

## Impact of the Discordance Between the American College of Cardiology/American Heart Association and American Diabetes Association Recommendations on Hypertension in Patients With Diabetes Mellitus in the United States

Doosup Shin, Chandrashekar Bohra, Kullatham Kongpakpaisarn

Hypertension is common in patients with diabetes mellitus,<sup>1,2</sup> and coexistence of hypertension and diabetes mellitus significantly increases the risk of atherosclerotic cardiovascular disease (ASCVD).<sup>3</sup> In 2017, the American College of Cardiology (ACC)/American Heart Association (AHA) published the new guideline for hypertension,<sup>2</sup> and the American Diabetes Association (ADA) also published a position statement for hypertension and diabetes mellitus.<sup>4</sup> The ACC/AHA recommended 130/80 mmHg as the blood pressure (BP) threshold to define hypertension, whereas the ADA recommended 140/90 mmHg. The authors of the ADA position statement emphasized the importance of an individualized approach to treat hypertension in patients with diabetes mellitus rather than changing the BP threshold.<sup>5</sup> Because of the difference between the 2 recommendations and lack of quality evidence to determine a precise BP threshold/target in patients with diabetes mellitus,<sup>5</sup> uncertainty still remains in this population. Because the clinical impact of this difference has never been studied, we investigated the prevalence and characteristics of diabetic patients with hypertension and discordant population in the United States according to the ACC/AHA and ADA recommendations.

### Methods

We used data from the National Health and Nutrition Examination Survey (NHANES) 2005 to 2014, a cross-sectional survey representing the noninstitutionalized civilian population in the United States. It was conducted by the National Center for Health Statistics using a stratified, multistage probability sample design. Anonymized data are publicly available at the Centers for Disease Control and Prevention website and can be accessed at <https://www.cdc.gov/nchs/nhanes/index.htm>. Between 2005 and 2014, the overall response rates ranged from 68.5% to 77.5%. NHANES was approved by the National Center for Health Statistics Research Ethics Review Board. All participants provided written informed consent.

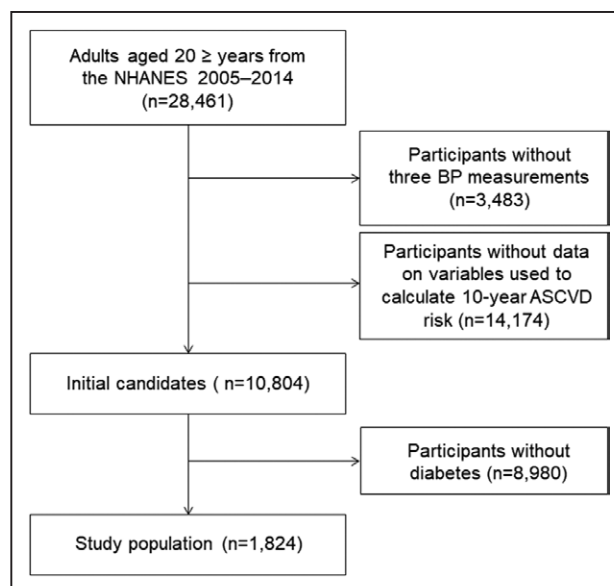
Among 28461 adults aged  $\geq 20$  years from the NHANES 2005 to 2014, we firstly excluded participants without 3 BP measurements (n=3483) or data on variables used to calculate 10-year ASCVD

risk (n=14174). Out of the initial candidates (n=10804), individuals without diabetes mellitus were excluded (n=8980). Diabetes mellitus was defined as (1) a hemoglobin A<sub>1c</sub> concentration  $\geq 6.5\%$ ; (2) self-reported diagnosis of diabetes mellitus by a healthcare provider; or (3) self-reported use of antidiabetes mellitus medications. After these exclusions, 1824 adults with diabetes mellitus were finally included in this study. A flowchart for selection of study population is demonstrated in the Figure.

BP was measured based on standardized protocol using mercury sphygmomanometer. Before the BP measurement, participants were allowed to rest for 5 minutes, and upper arm circumference was measured to guide selection of appropriate cuff size. The average of 3 BP measurements was used in this study. Hypertension was defined as (1) a BP  $\geq 130/80$  mmHg (ACC/AHA) or  $\geq 140/90$  mmHg (ADA) or (2) self-reported use of antihypertensive medications. Presence of ASCVD was defined based on self-reported history of coronary heart disease, angina, myocardial infarction, and stroke. The 10-year ASCVD risk scores were calculated using the pooled cohort equations based on the 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk.<sup>6</sup> Chronic kidney disease (CKD) was defined as an estimated glomerular filtration rate  $< 60$  mL/min per 1.73 m<sup>2</sup>, calculated using the 4-variable equation from the Modification of Diet in Renal Disease.<sup>7</sup> Cigarette smoking was determined based on self-reported claims of smoking every day or some days.

### Statistical Analysis

We first assessed individuals who were already taking antihypertensive medications. They were considered to be receiving the



**Figure.** Flowchart for selection of study population. ASCVD indicates atherosclerotic cardiovascular disease; BP, blood pressure; and NHANES, National Health and Nutrition Examination Survey.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

From the Department of Internal Medicine, University of South Florida Morsani College of Medicine, Tampa.

Correspondence to Doosup Shin, Department of Internal Medicine, University of South Florida Morsani College of Medicine, 17 Davis Blvd, Suite 308, Tampa, FL 33606. E-mail [dshin@health.usf.edu](mailto:dshin@health.usf.edu)

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medication appropriately based on each guideline. Then, we estimated individuals with hypertension and eligible for initiating anti-hypertensive drug therapy according to the ACC/AHA and ADA recommendations. We also investigated prevalence and clinical characteristics of discordant population who needs antihypertensive drug therapy based on the ACC/AHA guideline but not the ADA recommendation. Individuals in this discordant group had a BP of 130 to 139/80 to 89 mmHg (defined as stage 1 hypertension in the ACC/AHA guideline). The analyses were repeated after being stratified by race/ethnicity (non-Hispanic white, non-Hispanic black, and Hispanic). As NHANES before 2011 did not report data for Asian separately, we could not repeat the analysis for the Asian population. All statistical analyses were performed according to the analytic guidelines of the NHANES<sup>8</sup> using Stata 12.1 (Stata Corp, College Station, TX). Sample weights were used to account for complex sampling design and nonresponse rate.

**Results**

Table 1 demonstrates characteristics of study populations. The median age of the overall diabetic population was 61 years (interquartile range, 51–69 years) and 40.7% (95% confidence interval [CI], 39.4–42.1) were women. Among them, the prevalence of hypertension was 76.3% (95% CI, 73.1–79.3) and 66.0% (95% CI, 62.7–69.1) according to the ACC/AHA and ADA recommendations, respectively.

In addition to 56.7% (95% CI, 53.4–59.9) of patients with diabetes mellitus who were already receiving antihypertensive medications, 19.7% (95% CI, 17.0–22.6) and 9.3% (95% CI, 7.5–11.5) would be eligible for initiating antihypertensive medication according to the ACC/AHA and ADA recommendations, respectively (Table 2). As a result, 10.4% (95% CI, 8.5–12.6)

**Table 1. Characteristics of Study Population and Diabetic Adults With Hypertension According to the ACC/AHA and the ADA Recommendations**

Characteristics	Overall Population	Receiving Antihypertensive Medications	Hypertension	
			ACC/AHA	ADA
No. of sample	1824	1071	1411	1247
Extrapolated, N	27.4 million	15.5 million	20.9 million	18.1 million
Weighted proportion, % (95% CI)	100	56.7 (53.4–59.9)	76.3 (73.1–79.3)	66.0 (62.7–69.1)
Age, median (IQR), y	61 (51–69)	64 (56–72)	62 (53–70)	64 (55–71)
Elderly*, % (95% CI)	40.1 (37.8–43.1)	49.5 (43.3–55.7)	43.7 (39.2–48.3)	47.1 (42.0–52.3)
Female, % (95% CI)	40.7 (37.6–44.0)	43.2 (42.2–44.2)	40.9 (35.6–46.4)	41.8 (38.4–45.2)
Race/ethnicity, % (95% CI)				
Non-Hispanic white	66.4 (62.0–70.6)	67.7 (66.6–68.7)	67.1 (62.6–71.4)	66.8 (64.3–69.2)
Non-Hispanic black	13.7 (11.4–16.4)	17.4 (10.4–27.6)	15.9 (13.1–19.2)	16.8 (11.6–23.7)
Hispanic	13.7 (10.9–17.0)	10.2 (6.7–15.3)	12.5 (9.6–16.2)	11.8 (8.1–16.9)
SBP, median (IQR), mm Hg	128.0 (116.7–140.7)	131.3 (119.3–144.0)	133.3 (122.7–146.0)	134.7 (122.0–147.3)
DBP, median (IQR), mm Hg	69.3 (60.7–77.3)	67.3 (58.0–76.7)	70.0 (60.0–80.0)	68.7 (59.3–78.0)
TC, median (IQR), mg/dL	176 (152–209)	171 (148–201)	175 (151–175)	173 (149–207)
HDL-C, median (IQR), mg/dL	44 (37–52)	43 (36–53)	43 (36–53)	43 (36–53)
LDL-C, median (IQR), mg/dL	96 (74–122)	89 (67–113)	94 (71–121)	91 (68–115)
Obesity†, % (95% CI)	60.4 (56.5–64.2)	64.6 (51.1–76.0)	63.3 (53.5–72.1)	64.3 (56.0–71.9)
Smoking‡, % (95% CI)	33.0 (30.5–35.5)	28.0 (20.7–36.7)	29.7 (24.0–36.2)	29.0 (21.6–37.8)
CKD§, % (95% CI)	8.9 (7.2–11.0)	11.2 (9.7–12.8)	10.1 (8.7–11.7)	10.6 (8.8–12.7)
ASCVD, % (95% CI)	26.1 (23.6–28.7)	34.2 (33.1–35.2)	28.7 (26.7–30.7)	31.1 (29.4–32.9)
10-y ASCVD risk  , median (IQR), %	19.7 (9.3–36.6)	26.9 (13.4–42.9)	23.3 (12.1–40.9)	25.9 (13.8–42.9)
High ASCVD risk¶, % (95% CI)	73.3 (69.3–76.9)	81.8 (73.4–88.1)	79.1 (73.8–83.6)	82.2 (77.2–86.2)
High ASCVD risk¶ or having ASCVD, % (95% CI)	76.7 (73.6–79.6)	85.4 (78.8–90.1)	82.4 (79.3–85.1)	85.2 (81.4–88.3)
High ASCVD risk¶ or having ASCVD/CKD, % (95% CI)	77.5 (74.4–80.3)	85.8 (78.1–91.1)	83.2 (81.1–85.1)	85.9 (82.7–88.6)

ACC indicates American College of Cardiology; ADA, American Diabetes Association; AHA, American Heart Association; ASCVD, atherosclerotic cardiovascular disease (coronary heart disease, angina, myocardial infarction, and stroke); CI, confidence interval; CKD, chronic kidney disease; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; and TC, total cholesterol.

SI conversion factor: to convert cholesterol to mmol/L, multiply values by 0.0259.

\*Age ≥65 y.

†Body mass index ≥30 kg/m<sup>2</sup>.

‡Cigarette smoking was determined based on self-reported claims of smoking every day or some days.

§Estimated glomerular filtration rate <60 mL/min per 1.73 m<sup>2</sup>.

||Calculated using the pooled cohort equations based on the 2013 ACC/AHA guideline on the assessment of cardiovascular risk.

¶Ten-year predicted ASCVD risk ≥10%.

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of the diabetic population needed antihypertensive medication according to the ACC/AHA, but not by the ADA recommendation. The median age of this discordant population was 51 years (interquartile range, 44–63) and 21.9% (95% CI, 13.8–33.1) were aged  $\geq 65$  years. Among them, 60.0% (95% CI, 42.6–75.2) had a high 10-year ASCVD risk ( $\geq 10\%$ ), and 65.9% (95% CI, 62.8–68.8) had high-risk features (high 10-year ASCVD risk or presence of ASCVD/CKD).

Table 3 demonstrates race/ethnicity-specific prevalence of hypertension in diabetic patients and antihypertensive medication-needed population according to the ACC/AHA and ADA recommendations. The prevalence of hypertension in patients with diabetes mellitus was highest among non-Hispanic blacks regardless of BP thresholds, but the proportion of discordant population was lowest among them. Although the prevalence of

hypertension in diabetic patients was lowest among Hispanics, the proportion of patients who needed initiation of antihypertensive drug therapy was highest among them.

## Discussion

Our study demonstrated that 76.3% (95% CI, 73.1–79.3) and 66.0% (95% CI, 62.7–69.1) of US adults with diabetes mellitus had hypertension according to the ACC/AHA and ADA recommendations, respectively. As a result, 10.4% (2.8 million) would be reclassified as having or not having hypertension based on the different BP thresholds from the 2 recent recommendations. This discordant population with a BP of 130 to 139/80 to 89 mmHg was relatively younger and had a lower prevalence of ASCVD or CKD compared with the overall or hypertensive population with diabetes mellitus.

**Table 2. Characteristics of Antihypertensive Medication-Needed Populations According to the ACC/AHA and the ADA Recommendations**

Characteristics	Antihypertensive Medication-Needed Population		
	ACC/AHA	ADA	Discordant Population
No. of sample	340	176	164
Extrapolated, N	5.4 million	2.5 million	2.8 million
Weighted proportion, % (95% CI)	19.7 (17.0–22.6)	9.3 (7.5–11.5)	10.4 (8.5–12.6)
Age, median (IQR), y	55 (47–65)	58 (52–67)	53 (44–63)
Elderly*, % (95% CI)	27.1 (21.8–33.1)	32.9 (20.0–48.9)	21.9 (13.8–33.1)
Female, % (95% CI)	34.2 (15.4–59.7)	33.0 (9.5–69.9)	35.3 (21.8–51.6)
Race/ethnicity, % (95% CI)			
Non-Hispanic white	65.6 (59.0–71.6)	61.8 (46.0–75.5)	69.0 (63.5–74.0)
Non-Hispanic black	11.7 (10.1–13.4)	13.3 (8.0–21.3)	10.2 (8.0–12.8)
Hispanic	19.0 (14.8–24.2)	21.1 (11.2–36.3)	17.1 (13.2–21.9)
SBP, median (IQR), mm Hg	137.3 (131.3–147.3)	147.3 (142.0–158)	132.0 (128.7–135.3)
DBP, median (IQR), mm Hg	80.0 (70.7–85.3)	80.7 (68.0–90.7)	80.0 (70.7–82.7)
TC, median (IQR), mg/dL	189 (162–231)	193 (161–246)	187 (163–219)
HDL-C, median (IQR), mg/dL	43 (38–52)	42 (38–50)	44 (38–53)
LDL-C, median (IQR), mg/dL	107 (83–142)	107 (84–149)	110 (82–132)
Obesity†, % (95% CI)	59.6 (57.4–61.9)	63.0 (42.4–79.7)	56.7 (41.7–70.5)
Smoking‡, % (95% CI)	34.6 (34.4–34.7)	35.2 (31.2–39.4)	34.0 (29.6–38.8)
CKD§, % (95% CI)	7.0 (3.9–12.5)	7.4 (1.9–24.4)	6.7 (3.8–11.6)
ASCVD, % (95% CI)	12.7 (6.4–23.7)	12.6 (10.7–14.7)	12.9 (4.0–34.6)
10-y ASCVD risk  , median (IQR), %	17.5 (7.9–30.8)	21.9 (14.4–42.2)	12.1 (6.2–22.9)
High ASCVD risk¶, % (95% CI)	71.4 (67.8–74.6)	84.0 (69.4–92.4)	60.0 (42.6–75.2)
High ASCVD risk¶ or having ASCVD, % (95% CI)	73.8 (66.5–80.0)	84.0 (69.4–92.4)	64.7 (56.5–72.1)
High ASCVD risk¶ or having ASCVD/CKD, % (95% CI)	75.7 (60.0–86.6)	86.6 (55.5–97.1)	65.9 (62.8–68.8)

ACC indicates American College of Cardiology; ADA, American Diabetes Association; AHA, American Heart Association; ASCVD, atherosclerotic cardiovascular disease (coronary heart disease, angina, myocardial infarction, and stroke); CI, confidence interval; CKD, chronic kidney disease; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; and TC, total cholesterol.

SI conversion factor: to convert cholesterol to mmol/L, multiply values by 0.0259.

\*Age  $\geq 65$  y.

†Body mass index  $\geq 30$  kg/m<sup>2</sup>.

‡Cigarette smoking was determined based on self-reported claims of smoking every day or some days.

§Defined as estimated glomerular filtration rate  $< 60$  mL/min per 1.73 m<sup>2</sup>.

||Calculated using the pooled cohort equations based on the 2013 ACC/AHA guideline on the assessment of cardiovascular risk.

¶Ten-year predicted ASCVD risk  $\geq 10\%$ .

**Table 3. Race/Ethnicity-Specific Prevalence of Hypertension in Diabetic Patients and Antihypertensive Medication-Needed Population According to the ACC/AHA and the ADA Recommendations**

Race/Ethnicity	Overall Hypertension		Already Receiving Medication	Antihypertensive Medication-Needed Population		
	ACC/AHA	ADA		ACC/AHA	ADA	Discordant Population
Non-Hispanic white	77.2 (67.6–84.6)	66.4 (63.3–69.3)	57.7 (47.8–67.1)	19.4 (17.6–21.3)	8.6 (3.7–19.0)	10.8 (5.9–18.8)
Non-Hispanic black	88.7 (87.7–89.7)	81.0 (75.9–85.3)	72.0 (65.8–77.5)	16.8 (11.4–23.9)	9.1 (7.9–10.4)	7.7 (4.0–14.4)
Hispanic	69.9 (58.7–79.1)	56.9 (48.9–64.5)	42.5 (31.2–54.6)	27.4 (25.7–29.2)	14.4 (10.4–19.6)	13.0 (10.5–16.1)

Data presented as weighted proportion, % (95% confidence interval). ACC indicates American College of Cardiology; ADA, American Diabetes Association; and AHA, American Heart Association.

Although ADA did not change the BP threshold/target for most of the patients with diabetes mellitus,<sup>5</sup> an individualized approach with a lower BP target (130/80 mmHg) was recommended for patients at high risk of cardiovascular or kidney disease.<sup>4,5</sup> When this individualized approach was applied to the discordant population, 65.9% (95% CI, 62.8–68.8) would be eligible for a lower BP target (130/80 mmHg) based on their high 10-year ASCVD risk or coexisting conditions (ASCVD or CKD).

It should be noticed that the ACC/AHA guideline also recommended ASCVD risk assessment in all adults with hypertension, including those with diabetes mellitus, to determine the need for antihypertensive drug therapy.<sup>2</sup> The risk assessment is particularly important for individuals with stage 1 hypertension (BP, 130–139/80–89 mmHg) because initiation of antihypertensive drug therapy is recommended at a BP  $\geq$ 130/80 mmHg if a 10-year ASCVD risk is 10% or greater. For convenience, the ACC/AHA guideline assumed that most adults with diabetes mellitus have a 10-year ASCVD risk  $\geq$ 10% and recommended to start antihypertensive medications at BP  $\geq$ 130/80 mmHg.<sup>2</sup> However, our study showed that only 60.0% (95% CI, 42.6–75.2) of diabetic patients with stage 1 hypertension had a 10-year ASCVD risk  $\geq$ 10%. Even after considering those with ASCVD or CKD, >30% of diabetic patients with stage 1 hypertension did not have high-risk features that would require initiation of antihypertensive drug therapy at a low BP threshold (130/80 mmHg) per the ACC/AHA guideline. Therefore, an individualized approach with ASCVD risk assessment would be important in diabetic patients with stage 1 hypertension to determine antihypertensive treatment if the ACC/AHA guideline is strictly applied.

With discordance between the 2 recent recommendations on hypertension, controversy remains on an optimal BP threshold and target for hypertensive patients with diabetes mellitus. As discussed in the ACC/AHA guideline, this is mainly because there is limited quality evidence on this topic and no randomized trials directly demonstrated better clinical outcomes with intensive BP control <130/80 mmHg in diabetic patients.<sup>2,9</sup> Therefore, more quality studies are needed to solve this uncertainty and guide clinical practice. Furthermore, cost-benefit analysis of treating diabetic patients with stage 1 hypertension would give us additional information from public health perspective.

There are limitations in our study. First, our results rely on the accuracy and representativeness of the NHANES data for the current US population.<sup>10</sup> Second, BP was measured at a single visit in the NHANES.<sup>11</sup> Third, self-reported medical history and medication use might not be accurate.

In conclusion, application of different BP thresholds from the ACC/AHA and ADA recommendations would result in

reclassification of 10.4% of US adults with diabetes mellitus as having or not having hypertension. An individualized approach with ASCVD risk assessment would be important in those discordant patients to determine antihypertensive treatment. More studies are needed to guide hypertension management in diabetic population.

## Disclosures

None.

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