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Original Investigation

Effects of Sodium Intake and Diet on Racial Differences in Urinary Potassium Excretion: Results From the Dietary Approaches to Stop Hypertension (DASH)-Sodium Trial

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Background: We previously showed that African Americans excreted less urinary potassium than whites, even while consuming similar diets in the Dietary Approaches to Stop Hypertension (DASH) trial. We hypothesized that a low-sodium diet may eliminate these differences.

Study Design: Data from the DASH-Sodium randomized controlled feeding trial were analyzed.

Setting & Participants: 412 adults with prehypertension or stage 1 hypertension.

Intervention: Random assignment to either a typical American "control" diet (1.7 g [43 mEq] potassium/2,100 kcal/d) or the DASH diet (4.1 g [105 mEq] potassium/2,100 kcal/d). Within each diet, participants received 3 levels of sodium intake in random order for 30 days.

Outcomes & Measurements: 24-hour urine samples were analyzed at the end of each period. The primary outcome was urinary potassium excretion.

Results: On the DASH diet, African Americans consistently excreted significantly less urinary potassium (mean 24-hour urinary potassium excretion, 2,594 ± 961 mg [66 ± 25 mEq]) than whites (3,412 ± 1,016 mg [87 ± 26 mEq]) at the highest sodium level; adjusted ($P < 0.001$); this difference was not altered by sodium level ($P = 0.6$ comparing white to African American difference in urinary potassium excretion on high- vs low-sodium diet). In contrast, there was a smaller but significant white−African American difference in mean daily urinary potassium excretion in participants fed the control/high-sodium diet that was not present in the control/low-sodium diet (adjusted differences of 281 mg [7 mEq]/d vs 20 mg [0.5 mEq]/d, respectively; $P = 0.007$). Significant interactions were found between race and diet ($P < 0.001$) and between race and sodium ($P = 0.02$).

Limitations: Single rather than multiple urine collections were available at each time. Lack of stool potassium and sweat potassium values.

Conclusions: Racial differences in urinary potassium excretion depend on sodium intake and diet. Our results may help explain the previously documented large variability in urinary potassium excretion.
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INDEX WORDS: Potassium; sodium; urinary excretion; racial differences; blood pressure; diet.

Hypertension, a leading and modifiable risk factor for the development of chronic kidney disease, cardiovascular disease, and stroke, is more common in African American individuals than in white individuals. The causes of racial differences in blood pressure (BP) likely include genetic and dietary factors, particularly differences in sodium and potassium intake. There is substantial evidence that increasing potassium intake decreases BP.[1-11] High sodium intake increases BP. The magnitude of decrease in BP resulting from an increase in potassium intake appears to be greater in African American than in white individuals.[1,3,9] Similarly, African American individuals may be more "salt sensitive" than whites, meaning that their BP, on average, increases more with increased sodium intake.

African American individuals in the United States typically eat less potassium than do white individuals.[1,12-14] According to NHANES (National Health and Nutrition Examination Survey) data from 2007-2008, the estimated mean daily amount of potassium consumed by individuals 20 years and older was 2.7 g (69 mEq) for non-Hispanic whites and 2.2 g (47 mEq) for non-Hispanic blacks.[14] African American individuals also typically excrete less urinary potassium than do white individuals; however, this difference may not be purely due to differences in intake.[1,3,15-20] Several small studies have documented that daily urinary potassium excretion was lower in African

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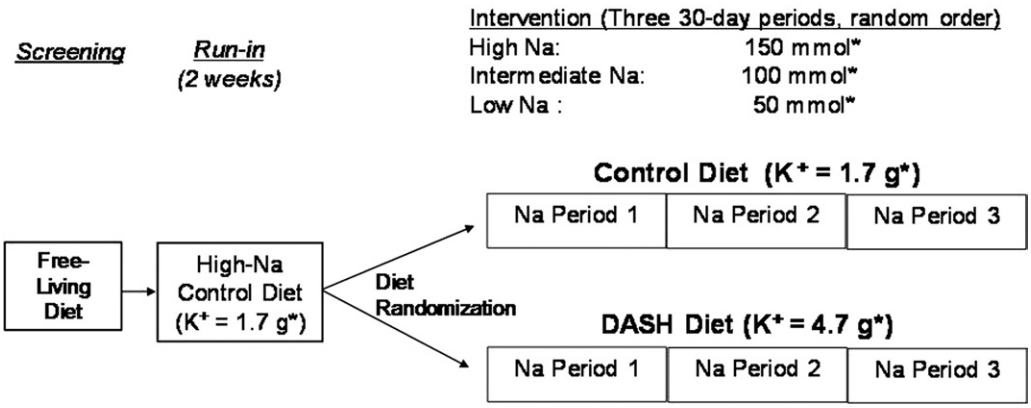

Figure 1. Dietary Approaches to Stop Hypertension (DASH)-Sodium (Na) Study design. The screening period was followed by a 2-week run-in period. Participants then were randomly assigned to either the control or DASH diet. During the intervention period, participants were given 3 different levels of sodium intake, for 1 month each, in random order. *Per 2,100 kcal per day. Abbreviation: K+, potassium.

Americans than in whites on free-living diets and when given similar potassium intakes.[16-19]

We demonstrated that racial differences in urinary potassium excretion were evident in participants in the original Dietary Approaches to Stop Hypertension (DASH) controlled feeding trial[2] at baseline and when both groups of participants were fed the DASH diet for 8 weeks.[21] In that study, we also found that the type of diet (control, fruit/vegetable, or DASH) modifies the racial difference in urinary potassium excretion in the setting of fixed sodium intake. Racial differences in the effects of dietary sodium intake on urinary potassium excretion have not been well studied and may contribute to differences in potassium excretion. We used data from the DASH-Sodium trial[22] to determine whether racial differences in urinary potassium excretion are affected by level of sodium intake.

METHODS

Study Design

The DASH-Sodium trial was a multicenter randomized trial that evaluated the main and interactive effects of 3 different levels of dietary sodium intake (goals of 50, 100, and 150 mEq/2,100 kcal/d, equivalent to 1,150, 2,300, and 3,450 mg/2,100 kcal/d) and 2 diets (a control diet and the DASH diet) on BP in 412 participants with systolic BP of 120-159 mm Hg and diastolic BP of 80-95 mm Hg.[22] BP was measured with random zero sphygmomanometers while participants were seated. Two measurements were obtained; the first was obtained after an initial 5-minute period of rest, and the second was obtained 30 seconds later. The study design is shown in Fig 1.

After a 2-week run-in period during which participants were fed the control diet at the higher sodium level, participants were randomly assigned to either the control or DASH diet. The control diet, typical of what is consumed in the United States, had a potassium target of 1.7 g (43 mEq)/2,100 kcal/d. The DASH diet was rich in fruits, vegetables, and low-fat dairy; modestly increased in protein; and low in saturated and total fat (potassium target, 4.7 g [120 mEq]/2,100 kcal/d). Detailed characteristics of the diets and study design have been published previously.[23] Briefly, ingredients were weighed and all meals were prepared on site in metabolic kitchens by trained staff. Participants came to the study site to eat one supervised meal (lunch or dinner) per day 5 days per week and were given food to eat off site for the rest of the meals. Participants were instructed to eat all of what was given to them and nothing else. Energy intake was adjusted as needed to keep participant body weight constant throughout the study. Efforts were made to ensure adherence, including reviewing the daily diaries filled out by participants. The study was approved by institutional review boards at each clinical site. All participants provided informed consent.

Within the assigned diets, there were three 30-day feeding periods, each with a different sodium level presented in random order. The 3 intervention feeding periods were separated by a break of up to 5 days. The "high sodium" level is the typical level of sodium intake consumed in the United States, the intermediate level was close to the recommended upper limit, and the lowest level was considered a possibly ideal level of sodium intake.

Twenty-four–hour urine collections were obtained at screening (baseline) and the end of each intervention period. Special efforts were made to collect complete 24-hour urine samples. Urinary measurements included sodium, potassium, and creatinine.

Statistical Analyses

Only participants who self-reported to be white or black were included in our analyses. Participants were included in the analyses only if for that particular period, they had complete 24-hour urine collections and a complete set of covariates.

Differences between urinary potassium excretion in African Americans and whites were tested during screening and separately by treatment group at the end of each diet-sodium period. To assess for these differences during screening, multivariate linear regression models were used, with adjustment for age, sex, and baseline weight. To test for differences in 24-hour urinary potassium excretion in African Americans compared with whites at the end of each intervention period stratified by diet type (control vs DASH), a general linear model of race and sodium level factors was used with generalized estimating equations to account for within-person correlations across sodium levels. The models included 2-way interactions and were adjusted for age, sex, caloric intake, sodium order (to account for possible carryover effects), and clinical site.

Sensitivity analyses also were performed to evaluate the effects of excluding urinary potassium measurements that appeared phys-