideline, and the 2017 ACC/AHA guideline but not the JNC7 guideline were calculated. In a secondary analysis, we calculated the percentage of US adults with hypertension, recommended for antihypertensive medication, and with BP above goal according to the JNC8 panel member report published in 2014.

NHANES sampling weights were used in all calculations to obtain US nationally representative prevalence estimates. These weights were recalibrated based on the proportion of participants missing data by age, sex, and race/ethnicity within each NHANES cycle. Recalibration of the sampling weights corrects for differences in missing data across age,

sex, and race/ethnicity strata, and assumes that data within strata are missing at random.<sup>6</sup> Data management was conducted in SAS version 9.4 (SAS Institute, Cary, North Carolina) and data analysis was conducted in Stata version 14 (Stata Corporation, College Station, Texas).

## RESULTS

In 2011 to 2014, 42.3%, 12.1%, 13.7%, and 7.7% of US adults not taking antihypertensive medication had SBP/DBP levels of <120/80 mmHg, 120 to 129/<80 mmHg, 130 to 139/80 to 89 mmHg, and

**Table 2. Characteristics of US Adults by BP Levels and Antihypertensive Medication Use Based on the 2011 to 2014 NHANES**

	SBP/DBP Categories Among US Adults Not Taking Antihypertensive Medication (mm Hg)				Taking Antihypertensive Medication (n = 2587)
	<120/80 (n = 3827)	120–129/<80 (n = 1114)	130–139/80–89 (n = 1276)	≥140/90 (n = 819)	
Percentage of US population	42.3 (40.3–44.3)	12.1 (11.0–13.3)	13.7 (12.7–14.9)	7.7 (6.8–8.7)	24.1 (22.4–26.0)
Population characteristics					
Age, yrs	38.8 ± 0.4	45.0 ± 0.7	47.1 ± 0.7	54.6 ± 0.6	61.6 ± 0.3
Male	41.1	60.4	58.0	58.1	45.0
Race/ethnicity					
Non-Hispanic white	63.5	66.2	66.7	63.7	71.2
Non-Hispanic black	9.1	10.8	11.6	14.5	14.8
Non-Hispanic Asian	6.5	4.9	4.7	6.0	3.4
Hispanic	18.2	14.9	14.0	12.4	8.7
Cigarette smoking	19.8	23.8	20.6	21.0	15.5
Total cholesterol, mg/dl	187.6 ± 1.0	195.3 ± 1.1	201.0 ± 1.8	206.3 ± 2.1	190.2 ± 1.3
HDL cholesterol, mg/dl	54.2 ± 0.4	51.9 ± 0.6	52.8 ± 0.7	54.0 ± 0.9	51.6 ± 0.5
Statin use	6.7	12.0	12.0	13.5	47.8
Diabetes	3.7	7.6	9.1	14.1	26.7
Reduced eGFR	2.3	2.3	3.4	8.7	20.8
Albuminuria	4.7	6.1	9.4	15.6	17.6
SBP, mmHg	108.9 ± 0.2	124.2 ± 0.1	128.0 ± 0.3	148.3 ± 0.9	130.7 ± 0.6
DBP, mmHg	66.5 ± 0.3	70.4 ± 0.4	78.6 ± 0.3	82.5 ± 0.7	71.1 ± 0.4
Mean 10-yr predicted CVD risk*	2.4 ± 0.1	5.0 ± 0.2	5.9 ± 0.3	13.1 ± 0.6	17.8 ± 0.4
High risk, † %	7.5	15.1	19.8	46.1	61.8
10-yr risk categories					
<5%	85.6	69.7	63.5	37.4	21.7
5% to <10%	6.9	15.2	16.7	16.4	16.6
10% to <20%	3.2	6.8	10.5	19.8	19.7
≥20%	1.5	4.7	5.1	20.4	20.1
History of CVD	2.9	3.6	4.2	6.0	21.9

Values are % (95% confidence interval), mean ± standard error, or %. US adults were grouped into the higher category of SBP and DBP. For example, if a person had SBP of 146 mmHg and DBP of 82 mmHg, they were grouped into the ≥140/90 mmHg category. Reduced eGFR was defined by levels <60 ml/min/1.73 m<sup>2</sup>. Albuminuria was defined by an albumin-to-creatinine ratio ≥30 mg/g.

\*10-year predicted risk was calculated using the Pooled Cohort risk equations. Mean risk was calculated among adults without a history of CVD.

†High risk defined as a 10-year predicted cardiovascular disease risk ≥10% or history of CVD.

CI = confidence interval; CVD = cardiovascular disease; eGFR = estimated glomerular filtration rate; HDL = high-density lipoprotein; NHANES = National Health and Nutrition Examination Survey; other abbreviations as in Table 1.

**Table 3.** Percentage of US Adults Meeting the Definition for Hypertension and Recommended Antihypertensive Medication According to the 2017 ACC/AHA Guideline and the JNC7 Guideline Based on the 2011–2014 NHANES

	2017 ACC/AHA Guideline		JNC7 Guidelines		Difference (2017 ACC/AHA, But Not JNC7)	
	Hypertension	Recommended Antihypertensive Medication	Hypertension	Recommended Antihypertensive Medication	Hypertension	Recommended Antihypertensive Medication
Overall	45.6 (43.6–47.6)	36.2 (34.2–38.2)	31.9 (30.1–33.7)	34.3 (32.5–36.2)	13.7 (12.7–14.9)	1.9 (1.5–2.3)
Age group, yrs						
20–44	24.0 (21.8–26.2)	12.5 (11.2–13.9)	10.5 (9.4–11.7)	12.2 (10.9–13.6)	13.4 (12.0–15.0)	0.3 (0.1–0.5)
45–54	47.1 (44.4–49.8)	33.4 (30.8–36.1)	29.5 (27.0–32.2)	32.7 (30.1–35.4)	17.6 (15.1–20.4)	0.7 (0.4–1.2)
55–64	66.6 (63.6–69.5)	58.2 (54.9–61.4)	52.4 (49.1–55.7)	55.0 (62.0–58.0)	14.2 (12.1–16.6)	3.2 (2.1–4.7)
65–74	75.6 (73.4–77.6)	74.1 (71.4–76.6)	63.6 (60.2–66.9)	66.9 (63.7–69.9)	12.0 (9.4–15.2)	7.2 (5.2–10.0)
≥75	82.3 (79.2–85.0)	82.3 (79.2–85.0)	75.1 (71.9–78.1)	78.5 (74.7–81.8)	7.1 (5.6–9.0)	3.8 (2.5–5.6)
Men	48.6 (45.9–51.3)	37.3 (34.9–39.8)	32.0 (29.8–34.3)	34.8 (32.4–37.3)	16.6 (15.0–18.3)	2.5 (2.0–3.1)
Women	42.9 (40.7–45.1)	35.1 (33.1–37.3)	31.8 (29.8–33.8)	33.8 (31.8–35.9)	11.1 (9.8–12.5)	1.3 (0.9–1.9)
Race/ethnicity						
Non-Hispanic white	47.3 (44.5–50.0)	37.9 (35.3–40.6)	33.4 (31.1–35.8)	35.7 (33.3–38.2)	13.8 (12.4–15.4)	2.2 (1.6–2.8)
Non-Hispanic black	54.9 (52.5–57.3)	44.8 (42.5–47.0)	41.0 (39.0–43.1)	43.6 (41.4–45.8)	13.9 (12.2–15.7)	1.2 (0.8–1.8)
Non-Hispanic Asian	36.7 (32.6–40.9)	27.9 (24.2–32.0)	24.4 (21.1–28.2)	26.8 (23.1–30.8)	12.2 (10.4–14.3)	1.1 (0.6–2.0)
Hispanic	34.4 (31.8–37.1)	25.5 (23.0–28.1)	21.1 (18.7–23.8)	24.3 (21.8–26.9)	13.3 (11.7–15.1)	1.2 (0.9–1.6)
Risk categories						
<5%	27.4 (25.6–29.3)	14.6 (13.3–16.0)	13.2 (12.0–14.5)	14.6 (13.3–16.0)	14.2 (13.1–15.4)	0.0 (0.0–0.0)
5% to <10%	61.4 (57.2–65.3)	48.4 (44.5–52.3)	42.7 (38.5–47.1)	46.6 (42.7–50.5)	18.6 (15.2–22.6)	1.8 (0.9–3.6)
10% to <20%	78.2 (74.7–81.4)	78.2 (74.7–81.4)	63.6 (58.4–68.5)	68.3 (63.5–72.7)	14.6 (11.5–18.4)	9.9 (7.7–12.7)
≥20%	85.7 (82.7–88.2)	85.7 (82.7–88.2)	77.3 (74.0–80.3)	81.4 (77.7–84.6)	8.4 (7.1–9.8)	4.3 (3.1–5.8)
History of CVD	79.3 (75.6–82.6)	79.3 (75.6–82.6)	72.1 (68.8–75.3)	75.7 (72.7–78.4)	7.2 (5.0–10.3)	3.7 (2.1–6.2)

Values are % of US adults (95% confidence interval). See Table 1 for the definitions of hypertension and antihypertensive medication treatment recommendations.

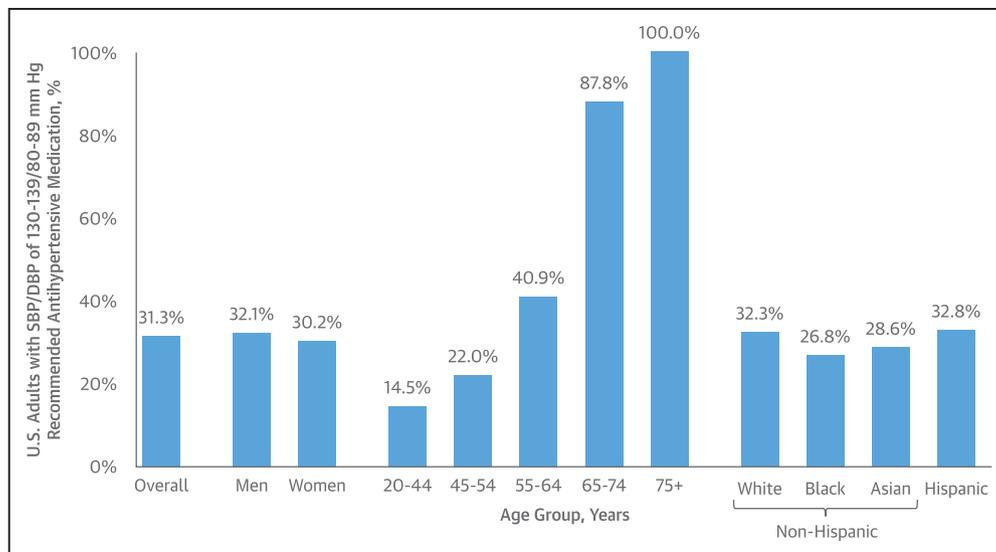
Abbreviations as in Tables 1 and 2.

≥140/90 mm Hg, respectively (Table 2). Additionally, 24.1% of US adults were taking antihypertensive medication. US adults with higher BP were older and were more likely to be non-Hispanic black; be taking a statin; and have diabetes, reduced estimated glomerular filtration rate, albuminuria, and a history of CVD. Total cholesterol levels and mean 10-year predicted CVD risk were higher at higher BP levels.

The prevalence of hypertension was 45.6% and 31.9% according to the 2017 ACC/AHA and JNC7 guideline definitions, respectively (Table 3). The prevalence of hypertension was higher when defined by the 2017 ACC/AHA guideline compared with the JNC7 guideline within all age, sex, race/ethnicity, and CVD risk category subgroups. Antihypertensive medication was advised for 36.2% of US adults according to the 2017 ACC/AHA guideline compared with 34.3% of adults with hypertension according to the JNC7 guideline. An increase in the percentage of the population recommended for antihypertensive medication by the

2017 ACC/AHA guideline compared with the JNC7 report was present for all age, sex, race/ethnicity, and CVD risk subgroups investigated except those with a 10-year CVD risk <5%. Among US adults with SBP/DBP of 130 to 139/80 to 89 mm Hg, 31.3% were recommended for antihypertensive medication according to the 2017 ACC/AHA guideline because they had diabetes, chronic kidney disease, or high CVD risk, or they had SBP of 130 to 139 mm Hg and were ≥65 years of age (Figure 1).

In 2011 to 2014, 103.3 million US adults met the definition for hypertension according to the 2017 ACC/AHA guideline compared with 72.2 million US adults according to the JNC7 guideline (Table 4). Based on use of the 2017 ACC/AHA guideline, 81.9 million US adults met criteria for treatment with antihypertensive medication in addition to nonpharmacological interventions, whereas 21.4 million met criteria for treatment with nonpharmacological therapy on its own. An additional 4.2 million US adults were recom-



**Figure 1.** Percentage of US adults with SBP of 130 to 139 mm Hg or DBP of 80 to 89 mm Hg recommended for antihypertensive medication according to the 2017 ACC/AHA guideline.

This figure shows the percentage of US adults not taking antihypertensive medication who have SBP of 130 to 139 mm Hg or DBP of 80 to 89 mm Hg that are recommended for antihypertensive medication. These individuals are recommended for antihypertensive medication according to the 2017 ACC/AHA hypertension guideline because they have SBP of 130 to 139 mm Hg or DBP 80 to 89 mm Hg and a history of cardiovascular disease, a 10-year predicted risk for cardiovascular disease  $\geq 10\%$ , diabetes, or chronic kidney disease; or have an SBP of 130 to 139 mm Hg and are  $\geq 65$  years of age. Overall, 31.3% of US adults with SBP of 130 to 139 mm Hg or DBP 80 to 89 mm Hg are recommended for antihypertensive medication according to the 2017 ACC/AHA guideline. ACC/AHA = American College of Cardiology/American Heart Association; DBP = diastolic blood pressure; SBP = systolic blood pressure.

mended for antihypertensive medication according to the 2017 ACC/AHA guideline compared with the JNC7 guideline.

Compared with US adults defined as having hypertension according to the JNC7 guideline, those with hypertension defined by the 2017 ACC/AHA guideline but not the JNC7 guideline were younger; had lower total cholesterol, SBP, DBP, and 10-year predicted CVD risk levels; and were less likely to have diabetes, reduced estimated glomerular filtration rate, albuminuria, and a history of CVD (online-only Data Supplement Table 3). Those recommended for antihypertensive medication by the 2017 ACC/AHA guideline but not the JNC7 guideline had lower mean SBP and DBP levels, but a higher mean 10-year CVD risk than their counterparts who were recommended for antihypertensive medication by the JNC7 guideline. Also, US adults in this group were older and were more likely to be male, be non-Hispanic white, be cigarette smokers, and have a history of CVD.

Among US adults taking antihypertensive medication, 53.4% had above-goal BP according to the 2017 ACC/AHA guideline compared with 39.0% with above-goal BP according to the JNC7 guideline (Table 5). BP above goal, defined using thresholds from the 2017 ACC/AHA guideline instead of the JNC7 guideline, was more than 10 percentage points higher in each subgroup investigated except for those  $\geq 75$

years of age and taking  $\geq 4$  classes of antihypertensive medication, where the prevalence was 7.1 and 9.3 percentage points higher, respectively. There were 54.7 million US adults taking antihypertensive medication in 2011 to 2014, of whom 29.2 and 21.3 million US adults had BP above goal according to the 2017 ACC/AHA and JNC7 guidelines, respectively (online-only Data Supplement Table 4). Characteristics of US adults taking antihypertensive medication with BP above goal according to the 2017 ACC/AHA guideline, the JNC7 guideline, and the 2017 ACC/AHA guideline but not the JNC7 guideline are presented in online-only Data Supplement Table 5. Overall, 47.9% and 31.8% of US adults with BP above goal according to the 2017 ACC/AHA guideline but not the JNC7 guideline were taking 1 and 2 classes of antihypertensive medication, respectively.

### Comparison of the 2017 ACC/AHA Guideline With JNC8 Panel Member Report

Overall, 31.1% of US adults had hypertension according to the JNC8 panel member report (online-only Data Supplement Table 6). Compared with the JNC8 panel member report, an additional 5.1% of US adults were recommended for antihypertensive medication accord-

**Table 4.** Number of US Adults, in Millions, Meeting the Definitions for Hypertension and for Treatment With Antihypertensive Medication According to the 2017 ACC/AHA Guideline and the JNC7 Guideline Based on the 2011–2014 NHANES

	2017 ACC/AHA Guideline		JNC7 Guideline		Difference (2017 ACC/AHA vs. JNC7)	
	Hypertension	Recommended Antihypertensive Medication	Hypertension	Recommended Antihypertensive Medication	Hypertension	Recommended Antihypertensive Medication
Overall	103.3 (92.7–114.0)	81.9 (73.8–90.1)	72.2 (65.3–79.1)	77.7 (70.0–85.5)	31.1 (26.6–35.6)	4.2 (3.3–5.1)
Age group, yrs						
20–44	24.7 (21.6–27.9)	12.9 (11.3–14.4)	10.9 (9.6–12.2)	12.6 (11.1–14.1)	13.9 (11.7–16.0)	0.3 (0.1–0.5)
45–54	20.1 (17.7–22.6)	14.3 (12.6–15.9)	12.6 (11.2–14.0)	14.0 (12.4–15.6)	7.5 (5.9–9.1)	0.3 (0.1–0.4)
55–64	26.2 (22.4–30.0)	22.9 (19.6–26.2)	20.6 (17.7–23.5)	21.6 (18.5–24.7)	5.6 (4.2–6.9)	1.3 (0.7–1.8)
65–74	18.5 (16.1–20.9)	18.1 (15.9–20.4)	15.6 (13.5–17.6)	16.4 (14.3–18.4)	2.9 (2.1–3.8)	1.8 (1.1–2.4)
≥75	13.8 (11.7–15.8)	13.8 (11.7–15.8)	12.6 (10.9–14.3)	13.1 (11.2–15.1)	1.2 (0.8–1.6)	0.6 (0.4–0.9)
Men	52.8 (46.6–59.1)	40.6 (35.7–45.5)	34.8 (30.6–39.0)	37.9 (33.2–42.6)	18.1 (15.3–20.8)	2.7 (2.0–3.4)
Women	50.5 (45.4–55.6)	41.4 (37.6–45.1)	37.4 (34.1–40.8)	39.9 (36.2–43.5)	13.1 (10.8–15.4)	1.5 (0.9–2.1)
Race/ethnicity						
Non-Hispanic white	70.8 (58.3–83.3)	56.8 (47.1–66.4)	50.1 (41.7–58.4)	53.5 (44.4–62.7)	20.7 (16.0–25.4)	3.2 (2.2–4.2)
Non-Hispanic black	14.3 (11.3–17.2)	11.6 (9.2–14.1)	10.7 (8.4–12.9)	11.3 (8.9–13.7)	3.6 (2.8–4.4)	0.3 (0.2–0.5)
Non-Hispanic Asian	4.4 (3.5–5.3)	3.3 (2.6–4.1)	2.9 (2.3–3.6)	3.2 (2.5–3.9)	1.5 (1.1–1.8)	0.1 (0.0–0.2)
Hispanic	11.3 (8.4–14.2)	8.4 (6.0–10.8)	6.9 (4.8–9.0)	8.0 (5.7–10.3)	4.4 (3.4–5.3)	0.4 (0.2–0.5)
Risk categories						
<5%	38.2 (33.6–42.7)	20.4 (18.0–22.8)	18.4 (16.2–20.6)	20.4 (18.0–22.8)	19.8 (16.9–22.6)	0.0 (0.0–0.0)
5% to <10%	17.1 (14.3–19.9)	13.5 (11.3–15.7)	11.9 (9.9–14.0)	13.0 (11.0–15.1)	5.2 (3.8–6.6)	0.5 (0.1–0.9)
10% to <20%	17.5 (15.3–19.8)	17.5 (15.3–19.8)	14.3 (12.4–16.1)	15.3 (13.4–17.3)	3.3 (2.3–4.3)	2.2 (1.5–2.9)
≥20%	16.1 (13.8–18.5)	16.1 (13.8–18.5)	14.6 (12.5–16.7)	15.3 (13.0–17.7)	1.6 (1.2–1.9)	0.8 (0.6–1.1)
History of CVD	14.3 (12.6–16.1)	14.3 (12.6–16.1)	13.0 (11.4–14.7)	13.7 (12.0–15.4)	1.3 (0.8–1.8)	0.7 (0.3–1.0)

Values are number of US adults in millions (95% CI). See Table 1 for the definitions of hypertension and antihypertensive medication treatment recommendations.

Abbreviations as in Tables 1 and 2.

ing to the 2017 ACC/AHA guideline. The percentage of US adults recommended for antihypertensive treatment according to the 2017 ACC/AHA guideline but not the JNC8 panel member report was higher at older ages, among men compared with women, and among non-Hispanic whites compared with other racial/ethnic groups, and was highest for US adults with 10-year predicted CVD risk of 10% to <20% and ≥20% compared with their counterparts in the other risk categories. Overall, 28.7% of US adults taking antihypertensive medication had BP above goal according to the thresholds in the 2017 ACC/AHA guideline, but met the BP goal according to the JNC8 panel member report (online-only Data Supplement Table 7).

## DISCUSSION

The current study documents the potential impact of the 2017 ACC/AHA guideline definition of hypertension, recommendation for antihypertensive medication in addition to nonpharmacological interventions, and

BP goals with antihypertensive drug treatment for US adults (Figure 2 - Central Illustration). We estimate that the 2017 ACC/AHA hypertension guideline will result in a substantial increase in the proportion of US adults defined as having hypertension. However, by using a combination of BP levels and CVD risk to guide treatment with antihypertensive medication, there will be only a small increase (1.9%) in the percentage of US adults who are recommended for antihypertensive medication according to the 2017 ACC/AHA guideline compared with the JNC7 guideline. Also, 14.4% of US adults taking antihypertensive medication had a BP above the goal defined by the 2017 ACC/AHA guideline, whereas they would have met the BP goal according to the JNC7 guideline. More intensive antihypertensive treatment is recommended to achieve the 2017 ACC/AHA guideline BP goal for these individuals.

The lower SBP and DBP levels (130 and 80 mm Hg, respectively) used to define hypertension in the 2017 ACC/AHA guideline were based on data from observational studies and clinical trials. Large observational studies demonstrate a graded association between

**Table 5. Percentage of US Adults Taking Antihypertensive Medication With BP Above Treatment Goals Recommended by the 2017 ACC/AHA Guideline and the JNC7 Guideline Based on the 2011–2014 NHANES**

	BP Above Goal According to		2017 ACC/AHA Guideline, But Not the JNC Guideline
	2017 ACC/AHA Guideline	JNC7 Guideline	
Overall	53.4 (49.9–56.8)	39.0 (36.4–41.6)	14.4 (12.4–16.5)
Age group, yrs			
20–44	46.3 (38.6–54.3)	23.2 (17.5–30.0)	23.1 (17.7–29.7)
45–54	46.0 (38.6–53.5)	29.5 (24.2–35.5)	16.4 (12.6–21.2)
55–64	50.5 (44.9–56.0)	33.1 (27.9–38.6)	17.4 (13.2–22.6)
65–74	54.4 (48.6–60.1)	43.4 (38.5–48.4)	11.0 (13.2–22.6)
≥75	67.2 (61.4–72.4)	60.1 (54.1–65.7)	7.1 (5.1–9.8)
Men	51.8 (47.9–55.7)	37.5 (34.5–40.6)	14.3 (11.8–17.2)
Women	54.7 (50.1–59.2)	40.3 (36.6–44.0)	14.4 (11.9–17.3)
Race/ethnicity			
Non-Hispanic white	50.6 (46.6–54.6)	36.4 (33.3–39.5)	14.2 (11.7–17.2)
Non-Hispanic black	63.0 (58.4–67.4)	48.6 (44.2–53.1)	14.4 (12.2–16.9)
Non-Hispanic Asian	62.9 (53.6–71.3)	47.1 (39.0–55.4)	15.8 (12.0–20.5)
Hispanic	56.0 (50.7–61.1)	41.7 (36.4–47.1)	14.3 (11.6–17.5)
Number of antihypertensive classes			
0	54.7 (38.3–70.2)	44.3 (28.2–61.7)	10.5 (3.0–30.6)
1	57.5 (52.9–61.9)	38.5 (35.0–42.1)	19.0 (16.1–22.3)
2	47.7 (41.4–54.0)	35.3 (30.0–41.0)	12.4 (9.6–15.7)
3	56.1 (47.8–64.0)	44.3 (37.3–51.6)	11.8 (8.0–17.0)
≥4	55.3 (47.8–62.4)	45.9 (39.4–52.6)	9.3 (5.6–15.1)

Values are % of US adults (95% CI). See Table 1 for the definition of blood pressure treatment goals in the JNC7 and 2017 ACC/AHA guidelines.

Abbreviations as in Tables 1 and 2.

higher BP and increased risk for CVD, end-stage renal disease, subclinical atherosclerosis, and all-cause mortality.<sup>7,8</sup>

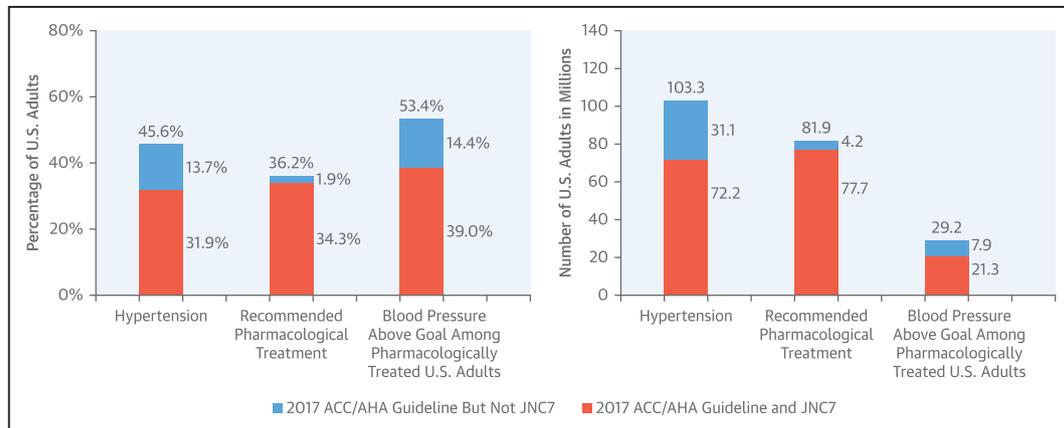
Although many studies have reported increased risk associated with an SBP/DBP of 120 to 129/80 to 84 mmHg versus <120/80 mmHg, the association is substantially stronger for an SBP/DBP of 130 to 139/85 to 89 mmHg versus <120/80 mmHg.<sup>9–12</sup> Randomized controlled trials of lifestyle modification<sup>13–15</sup> and low-dose antihypertensive medication<sup>16–18</sup> have demonstrated BP and CVD risk reduction benefits among adults with BP lower than those used to identify hypertension in the JNC7 guideline. In addition, intensive antihypertensive drug treatment in patients with hypertension to BP goals below those recommended in the JNC7 guideline has been associated with CVD and mortality risk reduction benefits.<sup>19–26</sup> Nonpharmacological therapy on its own is the recommended treatment for the majority of US adults with SBP/DBP of 130 to 139/80 to

89 mmHg. The 2017 ACC/AHA guideline writing committee concluded that there is insufficient evidence to support a recommendation for antihypertensive drug treatment in addition to nonpharmacological therapy for adults with SBP/DBP of 130 to 139/80 to 90 mmHg and low CVD risk. However, the diagnosis of hypertension provides an opportunity for health care providers and patients to discuss the value of nonpharmacological therapy in lowering BP, to implement recommended lifestyle changes, and to emphasize that BP is a risk factor that can be controlled.

CVD risk is used in conjunction with BP levels to guide the recommendation to initiate antihypertensive medication in the 2017 ACC/AHA guideline. This decision was based on a diverse set of data from randomized trials, observational studies, and simulation analyses.<sup>27</sup> In a meta-analysis of 11 trials (n = 51 917 participants), the absolute CVD risk reduction over 5 years of follow-up was –1.41, –1.95, –2.41, and –3.84 events/1 000 participants with 5-year predicted risk <11%, 11% to 15%, 15% to 21%, and >21%, respectively.<sup>28</sup> Also, simulation analyses have shown that using CVD risk in conjunction with BP levels has the potential to prevent more CVD events than basing treatment on BP levels alone, and using CVD risk in conjunction with BP levels to guide antihypertensive medication may be cost-effective.<sup>29,30</sup> In the current study, we estimated that the 2017 ACC/AHA and JNC7 guidelines would result in a small increase in the percentage of US adults being recommended for antihypertensive medication. US adults who were recommended for antihypertensive medication according to the 2017 ACC/AHA guideline but not the JNC7 guideline had high CVD risk, with 15.8% of this population having a history of CVD and a mean 10-year predicted CVD risk of 15.6% among those without a history of CVD. Based on the randomized trial evidence, this group should experience a large absolute reduction in CVD risk with antihypertensive medication.<sup>28</sup>

A number of randomized controlled trials have evaluated the potential CVD risk reduction benefits of BP goals lower than those used in JNC7.<sup>20–22</sup> The best evidence supporting BP treatment targets is derived from meta-analyses of these trials.<sup>19,23–26</sup> In a meta-analysis of 42 trials (n = 144 220 participants), the risk for CVD mortality was lowest with SBP levels between 120 and 124 mmHg.<sup>23</sup> Although some adults will benefit from treatment to lower BP levels, the 2017 ACC/AHA guideline writing committee selected SBP/DBP goals of 130/80 mmHg to account for the specific inclusion and exclusion criteria used in randomized trials and the more careful conduct of BP measurement performed in trials compared with clinical practice.<sup>20</sup>

The current analysis has several strengths. NHANES provides nationally representative estimates for the noninstitutionalized US population, and the results of



**Figure 2. Central Illustration. Prevalence of hypertension, recommendation for pharmacological antihypertensive treatment, and blood pressure above goal among US adults according to the 2017 ACC/AHA and the JNC7 guidelines.**

This graph shows the percentage (left) and number (right) of US adults with hypertension, recommended pharmacological treatment, and with blood pressure above goal among those receiving pharmacological treatment according to the 2017 ACC/AHA guideline (full bar height), the JNC7 guideline (orange bars), and the 2017 ACC/AHA guideline but not the JNC7 guideline (blue bars). ACC/AHA = American College of Cardiology/American Heart Association; JNC7 = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure.

this analysis have broad generalizability. NHANES enrolled a large sample size and oversampled population groups that facilitated the conduct of subgroup analysis. BP was measured following a standardized protocol.

### Study Limitations

The results should also be interpreted in the context of known and potential limitations. BP was measured at a single visit in NHANES. Also, the BP measurement protocol, including the use of a mercury sphygmomanometer, likely differs from the typical approach used in most settings. The 2017 ACC/AHA and the JNC7 guidelines suggest basing the diagnosis of hypertension on the average of multiple BP measurements obtained at 2 or more visits.

### CONCLUSIONS

The current analysis suggests a substantial increase in the prevalence of hypertension using the 2017 ACC/AHA guideline. However, the percentage of US adults recommended for antihypertensive medication increased modestly, with nonpharmacological interventions alone being recommended for the majority of US adults with hypertension according to the 2017 ACC/AHA guideline but not the JNC7 guideline. Additionally, over 50% of US adults taking antihypertensive medication do not meet the SBP/DBP goal of <130/80 mmHg set forth in the 2017 ACC/AHA guideline. More intensive antihypertensive drug therapy is recommended for this group. Given the high predicted CVD risk in this group, a substantial CVD risk reduction benefit should occur with more intensive antihypertensive medication treatment. The 2017 ACC/AHA hypertension guideline has the potential to increase hypertension awareness,

encourage lifestyle modification, and focus antihypertensive medication initiation and intensification on US adults who have high CVD risk.

### Abbreviations and Acronyms

**CVD** = cardiovascular disease

**DBP** = diastolic blood pressure

**JNC7** = Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure

**NHANES** = National Health and Nutrition Examination Survey

**SBP** = systolic blood pressure

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## FOOTNOTES

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**Potential US Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline**  
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Dr. Carolyn Lam:

Welcome to "Circulation on the Run," your weekly podcast summary and backstage pass to the journal and its editors. I'm Dr. Carolyn Lam, Associate Editor from the National Heart Center and Duke-National University of Singapore. Our featured discussion this week focuses on the new 2017 ACC/AHA high blood pressure guidelines, and the potential impact of these guidelines on the U.S. population. A must listen, coming right up after these summaries.

The first original paper this week provides insights into how extracellular matrix remodeling contributes to in-stent restenosis and thrombosis. First author, Dr. Suna, corresponding author, Dr. Mayr, and colleagues from King's College London, implanted bare metal and drug-eluting stents in pig coronary arteries with an overstretch and then harvested the stented segments up to 28 days poststenting for proteomics analysis of the media and neointima.

The authors found significant differences by proteomics in the extracellular matrix of coronary arteries after stent implantation. Most notably, an upregulation of aggrecan, a major extracellular matrix component of cartilaginous tissues that confers resistance to compression. In fact, this study provided the first evidence implicating aggrecan and aggrecanases in the vascular injury response after stenting. This opens a door to consideration of aggrecanase activity as new drug targets that may alter extracellular matrix remodeling in the vasculature.

The next paper tells us that empagliflozin could address a significant unmet need in patients with chronic kidney disease. First and corresponding author, Dr. Wanner, from Wurzburg University Clinic in Germany investigated the effects of empagliflozin on clinical outcomes in patients with chronic kidney disease in the EMPA-REG OUTCOME trial, where patients with type 2 diabetes, established cardiovascular disease, and an eGFR above 30 at screening were randomized to receive empagliflozin or placebo, in addition to standard of care.

In the current study, prevalent kidney disease was defined as an eGFR of less than 60 or urine albumin/creatinine ratio of more than 300 at baseline. In these patients, empagliflozin reduced the risk of cardiovascular death by 29% compared with placebo, reduced the risk of all-cause mortality by 24%, and reduced the risk of hospitalization for heart failure by 39%, and the risk of all-cause hospitalization by 19%.

The effects of empagliflozin on these outcomes were independent of renal function or albuminuria status at baseline. Furthermore, the adverse event profile of empagliflozin was similar across subgroups by renal function at baseline. Adverse events of particular concern in this population, such as urinary tract infection, acute renal failure, hypokalemia or fractures, lower limb amputations or hypoglycemia were not increased with empagliflozin compared to placebo.

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The next study provides mechanistic insights into exercise intolerance in heart failure with preserved ejection fraction or HFpEF. First author, Dr. Houstis, corresponding author, Dr. Lewis and colleagues from Massachusetts General Hospital, investigated the mechanism of exercise intolerance in 79 patients with HFpEF and 55 controls referred for cardiopulmonary exercise testing who were also studied with invasive monitoring to measure hemodynamics, blood gases and gas exchange during exercise.

These measurements were used to quantify six steps of oxygen transport and utilization in each HFpEF patients, identifying the defective steps that impaired each one's exercise capacity. The authors then quantified the functional significance of each pathway defect by calculating the improvement in exercise capacity that a patient could expect from correcting the defect.

The authors found that the vast majority of HFpEF patients harbored defects at multiple steps of the pathway, the identity and magnitude of which varied widely. Two of these steps, namely, cardiac output and skeletal muscle oxygen diffusion were impaired relative to controls by an average of 27% and 36% respectively. Due to interactions between a given patient's defects, the predicted benefit of correcting any single defect was often minor. At the individual level, the impact of any given pathway defect on a patient's exercise capacity was strongly influenced by comorbid defects.

The authors concluded that a personalized pathway analysis could identify patients most likely to benefit from treating a specific defect. However, the system properties of oxygen transport favor treating multiple defects at once, such as, with exercise training.

What are the potential benefits or risks of intensive systolic blood pressure lowering in individuals with a low diastolic blood pressure? Well, the final paper today tells us. In this study by first and corresponding author, Dr. Beddhu, and colleagues from Salt Lake City in Utah, a post hoc analysis of the SPRINT trial was performed. Remember that the SPRINT trial was a randomized control trial that compared the effects of intensive versus standard systolic blood pressure control in older adults with high blood pressure at increased risk of cardiovascular disease. The current post hoc analysis examined whether the effects of the systolic blood pressure intervention differed by baseline diastolic blood pressure.

The authors found that there were U-shaped relationships of baseline diastolic blood pressure with the primary cardiovascular disease outcome and all-cause death. However, the beneficial effects of intensive systolic blood pressure lowering on the primary cardiovascular disease outcome in all-cause death were not modified by baseline level of diastolic blood pressure.

Increased risk of kidney events and serious adverse effects of the intervention were consistent across baseline diastolic blood pressure quintals. Therefore,

there was no evidence that the benefit of intensive systolic blood pressure lowering differed by baseline diastolic blood pressure levels.

These findings suggest that the reason for the observed associations of worse outcomes with lower diastolic blood pressure was due to underlying processes, such as increased arterial stiffness that lead to a decline in diastolic blood pressure, rather than the level of diastolic blood pressure per se. Furthermore, lower levels of diastolic blood pressure within the ranges examined in SPRINT, should not be an impediment to intensive treatment of hypertension, at least in those without diabetes or stroke.

Well, that wraps it up for our summaries. Now for our feature discussion. The ACC/AHA guidelines for the management of hypertension in adults has really been a hot topic. Just published this year, and it really updates the seventh JNC report, which was published in 2003. Well, today's feature paper deals directly with a comparison of these two guidelines and how it may impact our practice.

I'm so pleased to have with us today the first and corresponding author of this paper, Dr. Paul Muntner, from University of Alabama at Birmingham and a very familiar wonderful voice, Dr. Wanpen Vongpatanasin, associate editor from UT Southwestern. Welcome!

Dr. Paul Muntner: Hi. Thank you for having me.

Dr. Wanpen Vongpatanasin: Hi, Carolyn.

Dr. Carolyn Lam: Paul, could I ask for you to start by painting the differences between the 2017 ACC/AHA guidelines and the JNC 7? We understand you were part of writing the guidelines, so who better than to draw our attention to the main differences.

Dr. Paul Muntner: I think that the new guideline, the ACC/AHA guideline, it was fairly comprehensive included 15 chapters, so there's a lot of new information in the guideline, everything from a dedicated section on the measurement of blood pressure to aspects of patient care.

The manuscripts featured in "Circulation" in this issue is focused on, in the past, there's different blood pressure thresholds in the guideline for defining hypertension, as well as recommendations for antihypertensive medication treatments, as well as blood pressure goals.

As everyone probably knows from JNC 7, hypertension was defined as a systolic blood pressure greater than or equal to 140 mmHg and/or a diastolic blood pressure greater than or equal to 90 mmHg, versus in the 2017 ACC/AHA guideline, these were lowered to 130/80.

In terms of treatment recommendations, there's really a fundamental shift with the new guideline, where the new guideline focuses not just on blood pressure

levels, but also on overall cardiovascular disease risk. So going to the new guideline, people are recommended treatment if their blood pressure is above 140/90 but also there's a group with a blood pressure in the 130 to 139 range for systolic blood pressure, of 80 to 89 mmHg for diastolic blood pressure, who are recommended treatment if they have a high cardiovascular disease risk.

Finally, I'll just finish with this last note is that blood pressure control for people taking antihypertensive medication is now 130/80 so a goal blood pressure for people taking antihypertensive medication is systolic blood pressure less than 130 mmHg, and a diastolic blood pressure less than 80 mmHg.

Dr. Carolyn Lam: That was beautifully explained. Paul, I just really loved table 1 of your paper, and I want to refer our audience to it. It so nicely summarizes the differences between the 2017 guidelines and JNC 7. At risk of oversimplifying, when you compare the two in this approach, it's sort of comparing using a cardiovascular risk in conjunction with blood pressure-type approach with a blood pressure-only number approach, isn't it?

Dr. Paul Muntner: Right. I think that's a key important piece of the new guideline and really CVD risk is used in conjunction with blood pressure levels to guide the recommendation to initiate antihypertensive medication. This decision was based on a wide variety of data from randomized trials, observational studies, as well as simulation or economic analyses that consistently showed the benefits of considering an individual's overall cardiovascular disease risk and providing effective and efficient treatment for lowering blood pressure.

Dr. Carolyn Lam: Right. And you analyzed the impact of this in the NHANES data in today's paper. Could you tell us a bit more about that?

Dr. Paul Muntner: The U.S. National Health and Nutrition Examination Survey, or NHANES, provides an opportunity to generate national representative point estimates on the prevalence of hypertension and treatment recommendations. So we're able to use data on about 9500 U.S. adults. Each person came in for a clinic examination where they had their blood pressure measured three times, and they were asked about their use of antihypertensive medication.

What we found was the prevalence of hypertension, or the percentage of U.S. adults with hypertension according to the new guideline, is about 46%, which compares to 32% according to the JNC 7 guideline, so really a big increase in the prevalence of hypertension of about 14%. However, by using the combination of risk and blood pressure, we're not recommending treatment for everyone with hypertension but rather people with hypertension with very high blood pressure as well as those at high cardiovascular disease risk.

So antihypertensive treatment, pharmacological antihypertensive treatment, is now being recommended for about 36% of U.S. adults compared to 34% of U.S. adults according to JNC 7. The rest of the people with hypertension are

recommended nonpharmacological therapies; exercise, diet, alcohol reduction, weight loss for people who are overweight and obese.

Really, it's an opportunity to treat people with pharmacological therapy if they're high risk. Then for people who aren't high risk, there's an opportunity for nonpharmacological therapies, so they can, hopefully, prevent the need for further treatment.

Overall, this equates to about 103 million U.S. adults with hypertension, so it's a very large number. However, only about 82 million of these individuals are recommended pharmacological antihypertensive treatment, so there's a big portion of the U.S. population who have hypertension, have high blood pressure, yet we think would benefit from nonpharmacological therapy.

Dr. Carolyn Lam: Wanpen, could I get you to chime in on what you think of the clinical implications of today's paper?

Dr. Wanpen Vongpatanasin: I think that this paper gives us at least reassurance that although we have 30 million more people with hypertension now, not all of them have to be started on medication right away. But it also put an emphasis on cardiovascular risk assessment, which we as the cardiologist are already doing this on a regular basis. It is a major step forward to incorporate cardiovascular risks as another way to gauge how people should be treated intensively, which we like that aspect of it.

Dr. Carolyn Lam: I agree. I think it's reassuring because most people think, "Oh, my goodness. We have got so much more hypertensives to manage." But then it tells us that a re-stratified approach really keeps it manageable, I suppose. But Wanpen, did you have some specific concerns or questions?

Dr. Wanpen Vongpatanasin: We look at the people who by JNC 7 calls prehypertension, which it's now some of them turn out to be a stage 1 hypertension. The question I have for Paul is that even though guidelines call for nonpharmacologic treatment first, the guidelines said give a try from three to six months, but what happens after that if they're still not reaching the goal?

Would people on the guidelines propose drug treatment eventually because, as you know, nonpharmacology treatment is easier said than done. Even though you might be able to tackle some aspect of it, but I doubt you can tackle everything; exercise, diet, sodium, weight loss all at the same time in a three to six month period.

Dr. Paul Muntner: It's a great question and it's something that the guidelines really spent a lot of time considering and reviewing the evidence. First, what the recommendation is that we recommend nonpharmacological intervention as you mentioned and the re-evaluation. If the person's blood pressure remains in the stage 1 hypertension range and they're not a high cardiovascular disease risk, then they

are recommended to continue attempts at the nonpharmacological interventions.

I've been asked several times since the guideline has been published, "What, are we supposed to just wait until people become high risk?" And my viewpoint on this is, it's hard enough to get people to adhere to their medications currently, let's be judicious about this, focus on the high-risk people, and maybe if we can communicate with people that have high-risk for cardiovascular disease, we can work with patients to improve medication adherence and really focus on the low-risk people in preventing the need for lifelong therapy.

Dr. Wanpen Vongpatanasin: That's great, I think that's really helpful in clarifying this point. Because even if you say that 30 million doesn't need to be started on the drug right away, that eventually have to be started on drug in six months, I think that doesn't really give us a reassurance but, obviously, we still have to continue to work on these patients who are on the fence of needing pharmacology intervention.

Dr. Paul Muntner: Right. I think what's interesting here is a lot of people since the guideline has been published have said to me, "Now this is done." I said, "No. Now we're really just starting. Now is the most important part of the guideline, which is implementation." And how are we going to implement the guideline, which, as we were just discussing, isn't just about initiating pharmacological therapy, but it's also about the nonpharmacological therapies as well as medication adherence and all these other issues that are in the guideline, proper measurement of blood pressure, etc.

I think that now is going to be the most important time to really have a big impact on our patients' lives by really using the evidence and now that it's in the guideline, we're using the evidence to direct treatment appropriately.

Dr. Carolyn Lam: Indeed, Paul. Just one thing. Along the lines of implementation, how about the issue of the lower target BP, to treat to? What did your study from NHANES show about that, numbers reaching targets, and do you see that as an issue?

Dr. Paul Muntner: It's an interesting question because the findings from our study found that it's currently over half of U.S. adults according to the new guideline, over half of U.S. adults on antihypertensive medication, have blood pressure above the goal in the new guideline. So in our study, 53% of U.S. adults taking antihypertensive medication had a blood pressure above 130/80. This represents an increase from the JNC 7 guideline of people with blood pressure above 140/90, of course, of about 14.4%. According to our estimates, there are about 8 million U.S. adults who are going to be recommended more intensive antihypertensive medication.

The blood pressure of less than 130/80 is a uniform goal for all people taking antihypertensive medication. This comes from several meta-analyses that have

consistently shown the cardiovascular and mortality risk reduction associated with achieving a blood pressure of less than 130/80. I think there's very firm evidence to stand on.

One interesting thing from the guidelines, it's in one of the tables, and I think it's a very important point to make, is that a lot of people who have above goal blood pressure, according to the new guideline, they're only taking one or two classes of antihypertensive medication. The vast majority of them are not taking multiple classes of antihypertensive medication, so we feel that these therapies can be optimized and we're not going to be pushing people into antihypertensive polypharmacy but rather they can receive substantial risk reductions without really giving them too many additional pills.

Dr. Carolyn Lam: Wow. Really about implementation. Wanpen, did you have any other comments before we close?

Dr. Wanpen Vongpatanasin: Yes, I think that is really interesting to see also with these guidelines how is this going to be embraced to the rest of the world. Actually, prior to this guideline, at least hypertension control rate in the U.S. is better than most countries, European countries, as well as in Asia. But now even lowering the bar, we use the same criteria for the rest of the world, that would be a lot worse control rate than now. I think it will be challenging, not only in this country but throughout the world.

Dr. Paul Muntner: That's a great point. Obviously, these guidelines are U.S. guidelines, however, new European guidelines should be coming out in 2018, is what I've heard. I think that even though these guidelines were developed by the American College of Cardiology and the American Heart Association, the data that we're using really comes from worldwide evidence. The evidence didn't stop at the borders. A lot of the evidence that was used in choosing the blood pressure levels to define hypertension, the blood pressure levels to recommend pharmacological interventions, as well as the blood pressure goals do come from other countries. A lot of data from Asia, Europe, Australia, so I think that the data used in these guidelines should be generalized when it's out of the United States.

I think there may be challenges with implementing these guidelines in different settings, and, obviously, a lot of things will have to be tailored to where they will be implemented. However, the overall goal is to reduce the burden of cardiovascular disease and renal disease related to hypertension and, hopefully, that can be a worldwide goal.

Dr. Carolyn Lam: What a great reminder. It is worldwide data, worldwide evidence for a worldwide problem. Well, listeners, you heard it right here on "Circulation on the Run." Thank you so much for joining us today and don't forget to tune in again next week.

## ONLINE SUPPLEMENT

Potential US population impact of the 2017 American College of Cardiology/American Heart Association High Blood Pressure Guideline

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Supplemental Table 1. Covariates included in the current analysis and the method of ascertainment in the National Health and Nutrition Examination Survey, 2011-2014.

Variable	Ascertainment in NHANES 2011-2014
Age	Self-report
Race-ethnicity	Self-report
Gender	Self-report
Cigarette smoking	Self-report
History of coronary heart disease	Self-report
History of myocardial infarction	Self-report
History of stroke	Self-report
History of heart failure	Self-report
Antihypertensive medication use	Self-report
Glucose lowering medication use	Self-report
Statin Use	Pill bottle review during the NHANES examination
Antihypertensive medication classes	Pill bottle review during the NHANES examination
Diabetes mellitus	Fasting serum glucose $\geq 126$ mg/dL, non-fasting serum glucose $\geq 200$ mg/dL, hemoglobin A1c $\geq 6.5\%$ or self-report of a history of diabetes with concurrent glucose lowering medication use
Reduced eGFR	eGFR $< 60$ ml/min/1.73 m <sup>2</sup> calculated using measured serum creatinine and the Chronic Kidney Disease Epidemiology Collaboration equation
Albuminuria	Urinary albumin-to creatinine ratio $\geq 30$ mg/g

NHANES – National Health and Nutrition Examination Survey

eGFR – Estimated glomerular filtration rate

Supplemental Table 2. Classification of blood pressure according to the 2017 ACC/AHA guideline and the JNC7 guideline.

Blood pressure levels			Guideline classification	
SBP, mm Hg		DBP, mm Hg	2017 ACC/AHA	JNC7
<120	And	<80	Normal blood pressure	Normal blood pressure
120–129	And	<80	Elevated blood pressure	Prehypertension
130–139	Or	80–89	Stage 1 Hypertension	Prehypertension
140 - 159	Or	90 - 99	Stage 2 Hypertension	Stage 1 Hypertension
≥ 160	Or	≥ 100	Stage 2 Hypertension	Stage 2 Hypertension

Participants with SBP and DBP in two categories (e.g., SBP < 120 mm Hg and DBP between 80 and 89 mm Hg) are designated into the higher category.

2017 ACC/AHA guideline - 2017 American College of Cardiology / American Heart Association Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults.

JNC7 guideline - Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure.

SBP – Systolic blood pressure; DBP – diastolic blood pressure.

Supplemental Table 3. Characteristics of US adults not taking antihypertensive medication meeting the definition for hypertension and recommended antihypertensive medication according to the 2017 ACC/AHA guideline and the JNC7 guideline based on the 2011-2014 National Health and Nutrition Examination Survey.

	Hypertension according to the:			Recommended Treatment by:		
	2017 ACC/AHA guideline (n=2,095)	JNC7 guideline (n=819)	2017 ACC/AHA but not the JNC guideline (n=1,276)	2017 ACC/AHA guideline (n=1,270)	JNC7 Guideline (n=1,085)	2017 ACC/AHA but not the JNC guideline (n=185)
Age, years	49.8 (0.6)	54.6 (0.6)	47.1 (0.7)	55.7 (0.6)	54.1 (0.7)	64.6 (0.7)
Male gender, %	58.1	58.1	58.0	58.6	57.6	64.1
Race/ethnicity, %						
Non-Hispanic white	65.6	63.7	66.7	65.5	63.4	77.3
Non-Hispanic black	12.6	14.5	11.6	12.9	13.9	7.3
Non-Hispanic Asian	5.2	6.0	4.7	5.4	5.8	3.3
Hispanic	13.4	12.4	14.0	13.2	13.9	9.3
Cigarette smoking, %	20.7	21.0	20.6	21.8	21.2	25.1
Total cholesterol, mg/dL	202.9 (1.4)	206.3 (2.1)	201.0 (1.8)	205.7 (1.9)	204.8 (2.0)	210.9 (4.0)
HDL cholesterol, mg/dL	53.2 (0.5)	54.0 (0.9)	52.8 (0.7)	53.4 (0.7)	52.8 (0.7)	56.7 (1.8)
Statin use, %	12.5	13.5	12.0	17.0	16.5	19.4
Diabetes, %	10.9	14.1	9.1	19.5	23.0	0.0
SBP, mm Hg	135.3 (0.6)	148.3 (0.9)	128.0 (0.3)	142.2 (0.7)	143.9 (0.8)	132.5 (0.5)

DBP, mm Hg	80.0 (0.4)	82.5 (0.7)	78.6 (0.3)	80.1 (0.5)	81.1 (0.6)	74.6 (0.8)
Reduced eGFR, %	5.3	8.7	3.4	9.4	11.1	0.0
Albuminuria, %	11.7	15.6	9.4	20.8	24.6	0.0
History of CVD, %	4.8	6.0	4.2	8.6	7.3	15.8
10-year CVD risk††	7.9 (0.4)	12.3 (0.6)	5.5 (0.3)	12.5 (0.5)	12.0 (0.6)	15.6 (0.7)

Characteristics in the table are column percentage or mean (standard error).

† The difference between the number of NHANES 2011-2014 participants meeting the 2017 ACC/AHA and the JNC7 guideline recommendations for treatment does not equal the number in the 2017 ACC/AHA but not the JNC guideline column because some US adults meet the JNC7 guideline recommendation for antihypertensive treatment but do not meet the criteria for treatment in the 2017 ACC/AHA guideline.

†† Among US adults without a history of cardiovascular disease

2017 ACC/AHA guideline - 2017 American College of Cardiology / American Heart Association Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults.

JNC7 guideline - Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure

See Table 1 for the definitions of hypertension and antihypertensive medication treatment recommendations.

ACC/AHA - American College of Cardiology/American Heart Association; eGFR – estimated glomerular filtration rate

Reduced estimated glomerular filtration rate was defined by levels < 60 ml/min/1.73 m<sup>2</sup>.

Albuminuria was defined by an albumin-to-creatinine ratio ≥ 30 mg/g.

SBP – Systolic blood pressure, DBP – Diastolic blood pressure, CVD – Cardiovascular disease.

Supplemental Table 4. Number of US adults taking antihypertensive medication with blood pressure above their treatment goal according to the 2017 ACC/AHA guideline and the JNC7 guideline based on the 2011-2014 National Health and Nutrition Examination Survey.

	Taking antihypertensive medication	Blood pressure above goal according to:		
		2017 ACC/AHA guideline	JNC7 guideline	2017 ACC/AHA guideline but not JNC7
Overall†	54.7 (48.8, 60.6)	29.2 (26.2, 32.2)	21.3 (19.2, 23.5)	7.9 (6.5, 9.2)
Age group				
20–44	5.9 (4.9, 7.0)	2.8 (2.1, 3.4)	1.4 (1.0, 1.7)	1.4 (0.9, 1.9)
45–54	9.3 (8.1, 10.6)	4.3 (3.6, 4.9)	2.8 (2.2, 3.3)	1.5 (1.2, 1.9)
55–64	15.9 (13.5, 18.3)	8.0 (6.6, 9.5)	5.3 (4.3, 6.3)	2.8 (1.8, 3.7)
65–74	13.1 (11.1, 15.0)	7.1 (6.0, 8.2)	5.7 (4.6, 6.7)	1.4 (1.0, 1.9)
75+	10.4 (8.9, 12.0)	7.0 (5.9, 8.1)	6.3 (5.3, 7.3)	0.7 (0.5, 1.0)
Men	24.6 (21.3, 27.9)	12.7 (11.0, 14.5)	9.2 (7.9, 10.5)	3.5 (2.7, 4.3)
Women	30.1 (27.0, 33.1)	16.4 (14.7, 18.2)	12.1 (10.8, 13.4)	4.3 (3.4, 5.2)
Race-ethnicity				
Non-Hispanic white	38.9 (32.4, 45.4)	19.7 (16.2, 23.1)	14.1 (11.6, 16.7)	5.5 (4.2, 6.9)
Non-Hispanic black	8.1 (6.4, 9.8)	5.1 (3.9, 6.3)	3.9 (3.0, 4.9)	1.2 (0.9, 1.5)
Non-Hispanic Asian	1.9 (1.3, 2.4)	1.2 (0.8, 1.6)	0.9 (0.6, 1.2)	0.3 (0.2, 0.4)
Hispanic	4.8 (3.2, 6.3)	2.7 (1.8, 3.6)	2.0 (1.3, 2.7)	0.7 (0.5, 0.9)
Number of antihypertensive classes				
0	1.2 (0.8, 1.6)	0.6 (0.4, 0.9)	0.5 (0.3, 0.7)	0.1 (0, 0.3)

1	19.8 (17.0, 22.7)	11.4 (9.6, 13.2)	7.6 (6.3, 8.9)	3.8 (3.0, 4.5)
2	20.3 (17.7, 22.9)	9.7 (8.2, 11.1)	7.2 (6.0, 8.3)	2.5 (1.9, 3.1)
3	8.8 (7.4, 10.2)	5.0 (3.9, 6.0)	3.9 (3.0, 4.8)	1.0 (0.6, 1.4)
≥ 4	4.6 (3.6, 5.6)	2.6 (1.9, 3.2)	2.1 (1.5, 2.7)	0.4 (0.2, 0.6)

Numbers in table are number of US adults in millions (95% confidence interval)

2017 ACC/AHA guideline - 2017 American College of Cardiology / American Heart Association Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults.

JNC7 guideline - Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure

SBP – systolic blood pressure; DBP – diastolic blood pressure; CVD – cardiovascular disease.

See Table 1 for the definitions of blood pressure treatment goals.

Supplemental Table 5. Characteristics of US adults taking antihypertensive medication with blood pressure above their treatment goal according to the 2017 ACC/AHA guideline and the JNC7 guideline based on the 2011-2014 National Health and Nutrition Examination Survey.

	Blood pressure above goal defined by:		
	2017 ACC/AHA guideline (n=1,488)	JNC7 guideline (n=1,151)	2017 ACC/AHA but not JNC7 guideline (n=337)
Age, years	63.2 (0.5)	65.4 (0.5)	57.3 (0.7)
Male gender, %	43.6	43.2	44.8
Race/ethnicity, %			
Non-Hispanic white	67.4	66.3	70.4
Non-Hispanic black	17.5	18.5	14.9
Non-Hispanic Asian	4.0	4.1	3.8
Hispanic	9.2	9.3	8.7
Cigarette smoking, %	14.0	13.5	15.4
Total cholesterol, mg/dL	194.9 (1.8)	194.1 (2.3)	196.8 (2.9)
HDL cholesterol, mg/dL	52.0 (0.5)	52.1 (0.6)	51.9 (0.9)
Statin use, %	45.6	47.4	40.7
Diabetes, %	27.5	37.6	0
Systolic blood pressure, mm Hg	143.2 (0.5)	147.7 (0.6)	130.8 (0.4)
Diastolic blood pressure, mm Hg	75.0 (0.6)	74.4 (0.7)	76.4 (0.5)
Reduced eGFR, %	21.8	29.8	0
Albuminuria, %	22.5	30.8	0

History of cardiovascular disease, %	22.4	25.6	13.6
10-year cardiovascular disease risk <sup>†</sup>	19.9 (0.6)	24.4 (0.7)	9.6 (0.5)
Number of antihypertensive classes, %			
0 <sup>††</sup>	2.2	2.4	1.6
1	39.0	35.7	47.9
2	33.1	33.5	31.8
3	17.0	18.3	13.2
≥ 4	8.8	10.0	5.5

Characteristics in the table are column percentage or mean (standard error).

† Among US adults without a history of cardiovascular disease

†† Participants taking 0 classes of antihypertensive medication in this table represent those who self-reported taking antihypertensive medication but had no classes of antihypertensive medication identified during the pill-bottle review conducted during the NHANES medical examination.

2017 ACC/AHA guideline - 2017 American College of Cardiology / American Heart Association Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults.

JNC7 guideline - Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure

eGFR – estimated glomerular filtration rate

See Table 1 for the definitions of hypertension, antihypertensive medication treatment recommendations, and goal blood pressure levels.

Supplemental Table 6. Percentage of US adults meeting the definition for hypertension and recommended antihypertensive medication according to the 2017 ACC/AHA guideline and the JNC 8 panel member report based on the 2011-2014 National Health and Nutrition Examination Survey.

	2017 ACC/AHA guideline		JNC8 panel member report	Difference (2017 ACC/AHA but not JNC8 panel member report)	
	Hypertension	Recommended antihypertensive medication	Hypertension <sup>†</sup>	Hypertension	Recommended antihypertensive medication
Overall	45.6 (43.6, 47.6)	36.2 (34.2, 38.2)	31.1 (29.4, 32.8)	14.5 (13.4, 15.7)	5.1 (4.4, 5.8)
Age group					
20-44	24.0 (21.8, 26.2)	12.5 (11.2, 14.0)	10.5 (9.4, 11.7)	13.4 (12.0, 15.0)	2.0 (1.4, 2.6)
45-54	47.1 (44.4, 49.8)	33.4 (30.8, 36.1)	29.5 (27.0, 32.2)	17.6 (15.1, 20.4)	3.9 (2.6, 5.7)
55-64	66.6 (63.6, 69.5)	58.2 (54.9, 61.4)	50.8 (47.2, 54.4)	15.8 (13.5, 18.4)	7.4 (6.0, 9.2)
65-74	75.6 (73.4, 77.6)	74.1 (71.4, 76.6)	60.8 (57.3, 64.3)	14.7 (11.8, 18.2)	13.2 (10.4, 16.8)
75+	82.3 (79.2, 85.0)	82.3 (79.2, 85.0)	72.4 (69.1, 75.6)	9.8 (7.8, 12.3)	9.8 (7.8, 12.3)
Men	48.6 (45.9, 51.3)	37.3 (34.9, 39.8)	31.1 (28.9, 33.4)	17.5 (15.9, 19.3)	6.2 (5.4, 7.2)
Women	42.9 (40.7, 45.1)	35.1 (33.0, 37.3)	31.1 (29.2, 33.0)	11.8 (10.5, 13.1)	4.0 (3.3, 4.9)
Race-ethnicity					
Non-Hispanic white	47.3 (44.5, 50.0)	37.9 (35.3, 40.6)	32.6 (30.3, 34.9)	14.7 (13.3, 16.3)	5.3 (4.4, 6.5)
Non-Hispanic black	54.9 (52.5, 57.3)	44.8 (42.5, 47.0)	40.4 (38.4, 42.5)	14.5 (12.7, 16.4)	4.3 (3.4, 5.4)
Non-Hispanic Asian	36.7 (32.6, 40.9)	27.9 (24.2, 32.0)	23.9 (20.5, 27.6)	12.8 (11.1, 14.8)	4.1 (3.1, 5.3)
Hispanic	34.4 (31.8, 37.1)	25.5 (23.0, 28.1)	20.7 (18.2, 23.3)	13.7 (12.1, 15.6)	4.8 (4.0, 5.7)
Risk categories					
<5%	27.4 (25.6, 29.3)	14.6 (13.3, 16.0)	13.1 (11.9, 14.4)	14.3 (13.2, 15.5)	1.5 (1.1, 2.1)
5% to <10%	61.4 (57.2, 65.3)	48.4 (44.5, 52.3)	41.7 (37.5, 46.0)	19.7 (16.3, 23.6)	6.7 (4.8, 9.3)
10% to <20%	78.2 (74.7, 81.4)	78.2 (74.7, 81.4)	61.2 (56.1, 66.1)	17.0 (13.8, 20.8)	17.0 (13.8, 20.8)
≥20%	85.7 (82.7, 88.2)	85.7 (82.7, 88.2)	74.1 (70.7, 77.2)	11.6 (9.8, 13.7)	11.6 (9.8, 13.7)
History of CVD	79.3 (75.6, 82.6)	79.3 (75.6, 82.6)	71.1 (67.3, 74.7)	8.2 (5.6, 11.8)	8.2 (5.6, 11.8)

Numbers in table are percentage of US adults (95% confidence interval)

<sup>†</sup> All adults with hypertension according to the JNC8 panel member report definition of hypertension are recommended treatment with antihypertensive medication.

See Table 1 for the definitions of hypertension and antihypertensive medication treatment recommendations. 2017 ACC/AHA guideline - 2017 American College of Cardiology/American Heart Association Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults.

JNC8 panel member report - 2014 Evidence-Based Guideline for the Management of High Blood Pressure in Adults: Report From the Panel Members Appointed to the Eighth Joint National Committee.

CVD – cardiovascular disease

Supplemental Table 7. Percentage of US adults taking antihypertensive medication with above goal blood pressure according to the 2017 ACC/AHA guideline and the JNC 8 report based on the 2011-2014 National Health and Nutrition Examination Survey.

	Above goal blood pressure according to:		2017 ACC/AHA guideline but not the JNC8 panel member report
	2017 ACC/AHA guideline	JNC8 panel member report	
Overall†	53.4 (49.9, 56.8)	24.7 (22.5, 27.1)	28.7 (25.8, 31.7)
Age group			
20–44	46.3 (38.6, 54.3)	16.8 (12.1, 22.9)	29.6 (23.6, 36.3)
45–54	46.0 (38.6, 53.5)	22.9 (18.1, 28.5)	23.1 (18.4, 28.4)
55–64	50.5 (44.9, 56.0)	22.2 (18.1, 27.0)	28.3 (23.1, 34.0)
65–74	54.4 (48.6, 60.1)	21.1 (18.1, 27.0)	33.2 (27.0, 40.1)
75+	67.2 (61.4, 72.4)	39.1 (32.5, 46.1)	28.1 (24.2, 32.4)
Men	51.8 (47.9, 55.7)	24.2 (21.5, 27.1)	27.6 (24.0, 31.4)
Women	54.7 (50.1, 59.2)	25.1 (22.2, 28.2)	29.6 (25.8, 33.6)
Race-ethnicity†			
Non-Hispanic white	50.6 (46.6, 54.6)	22.6 (19.8, 25.6)	28.0 (24.2, 32.1)
Non-Hispanic black	63.0 (58.4, 67.4)	33.0 (29.2, 36.9)	30.1 (27.7, 32.5)
Non-Hispanic Asian	62.9 (53.6, 71.3)	26.3 (20.8, 32.7)	36.6 (28.9, 45.1)
Hispanic	56.0 (50.7, 61.1)	26.9 (22.3, 31.9)	29.1 (25.5, 33.0)
Number of antihypertensive classes			
0	54.7 (38.3, 70.2)	21.5 (11.2, 37.4)	33.2 (22.6, 45.8)
1	57.4 (52.9, 61.9)	25.4 (20.9, 30.4)	32.1 (27.8, 36.7)
2	47.7 (41.4, 54.0)	21.5 (17.9, 25.7)	26.2 (22.2, 30.5)
3	56.1 (47.8, 64.0)	29.2 (23.1, 36.2)	26.9 (21.2, 33.4)
≥ 4	55.3 (47.8, 62.4)	28.0 (20.8, 36.6)	27.2 (20.8, 34.9)

Numbers in table are percentage of US adults (95% confidence interval)

SBP – systolic blood pressure; DBP – diastolic blood pressure; CVD – cardiovascular disease.

2017 ACC/AHA guideline - 2017 American College of Cardiology / American Heart Association  
Guideline for the Prevention, Detection, Evaluation and Management of High Blood Pressure in Adults.  
JNC8 panel member report - 2014 Evidence-Based Guideline for the Management of High Blood  
Pressure in Adults: Report From the Panel Members Appointed to the Eighth Joint National Committee.  
See Table 1 for the definition of above goal blood pressure in the 2017 ACC/AHA guideline. Above goal  
blood pressure was defined as systolic blood pressure  $\geq 140$  or diastolic blood pressure  $\geq 90$  mm Hg  
among adults  $< 60$  years of age and those  $\geq 60$  years of age with chronic kidney disease or diabetes.  
Above goal blood pressure was defined as systolic blood pressure  $\geq 150$  or diastolic blood pressure  $\geq 90$   
mm Hg among adults  $\geq 60$  years of age without chronic kidney disease or diabetes.