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ORIGINAL INVESTIGATIONS

2017 ACC/AHA Blood Pressure Treatment Guideline Recommendations and Cardiovascular Risk

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ABSTRACT

BACKGROUND The 2017 American College of Cardiology/American Heart Association (ACC/AHA) blood pressure (BP) guideline provides updated recommendations for antihypertensive medication initiation and intensification.

OBJECTIVES Determine the risk for cardiovascular disease (CVD) events among adults recommended and not recommended antihypertensive medication initiation or intensification by the 2017 ACC/AHA BP guideline.

METHODS The authors analyzed data for black and white REGARDS (REasons for Geographic And Racial Differences in Stroke) study participants (age ≥45 years). Systolic BP (SBP) and diastolic BP (DBP) were measured twice at baseline (2003 to 2007) and averaged. Participants not taking (n = 14,039) and taking (n = 15,179) antihypertensive medication were categorized according to their recommendations for antihypertensive medication initiation and intensification by the 2017 ACC/AHA guideline. Overall, 4,094 CVD events (stroke, coronary heart disease, and heart failure) occurred by December 31, 2014.

RESULTS Among participants not taking antihypertensive medication, 34.4% were recommended pharmacological antihypertensive treatment initiation. The CVD event rate per 1,000 person-years among participants recommended antihypertensive medication initiation with SBP/DBP ≥140/90 mm Hg was 22.7 (95% confidence interval [CI]: 20.3 to 25.0). Among participants with SBP/DBP 130 to 139/80 to 89 mm Hg, the CVD event rate was 20.5 (95% CI: 18.5 to 22.6) and 3.4 (95% CI: 2.4 to 4.4) for those recommended and not recommended antihypertensive medication initiation, respectively. Among participants taking antihypertensive medication, 62.8% were recommended treatment intensification. The CVD event rate per 1,000 person-years among participants recommended treatment intensification was 33.6 (95% CI: 31.5 to 35.6) and 22.4 (95% CI: 20.8 to 23.9) for those with SBP/DBP ≥140/90 mm Hg and 130 to 139/80 to 89 mm Hg, respectively.

CONCLUSIONS Implementing the 2017 ACC/AHA guideline would direct antihypertensive medication initiation and intensification to adults with high CVD risk. (J Am Coll Cardiol 2018;72:1187–97) © 2018 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

ACC = American College of Cardiology

AHA = American Heart Association

BP = blood pressure

CHD = coronary heart disease

CI = confidence interval

CKD = chronic kidney disease

CVD = cardiovascular disease

DBP = diastolic blood pressure

MI = myocardial infarction

SBP = systolic blood pressure

In 2017, the American College of Cardiology (ACC) and the American Heart Association (AHA) published an evidence-based guideline for the prevention, detection, evaluation, and management of high blood pressure (BP) in adults (1). All adults with hypertension, defined by an average systolic BP (SBP) ≥130 mm Hg or diastolic BP (DBP) ≥80 mm Hg, are recommended nonpharmacological therapy according to this guideline. However, not all adults with hypertension are recommended to initiate antihypertensive medication. Antihypertensive medication initiation is recommended for adults with an SBP ≥140 mm Hg or DBP ≥90 mm Hg and those with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg who are at high risk for cardiovascular disease (CVD) events. This includes adults with a prior diagnosis of diabetes, chronic kidney disease (CKD), or CVD, a 10-year predicted CVD risk ≥10%, or those ≥65 years of age with SBP ≥130 mm Hg (1). The recommendation for using CVD risk to guide the initiation of pharmacological therapy among adults with SBP between 130 and 139 mm Hg or DBP between 80 to 89 mm Hg was based on results of randomized trials that have consistently demonstrated that the absolute risk reduction for CVD events and all-cause mortality associated with antihypertensive medication increases with a higher predicted risk (2). Among adults taking antihypertensive medication, the 2017 ACC/AHA guideline recommend an SBP treatment target goal of <130 mm Hg. Also, a DBP treatment target goal of <80 mm Hg is recommended for adults <65 years of age and those ≥65 years of age with diabetes, CKD, a history of CVD, or a 10-year predicted CVD risk ≥10%.

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If the CVD event and all-cause mortality rates are high among adults recommended for antihypertensive medication initiation or intensification, this would indicate that the implementation of the 2017 ACC/AHA BP guideline is directing pharmacological treatment toward populations most likely to receive the largest absolute risk reduction. We used data from a large prospective population-based cohort, the REGARDS (REasons for Geographic And Racial Differences in Stroke) study (3), to determine the rates of CVD events and all-cause mortality among adults not taking antihypertensive medication who are recommended and not recommended for antihypertensive medication initiation according to the 2017 ACC/AHA BP guideline. Among REGARDS study participants taking antihypertensive medication, we also determined the rates of CVD events and all-cause mortality for those who are recommended and not recommended for antihypertensive medication intensification.

METHODS

STUDY POPULATION. The REGARDS study included a total of 30,239 black and white men and women ≥45 years of age from all 48 contiguous U.S. states and the District of Columbia between January 2003 and October 2007. For the present analysis, we excluded participants with missing data at baseline for BP (n = 143), self-reported antihypertensive medication use (n = 225), or variables needed to determine their recommendation for antihypertensive medication initiation or intensification according to the 2017 ACC/AHA guideline (n = 195). After the exclusion of an additional 458 participants without follow-up data, a total of 29,218 REGARDS study participants were included in the current analysis (Online Figure 1). The REGARDS study protocol was approved by the institutional review boards governing research in human subjects at the participating centers, and all participants provided written informed consent.

BASELINE ASSESSMENT. Computer-assisted telephone interviews were administered by trained staff and used to collect information on each participant's age, race, sex, home address, cigarette smoking, cognitive impairment, depressive symptoms, exhaustion, impaired mobility, history of falls, medical history

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(e.g., stroke, myocardial infarction [MI], coronary revascularization, diabetes, and dialysis therapy), and use of insulin and oral hypoglycemic and antihypertensive medications. Using the home address, participants were categorized into region of residence (i.e., stroke belt, stroke buckle, or other U.S. regions), as defined in Online Table 1. After completion of the interview, trained health professionals conducted in-home examinations following standardized protocols. Procedures included an electrocardiogram, collection of blood and urine samples, an inventory of prescription and over-the-counter medications taken during the 2-week period before each participant's study visit, and measurements of height and weight, which were used to calculate the body mass index. Serum total and high-density lipoprotein cholesterol, triglycerides, glucose, and creatinine were measured using the blood samples collected during the study visit (4). Estimated glomerular filtration rate was calculated using age, race, sex, serum creatinine, and the Chronic Kidney Disease Epidemiology equation (5). Urinary albumin and creatinine were measured and used to calculate the albumin-to-creatinine ratio.

Definitions for a history of CVD, diabetes, CKD, and frailty indicators, including low body mass index, cognitive impairment, depressive symptoms, exhaustion, impaired mobility, and history of falls are provided in Online Table 1. For participants without a history of CVD, the 10-year predicted CVD risk was calculated using the Pooled Cohort risk equations (6). Statin use was identified based on the medication inventory.

BP MEASUREMENTS. For each participant, BP was measured 2 times by a trained health professional during the in-home examination using the auscultatory method and an aneroid sphygmomanometer (American Diagnostic Corporation, Hauppauge, New York) with an appropriate-sized cuff following a standardized protocol. Before their first BP measurement, participants rested for 5 min in a seated position with both feet on the floor. At least 30 s elapsed between each measurement. Quality control for the BP measurements included routine calibration of the aneroid device by the manufacturer and monitoring of the readings for digit preference. The 2 BP measurements from each participant were averaged for the current analyses. Participants were grouped into 3 mutually exclusive categories based on their BP: 1) SBP <130 mm Hg and DBP <80 mm Hg; 2) SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg; and 3) SBP ≥140 mm Hg or DBP ≥90 mm Hg. Participants whose SBP and DBP corresponded to 2 separate categories were assigned to the higher BP group (e.g., participants with an SBP of 136 mm Hg and a DBP of 92 mm Hg were assigned to the SBP ≥140 mm Hg or DBP ≥90 mm Hg category). Hypertension was defined as an SBP ≥130 mm Hg or DBP ≥80 mm Hg (1). REGARDS study participants with SBP ≥140 mm Hg or DBP ≥90 mm Hg were advised to seek care from a health care professional (3). No recommendations on antihypertensive medication initiation or intensification were provided as part of the REGARDS study.

TABLE 1 Baseline Characteristics of REGARDS Study Participants Not Taking Antihypertensive Medication by BP Categories

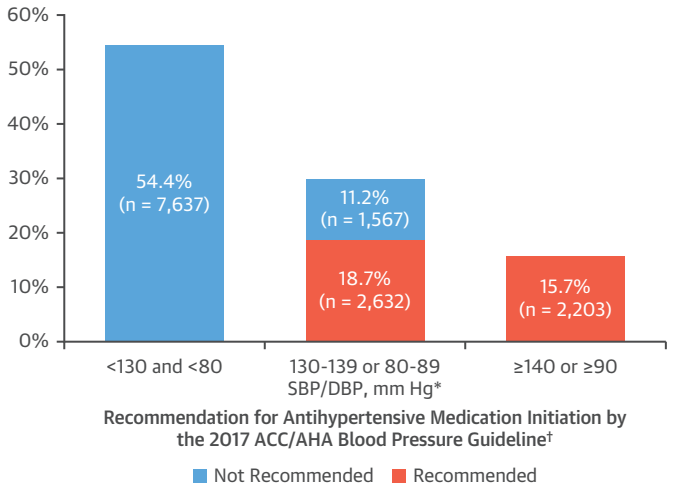
	SBP/DBP, mm Hg*		
	<130 and <80 (n = 7,637)	130–139 or 80–89 (n = 4,199)	≥140 or ≥90 (n = 2,203)
Age, yrs	62.8 ± 9.5	63.6 ± 9.5	65.7 ± 9.8
Male	3,257 (42.6)	2,202 (52.4)	1,186 (53.8)
Black	1,935 (25.3)	1,481 (35.3)	945 (42.9)
Geographic region of residence			
Stroke belt†	2,618 (34.3)	1,372 (32.7)	789 (35.8)
Stroke buckle‡	1,642 (21.5)	806 (19.2)	413 (18.7)
Other U.S. regions§	3,377 (44.2)	2,021 (48.1)	1,001 (45.4)
Less than high school education	580 (7.6)	418 (10.0)	313 (14.2)
Current smoking	1,140 (15.0)	593 (14.2)	428 (19.5)
SBP, mm Hg	113.8 ± 9.4	128.0 ± 7.9	148.3 ± 13.1
DBP, mm Hg	69.6 ± 6.5	79.8 ± 5.6	85.9 ± 9.9
Total cholesterol, mg/dl	195.2 ± 39.0	198.2 ± 39.2	201.1 ± 41.9
HDL cholesterol, mg/dl	54.0 ± 16.6	51.9 ± 15.8	52.3 ± 17.0
Statin use	1,696 (22.3)	879 (21.0)	421 (19.2)
History of CVD or 10-year CVD risk ≥10%	3,073 (40.2)	2,278 (54.3)	1,611 (73.1)
Age ≥65 yrs with SBP ≥130 mm Hg	0 (0.0)	1,196 (28.5)	1,147 (52.1)
Diabetes	782 (10.6)	538 (13.0)	347 (16.4)
Chronic kidney disease	800 (10.6)	590 (14.1)	495 (22.7)
Frailty indicators			
Depressive symptoms	720 (9.5)	356 (8.5)	226 (10.3)
Low body mass index	166 (2.2)	28 (0.7)	19 (0.9)
Cognitive impairment	357 (5.6)	244 (7.4)	151 (8.9)
Exhaustion	763 (10.0)	406 (9.7)	234 (10.6)
Impaired mobility	810 (10.6)	465 (11.1)	297 (13.5)
History of falls	480 (6.3)	241 (5.7)	142 (6.5)

Values are mean ± SD or n (%). *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Stroke buckle includes coastal North Carolina, South Carolina, and Georgia. ‡Stroke belt includes the remaining parts of the stroke buckle states and Tennessee, Mississippi, Alabama, Louisiana, and Arkansas. §Other U.S. regions includes the remaining 40 contiguous U.S. states and the District of Columbia.

CVD = cardiovascular disease; DBP = diastolic blood pressure; HDL = high-density lipoprotein; REGARDS = REasons for Geographic And Racial Differences in Stroke; SBP = systolic blood pressure.

IDENTIFICATION OF STROKE, CORONARY HEART DISEASE, AND HEART FAILURE HOSPITALIZATION EVENTS. Living REGARDS participants or proxy respondents are contacted every 6 months via telephone to identify suspected stroke, coronary heart disease (CHD) (i.e., MI or CHD death), and heart failure hospitalization events, which are subsequently reviewed using medical records (3,7). Stroke events are confirmed by a panel of neurologists following the World Health Organization definition (8). Events not

FIGURE 1 Distribution of REGARDS Study Participants Not Taking Antihypertensive Medication



Distribution of REGARDS study participants not taking antihypertensive medication by blood pressure category and recommendation for pharmacological treatment initiation is shown. *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Recommendations for antihypertensive medication initiation according to the 2017 ACC/AHA blood pressure guideline are shown in Online Table 2. ACC = American College of Cardiology; AHA = American Heart Association; CVD = cardiovascular disease; DBP = diastolic blood pressure; REGARDS = REasons for Geographic And Racial Differences in Stroke; SBP = systolic blood pressure.

meeting this definition but characterized by symptoms lasting <24 h with neuroimaging consistent with acute infarct or hemorrhage are also classified as strokes. MIs and heart failure hospitalizations are confirmed by trained clinicians following published guidelines (9,10). When deaths are identified, trained clinicians determine the main underlying cause of death based on interviews with next-of-kin, medical records, death certificates, and autopsy reports (10,11). CVD events were defined as a nonfatal or fatal stroke, nonfatal or fatal MI, CHD death, or heart failure hospitalization. CVD events and all-cause mortality through December 31, 2014, were available for the current analysis. The attrition rate among REGARDS study participants was 2.9% per year.

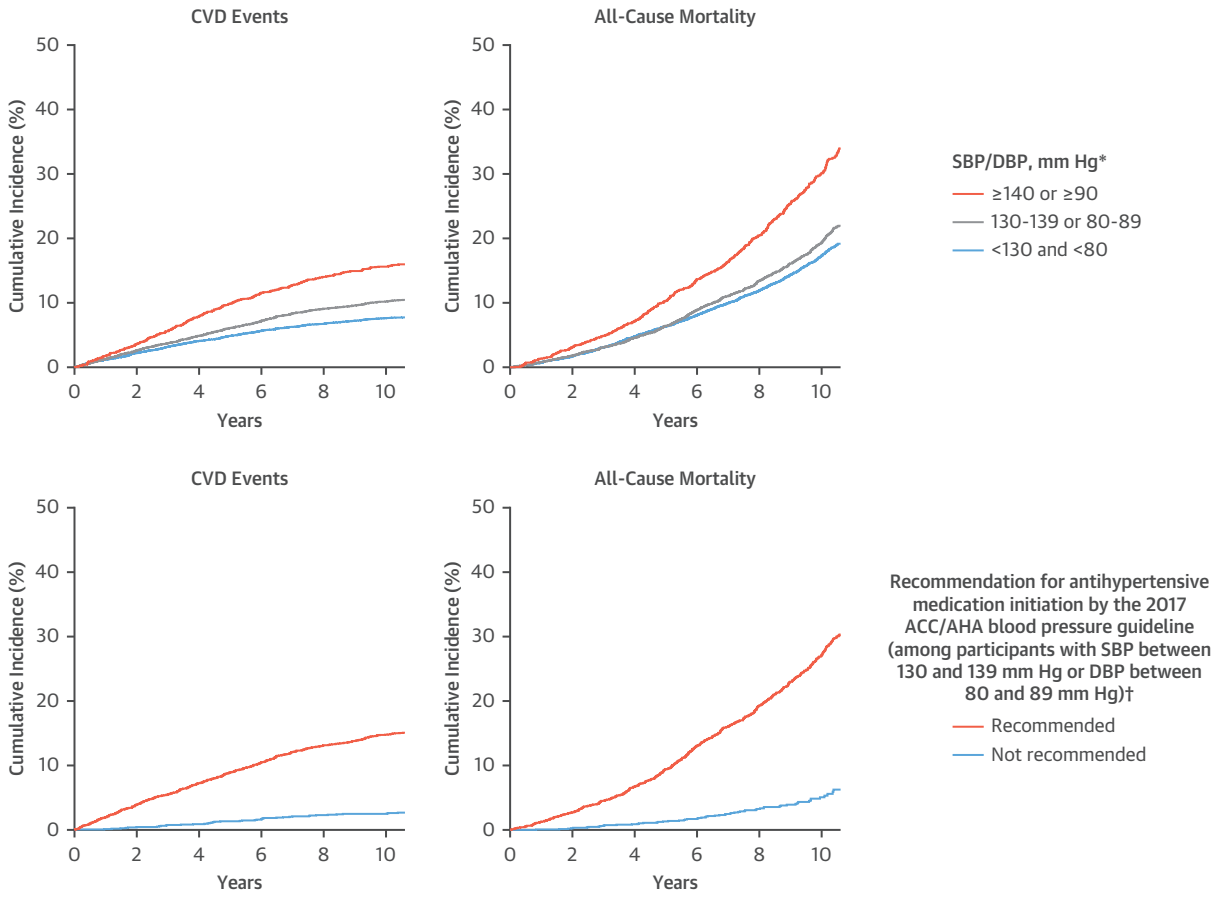
STATISTICAL ANALYSIS. All analyses described below were conducted among participants not taking and taking antihypertensive medication, separately. We calculated baseline characteristics by the 3 mutually exclusive BP categories (i.e., SBP <130 mm Hg and DBP <80 mm Hg, SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, and SBP ≥140 mm Hg or DBP ≥90 mm Hg). Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, we calculated baseline characteristics for those recommended and not recommended antihypertensive medication initiation or intensification by the 2017 ACC/AHA guideline (Online Table 2). We also calculated the distribution of REGARDS study participants across subgroups defined by the cross-tabulation between BP categories and recommendation for antihypertensive medication initiation or intensification by the 2017 ACC/AHA guideline.

We calculated CVD event rates as the number of participants who experienced a CVD event after baseline divided by the total person-years at risk. All-cause mortality rates were calculated as the number of participants who died divided by the total person-years at risk. For each participant, the time at risk for CVD was defined as the number of years from their in-home study visit (i.e., the end of the baseline assessment) through the occurrence of their first CVD event, death, last study contact, or December 31, 2014, whichever occurred first. For the analysis of all-cause mortality, participants were followed from their in-home visit through their death, last study contact, or December 31, 2014, whichever occurred first. We calculated the cumulative incidence of all-cause mortality using the Kaplan-Meier method. The Kaplan-Meier method overestimates the cumulative incidence in the presence of a competing risk event (12). Therefore, we calculated the cumulative incidence of CVD events as described by Fine and Gray taking into account the competing risk for mortality (12). For the calculation of the cumulative incidence of CVD events and all-cause mortality, participants were censored on their last study contact or December 31, 2014, whichever occurred first. The cumulative incidence and rate of CVD events and all-cause mortality were calculated by the 3 mutually exclusive BP categories. Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, we calculated the cumulative incidence and rate of CVD events and all-cause mortality for those recommended and not recommended pharmacological antihypertensive treatment initiation or intensification by the 2017 ACC/AHA guideline. Calculations of CVD event and all-cause mortality rates were also performed stratified by sex and race. All analyses were conducted using SAS v9.4 (SAS Institute, Cary, North Carolina).

RESULTS

PARTICIPANTS NOT TAKING ANTIHYPERTENSIVE MEDICATION. Participants in higher BP categories were older, more likely to be male, to be black, have

FIGURE 2 Cumulative Incidence of CVD Events and All-Cause Mortality Among REGARDS Study Participants Not Taking Antihypertensive Medication



Cumulative incidence of CVD events and all-cause mortality among 14,039 REGARDS study participants not taking antihypertensive medication by blood pressure category **(top)** and recommendation for pharmacological antihypertensive treatment initiation **(bottom)** is shown. *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Analyses of the recommendation for antihypertensive medication initiation were restricted to participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg. Recommendations for antihypertensive medication initiation according to the 2017 ACC/AHA blood pressure guideline are shown in Online Table 2. The median follow-up for CVD events was 8.3 years (maximum 11.9 years). The median follow-up for all-cause mortality was 8.5 years (maximum 11.9 years). On the x-axis, time 0 represents the date of the in-home baseline study visit for each participant. Abbreviations as in **Figure 1**.

less than a high school education, have a history of CVD or a 10-year predicted CVD risk ≥10%, diabetes, CKD, cognitive impairment, and impaired mobility (**Table 1**). Among participants not taking antihypertensive medication, 45.6% had hypertension and 34.4% were recommended to initiate antihypertensive medication according to the 2017 ACC/AHA BP guideline (**Figure 1**). Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, those recommended versus not recommended antihypertensive medication initiation by the 2017 ACC/AHA guideline were older, more likely to be men, have less than a high school education, smoke cigarettes, be taking a statin, and have cognitive impairment, exhaustion, impaired mobility, and a history of falls (Online Table 3).

The cumulative incidence and rate of CVD events and all-cause mortality were higher at higher BP levels (**Figure 2, Table 2**). Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, the rate of CVD events and all-cause mortality was 6-fold higher for those recommended versus not recommended antihypertensive medication by the 2017 ACC/AHA guideline (**Figure 2, Table 2**). In subgroups defined by sex and race, the rates of CVD events and all-cause mortality were higher with higher BP levels and among participants recommended versus not recommended

TABLE 2 Rates of CVD Events and All-Cause Mortality Among 14,039 REGARDS Study Participants Not Taking Antihypertensive Medication

	CVD Events		All-Cause Mortality	
	Events/ Person-Years	Rate (95% CI) per 1,000 Person-Years	Events/ Person-Years	Rate (95% CI) per 1,000 Person-Years
SBP/DBP, mm Hg*				
<130 and <80	599/58,581	10.2 (9.4–11.0)	1,059/60,400	17.5 (16.5–18.6)
130–139 or 80–89	444/32,133	13.8 (12.5–15.1)	674/33,465	20.1 (18.6–21.7)
≥140 or ≥90	356/15,711	22.7 (20.3–25.0)	551/16,729	32.9 (30.2–35.7)
Recommendation for antihypertensive medication initiation†				
Not recommended	43/12,615	3.4 (2.4–4.4)	61/12,739	4.8 (3.6–6.0)
Recommended	401/19,518	20.5 (18.5–22.6)	613/20,726	29.6 (27.2–31.9)

The median follow-up for CVD events was 8.3 years (maximum 11.9 years). The median follow-up for all-cause mortality was 8.5 years (maximum 11.9 years). *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Analyses of the recommendation for antihypertensive medication initiation were restricted to participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg. Recommendations for antihypertensive medication initiation according to the 2017 ACC/AHA blood pressure guideline include SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg with diabetes, chronic kidney disease, a history of CVD, or a 10-year predicted CVD risk ≥10%, or age ≥65 years with SBP ≥130 mm Hg. All participants with SBP ≥140 mm Hg or DBP ≥90 mm Hg are recommended antihypertensive medication initiation by the 2017 ACC/AHA blood pressure guideline.

CI = confidence interval; other abbreviations as in Table 1.

antihypertensive medication initiation by the 2017 ACC/AHA guideline (Online Table 4).

PARTICIPANTS TAKING ANTIHYPERTENSIVE MEDICATION. Participants taking antihypertensive medication with higher BP levels were more likely to be men, be black, have less than a high school education, a history of CVD or a 10-year predicted CVD risk ≥10%, diabetes, CKD, depressive symptoms, cognitive impairment, and exhaustion, and less likely to be taking a statin (Online Table 5). Overall, 62.8% of participants were recommended intensification of their antihypertensive medication to meet the BP target goals in the 2017 ACC/AHA guideline (Online Figure 2). Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, 5,023 (98.7%) were recommended antihypertensive medication intensification. The 66 participants not recommended antihypertensive medication intensification were women, nonsmokers, without diabetes, CKD, or a history of CVD, and with a 10-year predicted CVD risk <10% (Online Table 6).

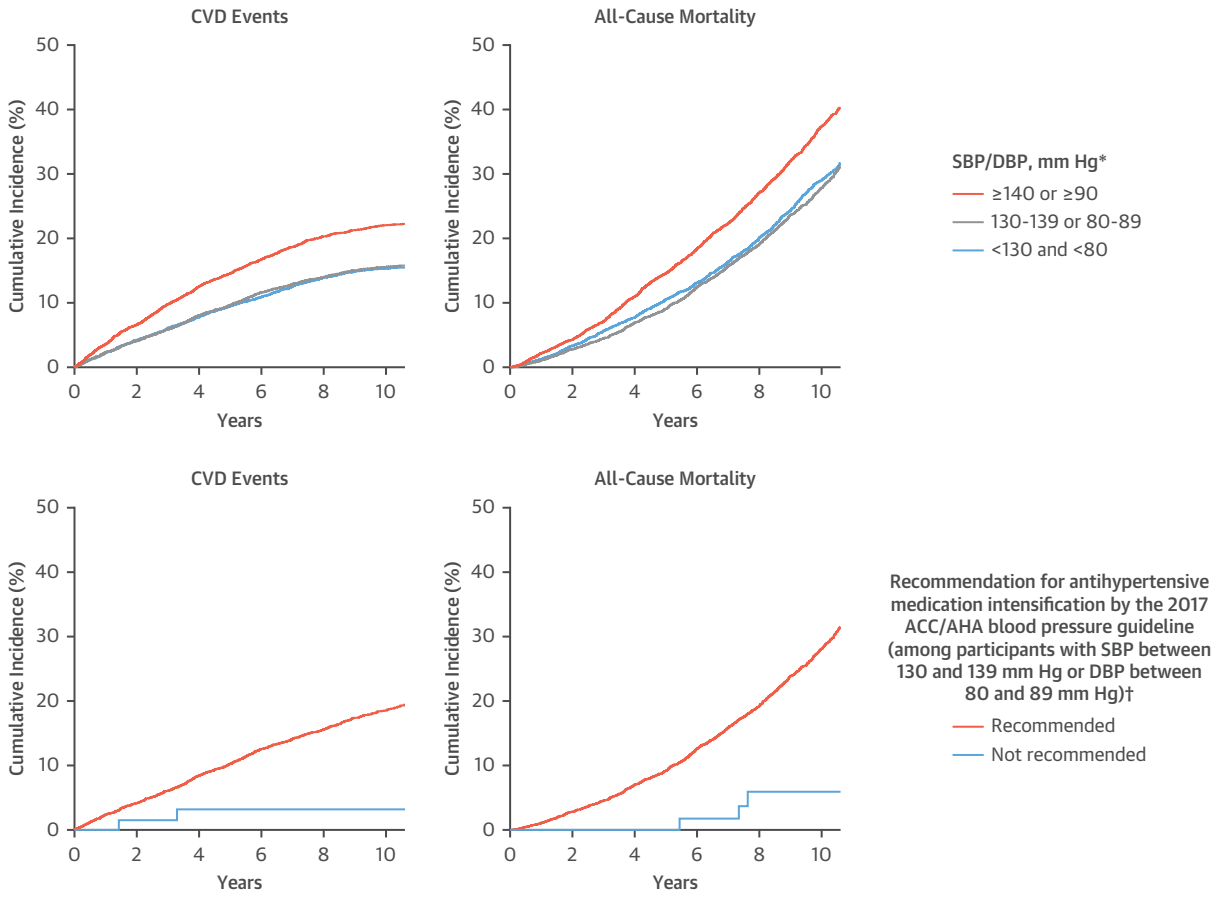
The risk for CVD events and all-cause mortality was higher among participants with SBP ≥140 mm Hg or DBP ≥90 mm Hg compared with their counterparts with lower BP levels (**Figure 3, Table 3**). Among participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg, the risk for CVD and all-cause mortality was higher for those recommended versus not recommended antihypertensive intensification by the 2017 ACC/AHA guideline (**Figure 3, Table 3**). The rates of CVD events and all-cause mortality were higher among participants with SBP ≥140 mm Hg or DBP ≥90 mm Hg versus their counterparts with lower BP levels, and among those recommended versus not recommended antihypertensive medication intensification when analyses were stratified by sex and race (Online Table 7).

DISCUSSION

In the current study, the rate of CVD events and all-cause mortality among participants not taking antihypertensive medication with an average SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg was 6-fold higher for those recommended versus not recommended pharmacological treatment initiation by the 2017 ACC/AHA BP guideline (**Central Illustration**). CVD event and all-cause mortality rates were also high among participants taking antihypertensive medication who are recommended treatment intensification. Results from the current study indicate that the implementation of the 2017 ACC/AHA BP guideline would direct pharmacological antihypertensive treatment initiation and intensification to adults with high risk for CVD events and all-cause mortality while avoiding treatment initiation and intensification for adults with low CVD risk.

The 2017 ACC/AHA BP guideline recommends considering BP levels and CVD risk in the decision to initiate pharmacological antihypertensive treatment (1). This approach was taken to direct pharmacological treatment to adults more likely to have CVD events and, therefore, maximize absolute risk reduction and quality-adjusted life-years saved from initiation of antihypertensive medication (13). Implementation of the 2017 ACC/AHA guideline has been projected to increase the number of U.S. adults ≥20 years of age recommended antihypertensive medication initiation by 4.2 million (14). In the current study, the CVD event rate among participants recommended initiation of pharmacological antihypertensive treatment by the 2017 ACC/AHA guideline was 22.7 per 1,000 person-years for those with SBP ≥140 mm Hg or DBP ≥90 mm Hg, and 20.5 per 1,000 person-years for those with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg. These high CVD rates suggest that a large absolute CVD risk reduction would occur with pharmacological antihypertensive treatment in these populations. Among U.S. adults ≥20 years of age not taking antihypertensive medication, 21.4 million have hypertension according to the 2017 ACC/AHA BP guideline, but are not recommended pharmacological treatment initiation (14). In the current analysis, the CVD event

FIGURE 3 Cumulative Incidence of CVD Events and All-Cause Mortality Among REGARDS Study Participants Taking Antihypertensive Medication



Cumulative incidence of CVD events and all-cause mortality among 15,179 REGARDS study participants taking antihypertensive medication by blood pressure category **(top)** and recommendation for pharmacological antihypertensive treatment intensification **(bottom)** is shown. *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Analyses of the recommendation for antihypertensive medication intensification were restricted to participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg. Recommendations for antihypertensive medication intensification according to the 2017 ACC/AHA blood pressure guideline are shown in Online Table 2. The median follow-up for CVD events was 7.8 years (maximum 11.8 years). The median follow-up for all-cause mortality was 8.2 years (maximum 11.9 years). On the x-axis, time 0 represents the date of the in-home baseline study visit for each participant. Abbreviations as in **Figure 1**.

rate was only 3.4 per 1,000 person-years among REGARDS study participants with hypertension who were not recommended to initiate pharmacological antihypertensive treatment by the 2017 ACC/AHA guideline. The low CVD event rate suggests a small absolute CVD risk reduction with antihypertensive medication in this population, supporting the recommendation to not initiate pharmacological treatment.

Several meta-analyses of randomized controlled trials have shown that intensification of pharmacological antihypertensive treatment to lower BP goals reduces the risk for CVD and mortality (15–18). Using data from 42 randomized trials, Bundy et al. (16) reported hazard ratios for CVD events and all-cause mortality comparing an achieved SBP of 120 to 124 mm Hg versus 130 to 134 mm Hg of 0.71 (95% confidence interval [CI]: 0.60 to 0.83) and 0.73 (95% CI: 0.58 to 0.93), respectively. The 2017 ACC/AHA BP guideline recommends SBP and DBP treatment goals of <130 mm Hg and <80 mm Hg, respectively, for the vast majority of adults taking antihypertensive medication (1). In the current study, participants taking antihypertensive medication who were recommended pharmacological treatment intensification had high rates of CVD events and

TABLE 3 Rates of CVD Events and All-Cause Mortality Among 15,179 REGARDS Study Participants Taking Antihypertensive Medication

	CVD Events		All-Cause Mortality	
	Events/ Person-Years	Rate (95% CI) per 1,000 Person-Years	Events/ Person-Years	Rate (95% CI) per 1,000 Person-Years
SBP/DBP, mm Hg*				
<130 and <80	873/39,821	21.9 (20.5–23.4)	1,289/42,168	30.6 (28.9–32.2)
130–139 or 80–89	808/36,566	22.1 (20.6–23.6)	1,151/38,984	29.5 (27.8–31.2)
≥140 or ≥90	1,014/30,201	33.6 (31.5–35.6)	1,407/33,108	42.5 (40.3–44.7)
Recommendation for antihypertensive medication intensification†				
Not recommended	2/523	3.8 (0.0–9.1)	3/538	5.6 (0.0–11.9)
Recommended	806/36,043	22.4 (20.8–23.9)	1,148/38,446	29.9 (28.1–31.6)

The median follow-up for CVD events was 7.8 years (maximum 11.8 years). The median follow-up for all-cause mortality was 8.2 years (maximum 11.9 years). *Blood pressure categories are mutually exclusive. Participants whose SBP and DBP correspond to 2 separate categories were assigned to the higher blood pressure group. †Analyses of the recommendation for antihypertensive medication intensification were restricted to participants with SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg. Recommendations for antihypertensive medication intensification according to the 2017 ACC/AHA blood pressure guideline include SBP between 130 and 139 mm Hg or DBP between 80 and 89 mm Hg with diabetes, chronic kidney disease, a history of CVD, or a 10-year predicted CVD risk ≥10%, age <65 years, or age ≥65 years with SBP ≥130 mm Hg. Participants ≥65 years of age with SBP <130 mm Hg, DBP between 80 and 89 mm Hg, and a 10-year predicted CVD risk <10% who do not have diabetes, chronic kidney disease, or a history of CVD are not recommended antihypertensive medication intensification according to the 2017 ACC/AHA blood pressure guideline.

Abbreviations as in Tables 1 and 2.

all-cause mortality. These results suggest that intensification of antihypertensive medication following the 2017 ACC/AHA guideline recommendations has the potential to result in a substantial absolute risk reduction for CVD events and all-cause mortality.

Participants taking antihypertensive medication in the current analysis who had an SBP <130 mm Hg and DBP <80 mm Hg had high CVD and mortality event rates. This result should not be interpreted as a lack of efficacy of pharmacological antihypertensive treatment, which has been demonstrated in clinical trials (2). Prior studies have shown that antihypertensive medication does not return CVD risk to the level of someone with normal or elevated BP not taking antihypertensive medication (19-23). Comprehensive risk reduction interventions including statin use and nonpharmacological therapies may be useful adjunctive therapies to further reduce the residual CVD risk among adults taking antihypertensive medication who are not recommended pharmacological treatment intensification according to the 2017 ACC/AHA BP guideline.

All adults with hypertension are recommended nonpharmacological therapy by the 2017 ACC/AHA BP guideline (1). Nonpharmacological therapies, including weight loss (24), healthy diet (25,26), reduced intake of dietary sodium (27,28), enhanced intake of dietary potassium (29), physical activity (30-33), and moderate alcohol intake (34,35) have been shown to reduce BP levels in randomized trials. Therefore, nonpharmacological therapy may lower BP below thresholds used to recommend antihypertensive medication initiation or intensification, reducing the need for initiating or intensifying pharmacological antihypertensive treatment (36-38). Future studies are needed to determine the potential impact of nonpharmacological therapies on CVD events among adults with hypertension according to the 2017 ACC/AHA guideline.

STUDY STRENGTHS AND LIMITATIONS. The current analysis has several strengths. We used data from the REGARDS study, a large, population-based cohort that enrolled adults in all 48 contiguous U.S. states and the District of Columbia. Baseline data collection in the REGARDS study was conducted by trained health professionals and included 2 BP measurements following a standardized protocol. Stroke, CHD, and heart failure events were adjudicated by trained personnel using published guidelines. Despite these strengths, the current results should be interpreted in the context of known and potential limitations.

Some REGARDS study participants may have initiated or intensified antihypertensive medication treatment after their baseline assessment if recommended by a health care professional following prior BP guidelines (e.g., the Joint National Committee Seventh Report). Therefore, the current results may underestimate the risk for CVD events and all-cause mortality among adults recommended antihypertensive medication initiation or intensification by the 2017 ACC/AHA BP guideline. The REGARDS study enrolled community-dwelling blacks and whites ≥45 years of age. Therefore, the results may not be generalizable to other race groups, those living in nursing homes, or adults <45 years of age. Also, the REGARDS study oversampled older adults, blacks, and residents of the stroke belt and stroke buckle regions of the United States (3). However, we have no reason to believe that the oversampling of these populations had a substantial effect on the main findings from the current analysis. BP was measured during a single visit and using an aneroid sphygmomanometer. The 2017 ACC/AHA BP guideline recommends making the diagnosis of hypertension based on 2 or more BP measurements taken on 2 or more separate occasions. Also, aneroid sphygmomanometers are susceptible to calibration issues. Some individuals who initiate or intensify antihypertensive medication may experience side effects (39). However, data on side effects

CENTRAL ILLUSTRATION **Rates of Cardiovascular Disease Events and All-Cause Mortality**

Systolic Blood Pressure and Diastolic Blood Pressure Levels, mm Hg	Cardiovascular Disease Events	All-Cause Mortality
Not Taking Antihypertensive Medication	Rate/1,000 person-years	Rate/1,000 person-years
≥140 or ≥90	22.7	32.9
130 to <140 or 80 to <90		
→ Recommended Antihypertensive Medication Initiation	20.5	29.6
→ Not Recommended Antihypertensive Medication Initiation	3.4	4.8
<130 and <80	10.2	17.5
Taking Antihypertensive Medication		
≥140 or ≥90	33.6	42.5
130 to <140 or 80 to <90		
→ Recommended Antihypertensive Medication Intensification	22.4	29.9
→ Not Recommended Antihypertensive Medication Intensification	3.8	5.6
<130 and <80	21.9	30.6

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Adults ≥45 years of age recommended antihypertensive medication initiation or intensification by the 2017 American College of Cardiology/American Heart Association blood pressure guideline had high risk for cardiovascular disease events and all-cause mortality.

associated with antihypertensive medication are not available in the REGARDS study. Despite the low annual attrition rate in the REGARDS study, loss to follow-up may not have been at random, which may result in biased estimations.

CONCLUSIONS

In the current study, participants with hypertension recommended pharmacological antihypertensive treatment initiation by the 2017 ACC/AHA BP guideline had a 6-fold higher rate of CVD events and all-cause mortality compared with their counterparts who had hypertension but are not recommended pharmacological antihypertensive treatment initiation. Among participants taking pharmacological antihypertensive medication, the risk for CVD events and all-cause mortality was high for those recommended to intensify their treatment to achieve the BP goals by the 2017 ACC/AHA guideline. These results support the implementation of the 2017 ACC/AHA BP guideline to identify populations who should receive substantial CVD and all-cause mortality risk reduction benefit through antihypertensive medication initiation or intensification.

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PERSPECTIVES

COMPETENCY IN PATIENT CARE AND PROCEDURAL SKILLS: The 2017 American College of Cardiology/American Heart Association blood pressure guideline recommends initiation and adjustment of antihypertensive medication in adults at high risk of cardiovascular events and all-cause mortality, and if implemented, these patients should gain substantial benefit.

TRANSLATIONAL OUTLOOK: Further efforts are needed to implement these guideline recommendations broadly across the population at risk.

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APPENDIX For supplemental tables and figures as well as more information on REGARDS, please see the online version of this paper.