

ORIGINAL INVESTIGATIONS

Potential U.S. Population Impact of the 2017 ACC/AHA High Blood Pressure Guideline



Paul Muntner, PhD,^a Robert M. Carey, MD,^b Samuel Gidding, MD,^c Daniel W. Jones, MD,^d Sandra J. Taler, MD,^e Jackson T. Wright, Jr, MD, PhD,^f Paul K. Whelton, MB, MD, MSc^g

ABSTRACT

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 U.S. 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 = 9,623). BP was measured 3 times following a standardized protocol and averaged. Results were weighted to produce U.S. population estimates.

RESULTS According to the 2017 ACC/AHA and JNC7 guidelines, the crude prevalence of hypertension among U.S. 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 U.S. adults, respectively. Nonpharmacological intervention is advised for the 9.4% of U.S. adults with hypertension who are not recommended for antihypertensive medication according to the 2017 ACC/AHA guideline. Among U.S. 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 U.S. adults recommended for antihypertensive medication, and more intensive BP lowering for many adults taking antihypertensive medication. (J Am Coll Cardiol 2018;71:109-18) © 2018 jointly by American College of Cardiology Foundation and American Heart Association. Published by Elsevier Inc. All rights reserved.



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From the ^aDepartment of Epidemiology, University of Alabama at Birmingham, Birmingham, Alabama; ^bDepartment of Medicine, University of Virginia, Charlottesville, Virginia; ^cNemours Cardiac Center, A. I. DuPont Hospital for Children, Wilmington, Delaware; ^dDepartment of Medicine, University of Mississippi, Jackson, Mississippi; ^eDivision of Nephrology and Hypertension, Mayo Clinic, Rochester, Minnesota; ^fDivision of Nephrology and Hypertension, University Hospitals Cleveland Medical Center, Cleveland, Ohio; and the ^gDepartment of Epidemiology, Tulane University, New Orleans, Louisiana. Dr. Muntner has received research support through grant 15SFRN2390002 from the American Heart Association; and has received research support and honoraria from Amgen, Inc. unrelated to this paper. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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**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

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 (1). 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 (2). 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 (1).

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The purpose of the current analysis was to estimate the percentage and number of U.S. adults with hypertension and the percentage recommended for pharmacological antihypertensive treatment according to the 2017 ACC/AHA guideline, as compared with the JNC7 guideline. Additionally, we estimated the percentage and number of U.S. adults taking antihypertensive medication with blood pressure (BP) levels above goal using targets from each guideline. U.S. 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 U.S. 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) (3).

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 U.S. general population (4). 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 U.S. population. Using sampling weights, nationally representative estimates for the noninstitutionalized U.S. 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 ($n = 10,907$). 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 9,623 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 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 (5). 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 ≥20%. High CVD risk was defined as having a history of CVD or a 10-year predicted CVD risk ≥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 ≥140/90 mm Hg, and those taking antihypertensive medication. These levels represent the BP stages in the 2017 ACC/AHA guideline ([Online Table 2](#)). Participants with SBP and DBP in 2 categories (e.g., 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 U.S. adults in each of these groups. Next, we calculated the percentage and number of U.S. 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 U.S. 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 U.S. adults with hypertension and, separately, taking antihypertensive medication with BP above goal according to the 2017 ACC/AHA guideline, JNC7

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.

guideline, and the 2017 ACC/AHA guideline but not the JNC7 guideline were calculated. In a secondary analysis, we calculated the percentage of U.S. 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 U.S. 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

TABLE 2 Characteristics of U.S. Adults by BP Levels and Antihypertensive Medication Use Based on the 2011 to 2014 NHANES

	SBP/DBP Categories Among U.S. Adults Not Taking Antihypertensive Medication (mm Hg)				Taking Antihypertensive Medication (n = 2,587)
	<120/80 (n = 3,827)	120-129/<80 (n = 1,114)	130-139/80-89 (n = 1,276)	≥140/90 (n = 819)	
Percentage of U.S. 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, mm Hg	108.9 ± 0.2	124.2 ± 0.1	128.0 ± 0.3	148.3 ± 0.9	130.7 ± 0.6
DBP, mm Hg	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 %. U.S. adults were grouped into the higher category of SBP and DBP. For example, if a person had SBP of 146 mm Hg and DBP of 82 mm Hg, they were grouped into the ≥140/90 mm Hg category. Reduced eGFR was defined by levels <60 ml/min/1.73 m². 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.

race/ethnicity strata, and assumes that data within strata are missing at random (6). 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 U.S. adults not taking antihypertensive medication had SBP/DBP levels of <120/80 mm Hg, 120 to 129/<80 mm Hg, 130 to 139/80 to 89 mm Hg, and ≥140/90 mm Hg, respectively (Table 2). Additionally, 24.1% of U.S. adults were taking antihypertensive medication. U.S. 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 U.S. 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 U.S. adults with SBP/DBP of 130 to 139/80 to 89 mm Hg, 31.3%

TABLE 3 Percentage of U.S. 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 U.S. adults (95% confidence interval). See Table 1 for the definitions of hypertension and antihypertensive medication treatment recommendations. Abbreviations as in Tables 1 and 2.

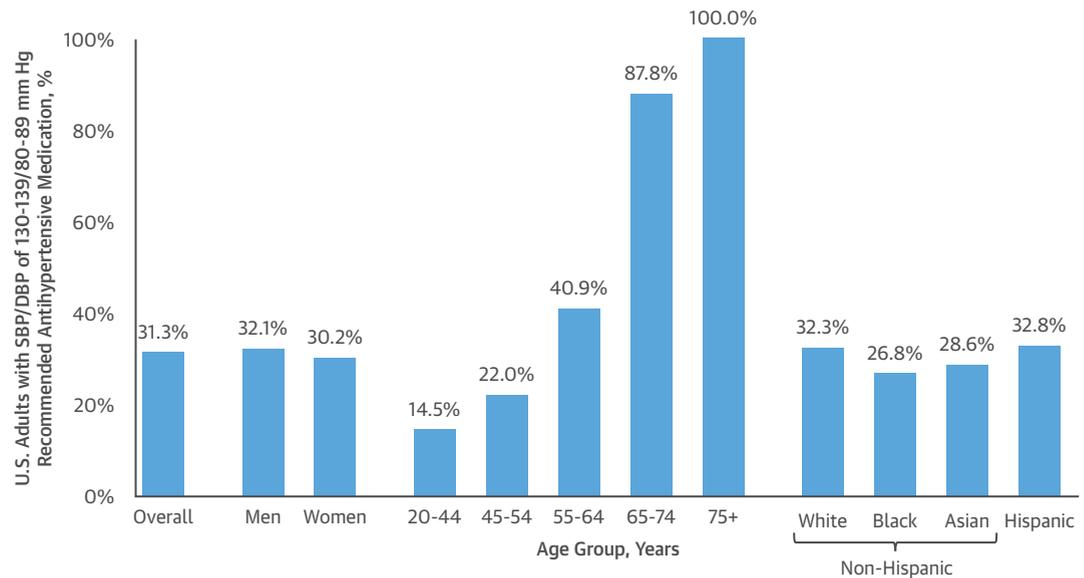
were recommended for antihypertensive medication according to the 2017 ACC/AHA guideline because they had diabetes, chronic kidney disease, or high CVD risk, or they had SBP of 130 to 139 mm Hg and were ≥65 years of age (Figure 1).

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

Compared with U.S. 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 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, U.S. 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 U.S. 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 ≥75 years of age and taking ≥4 classes of antihypertensive medication, where the prevalence was 7.1 and 9.3 percentage points higher, respectively. There were 54.7 million U.S. adults taking antihypertensive medication in 2011 to 2014, of whom 29.2 and 21.3 million U.S. adults had BP above goal according to the 2017 ACC/AHA and JNC7 guidelines, respectively

FIGURE 1 Percentage of U.S. 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 U.S. 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 ≥ 65 years of age. Overall, 31.3% of U.S. 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.

([Online Table 4](#)). Characteristics of U.S. 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 Table 5](#). Overall, 47.9% and 31.8% of U.S. 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 U.S. adults had hypertension according to the JNC8 panel member report ([Online Table 6](#)). Compared with the JNC8 panel member report, an additional 5.1% of U.S. adults were recommended for antihypertensive medication according to the 2017 ACC/AHA guideline. The percentage of U.S. 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 U.S. adults with 10-year predicted

CVD risk of 10% to $<20\%$ and $\geq 20\%$ compared with their counterparts in the other risk categories. Overall, 28.7% of U.S. 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 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 U.S. adults ([Central Illustration](#)). We estimate that the 2017 ACC/AHA hypertension guideline will result in a substantial increase in the proportion of U.S. 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 U.S. adults who are recommended for antihypertensive medication according to the 2017 ACC/AHA guideline

TABLE 4 Number of U.S. 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 U.S. 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.

compared with the JNC7 guideline. Also, 14.4% of U.S. 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.

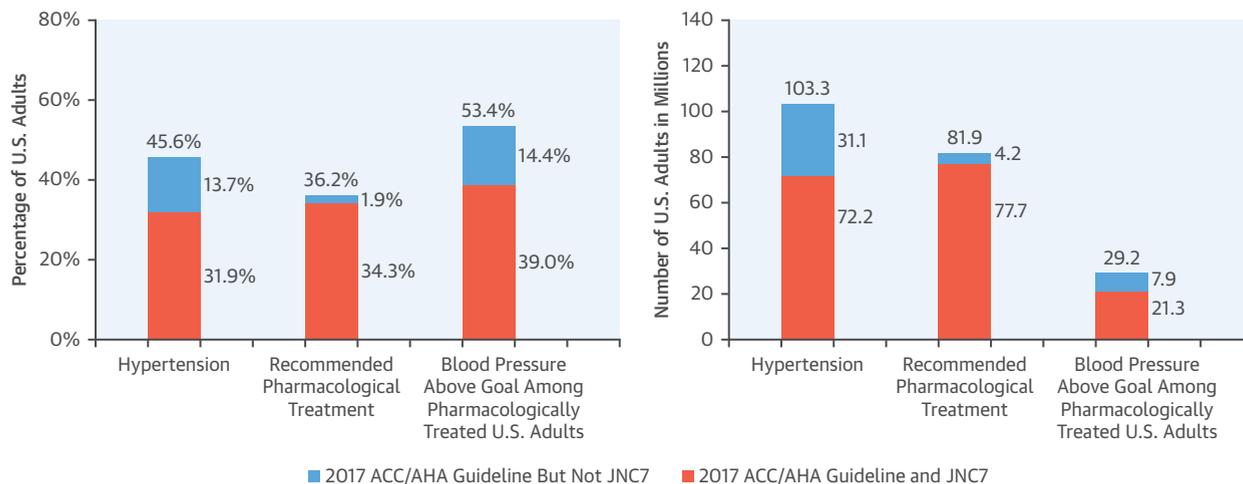
The lower SBP and DBP levels (130 and 80 mm Hg, respectively) used to define hypertension in the 2017 ACC/AHA guideline were based on data from observational studies and clinical trials. Large observational studies demonstrate a graded association between higher BP and increased risk for CVD, end-stage renal disease, subclinical atherosclerosis, and all-cause mortality (7,8).

Although many studies have reported increased risk associated with an SBP/DBP of 120 to 129/80 to 84 mm Hg versus <120/80 mm Hg, the association is substantially stronger for an SBP/DBP of 130 to 139/85 to 89 mm Hg versus <120/80 mm Hg (9-12). Randomized controlled trials of lifestyle modification (13-15) and low-dose antihypertensive medication (16-18) 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 (19-26). Nonpharmacological therapy on its own is the recommended treatment for the majority of U.S. adults with SBP/DBP of 130 to 139/80 to 89 mm Hg. 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 mm Hg 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 (27). 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

CENTRAL ILLUSTRATION Prevalence of Hypertension, Recommendation for Pharmacological Antihypertensive Treatment, and Blood Pressure Above Goal Among U.S. Adults According to the 2017 ACC/AHA and the JNC7 Guidelines



Muntner, P. et al. *J Am Coll Cardiol.* 2018;71(2):109-18.

This graph shows the percentage (left) and number (right) of U.S. 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.

TABLE 5 Percentage of U.S. 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 U.S. 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.

risk <11%, 11% to 15%, 15% to 21%, and >21%, respectively (28). 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 (29,30). In the current study, we estimated that the 2017 ACC/AHA and JNC7 guidelines would result in a small increase in the percentage of U.S. adults being recommended for antihypertensive medication. U.S. 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 (28).

A number of randomized controlled trials have evaluated the potential CVD risk reduction benefits of BP goals lower than those used in JNC7 (20-22). The best evidence supporting BP treatment targets is derived from meta-analyses of these trials (19,23-26). 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 mm Hg (23). 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 mm Hg 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 (20).

The current analysis has several strengths. NHANES provides nationally representative estimates for the noninstitutionalized U.S. population, and the results of 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 U.S. adults recommended for antihypertensive medication increased modestly, with nonpharmacological interventions alone being recommended for the majority of U.S. adults with hypertension according to the 2017 ACC/AHA guideline but not the JNC7

guideline. Additionally, over 50% of U.S. adults taking antihypertensive medication do not meet the SBP/DBP goal of <130/80 mm Hg 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 U.S. adults who have high CVD risk.

ADDRESS FOR CORRESPONDENCE: Dr. Paul Muntner, Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, 1700 University Boulevard, Suite 450, Birmingham, Alabama 35294. E-mail: pmuntner@uab.edu.

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Hypertension is a major risk factor for CVD in the United States and worldwide. Using cardiovascular risk in conjunction with BP levels is an efficient approach to direct pharmacological antihypertensive treatment to those who are likely to benefit most. Many U.S. adults are recommended for more intensive antihypertensive medication according to the 2017 ACC/AHA hypertension guideline.

TRANSLATIONAL OUTLOOK: Implementation of the 2017 ACC/AHA hypertension guideline has the potential to increase the prevalence of hypertension and use of antihypertensive medication among U.S. adults. This should translate into a reduction in CVD events.

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KEY WORDS hypertension, prevalence, treatment

APPENDIX For supplemental tables, please see the online version of this article.