**Predicted cardiovascular risk and blood pressure for Americans with diabetes, chronic kidney disease, and ≥65 years of age**

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**Main idea:**

Secondary analyses of randomized controlled trials have found that the absolute CVD risk reduction with antihypertensive medication is greater for adults with higher CVD risk (see Section 8.1.1, first paragraph). Based on these data, the 2017 ACC/AHA BP guideline recommends using CVD risk and BP levels to guide the decision to initiate antihypertensive medication. The guideline states that the vast majority of adults with diabetes, chronic kidney disease, or ≥65 years of age have a 10-year CVD risk ≥10%, placing them in the high risk category and are recommended the initiation of antihypertensive drug therapy with SBP ≥ 130 mm Hg or DBP ≥ 80 mm Hg\* (see Section 9.3, 9.6, and 10.3.1 of ACC/AHA guidelines: treatment recommendations paragraph). However, data from NHANES show that a substantial proportion of US adults with stage 1 hypertension and diabetes or chronic kidney disease do not have a 10-year predicted CVD risk ≥10%. Therefore, when considering whether to initiate or intensify treatment to lower BP for an adult patient with stage 1 hypertension, physicians who aim to direct these treatments to those at higher risk for CVD should calculate CVD risk for patients with diabetes or chronic kidney disease rather than assuming it is high, particularly for adults aged 40 to 55 years. For adults with diabetes or chronic kidney disease whose 10-year predicted CVD risk is < 10%, treatment to lower BP may still provide substantial reduction in lifetime risk for CVD and prevention of complications associated with diabetes or chronic kidney disease.

\* For adults aged ≥65 years DBP is not used.

**METHODS**

NHANES was designed to assess the health and nutritional status of the non-institutionalized US population and is conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (1). Since 1999-2000, NHANES has been conducted in two-year cycles using a multistage probability sampling design to select participants. Each cycle is independent with different participants recruited. For the current analysis, three cycles conducted in 2013-2014, 2015-2016 and 2017-2018 were pooled for analysis (2). The protocols for each NHANES cycle 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. The University of Alabama at Birmingham Institutional Review Board considered the analysis of NHANES data to be exempt research.

The current analysis was restricted to adults aged 40 to 79 years of age who complete the NHANES interview and examination (n = 9,937). Participants with age <40 or >79 were not included because the ASCVD risk prediction equation recommended by the ACC/AHA BP guideline is not recommended in these age ranges. Participants who did not have three SBP and DBP measurements (n = 565) and those who were missing information on age, race, sex, total and high-density lipoprotein cholesterol, smoking status, or diabetes (n = 575) were excluded. After these exclusions, over the three NHANES cycles, a total of 8,797 survey participants were included in the analysis (Online Figure 1).

***Data collection***

Data were collected during an in-home interview and a study visit completed at a mobile examination center. Standardized questionnaires were used to assess survey participants’ age, sex, race/ethnicity, smoking habits, medical history and use of antihypertensive medication, oral glucose lowering medication and insulin. Medical history included questions about whether the participant had been told by a doctor or other health professional that they had a heart attack, coronary heart disease stroke, or heart failure. Blood and urine samples were collected during the medical examination. Of relevance to the current analysis, serum creatinine, serum glucose and glycated hemoglobin (HbA1c) were measured. Diabetes was defined by fasting serum glucose ≥ 126 mg/dL, non-fasting glucose ≥ 200 mg/dL, HbA1c ≥ 6.5%, or self-reported use of insulin or oral glucose lowering medication. Estimated glomerular filtration rate was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation.(3) Urinary albumin and creatinine levels were measured and used to calculate the albumin-to-creatinine ratio (ACR). CKD was defined by an estimated glomerular filtration rate < 60 ml/min/1.73m² or an ACR ≥ 30 mg/dL. Ten-year predicted risk for ASCVD was calculated using the pooled cohort risk equations for participants without a history of CVD.(4) Participants with a history of CVD were presumed to have 10-year risk for ASCVD ≥10%.

***Blood pressure measurement***

Physicians conducting study examinations followed the same protocol to measure SBP and DBP in each NHANES cycle. After survey participants had rested 5 minutes, their BP was measured by a trained physician using a mercury sphygmomanometer and an appropriately sized cuff. Three BP measurements were obtained at 30 second intervals. The mean of all available measurements was used to define SBP and DBP. Quality control included re-certification of physicians every quarter with retraining if needed. All physicians participated in annual retraining.

***Definitions of hypertension***

Participants not taking antihypertensive medication were grouped into four non-overlapping categories based on the 2017 ACC/AHA BP guideline: Normal BP (SBP < 120 mm Hg and DBP < 80 mm Hg), elevated BP (SBP between 120 and 129 mm Hg and DBP < 80 mm Hg), stage 1 hypertension (SBP between 130 and 139 mm Hg and/or DBP between 80 and 89 mm Hg with SBP < 140 mm Hg and DBP < 90 mm Hg), stage 2 hypertension (SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg). Participants taking antihypertensive medication were placed in a fifth group.

***Statistical analysis***

Analyses were conducted for the overall population and among participants with diabetes, CKD, ≥65 years of age, and for those with any of these three conditions, separately. Participant characteristics were summarized as mean (standard error) and percentage for continuous and categorical variables, respectively. The percentage of US adults in each of the five BP/antihypertensive medication use categories was computed. The median 10-year predicted risk for ASCVD and the proportion with a predicted risk ≥ 10% was computed for participants in each of the BP/antihypertensive medication use categories. To assess the extent to which participants with a 10-year predicted ASCVD risk < 10% were ‘borderline’ cases (i.e., predicted ASCVD risk of 5% to <10% or 7.5% to <10%), the distribution of predicted risk among participants with predicted risk <10% was estimated and the percentage with predicted risk of 0% to <2.5%, 2.5% to <5.0%, 5.0% to <7.5%, and 7.5% to <10% was computed. The age-adjusted probability of having a 10-year predicted ASCVD risk ≥ 10% was estimated using logistic regression. The above analyses were repeated among participants with stage 1 hypertension.

NHANES sampling weights, which were calculated as the inverse probability of being selected for the survey, were used in all calculations to obtain US nationally representative estimates. The survey design of NHANES was also taken into account. Data analysis was conducted using R version 4.0.1 or higher (Vienna, Austria). P-values were two-sided.

**RESULTS**

**DISCUSSION**

**REFERENCES**

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