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Effects of Sodium Reduction and the DASH Diet in Relation to Baseline Blood Pressure

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Abstract

Background—Both sodium reduction and the DASH diet, a diet rich in fruits, vegetables, and low-fat dairy products and reduced in saturated fat and cholesterol, lower blood pressure. The separate and combined effects of these dietary interventions by baseline blood pressure (BP) has not been reported.

Objectives—We compared the effects of low versus high sodium, DASH versus control, and both (low sodium-DASH versus high sodium-control diets) on systolic BP (SBP) by baseline BP.

Methods—In the DASH-Sodium trial, adults with pre- or stage 1 hypertension, not using antihypertensive medications, were randomized to either DASH or a control diet. On either diet, participants were fed each of three sodium levels (50, 100, and 150 mmol/d at 2100 kcal) in random order over 4 weeks separated by 5-day breaks. Strata of baseline SBP were <130, 130-139, 140-149, and ≥150 mmHg.

Results—Of 412 participants, 57% were women, and 57% were black; mean age was 48 years, and mean SBP/DBP was 135/86 mmHg. In the context of the control diet, reducing sodium (from high to low) was associated with mean SBP differences of -3.20, -8.56, -8.99, and -7.04 mmHg across respective baseline SBP strata (listed above) (*P*-trend=0.004). In the context of high sodium, consuming the DASH compared to the control diet was associated with mean SBP differences of -4.5, -4.3, -4.7, and -10.6 mmHg, respectively (*P*-trend = 0.66). The combined effects of the low sodium-DASH diet versus the high sodium-control diet on SBP were -5.3, -7.5, -9.7, and -20.8 mmHg, respectively (*P*-trend<0.001).

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Conclusions—The combination of reduced sodium intake and the DASH diet lowered SBP throughout the range of pre- and stage 1 hypertension, with progressively greater reductions at higher levels of baseline SBP. SBP reductions in adults with the highest levels of SBP (≥150 mmHg) were striking and reinforce the importance of both sodium reduction and the DASH diet in this high risk group. Further research is needed to determine the effects of these interventions among adults with SBP ≥160 mmHg.

Keywords

DASH; sodium; diet; blood pressure; trial

Introduction

Consuming a healthful diet is an important approach to lower blood pressure (BP). This was shown definitively in the Dietary Approaches to Stop Hypertension (DASH) trial, which demonstrated that consuming a diet rich in fruits, vegetables, and low-fat dairy products and reduced in saturated fat and cholesterol lowered systolic blood pressure (BP) and diastolic blood pressure (DBP) (1). Subsequently, the DASH-Sodium trial confirmed that the DASH diet lowered SBP and DBP (2). In addition, this trial demonstrated that reducing sodium had a significant impact on BP independently of the effects of the DASH diet. Based on these studies, both of these strategies are recommended for all adults with pre-hypertension or stage 1 hypertension, as well as the general population (3). The DASH-Sodium trial has previously reported the effects of these interventions, alone and combined, overall and separately in pre-hypertensive and hypertensive individuals. However, whether the effects of the DASH diet or sodium reduction differ by level of BP has not been reported. Furthermore, using just baseline hypertension status (yes/no) underestimates the full effect of these interventions on either SBP or DBP. In order to determine whether the effects from the DASH diet or sodium reduction differ by hypertension severity, it is necessary to document the effects of these interventions by strata of absolute level of baseline SBP or DBP.

We conducted this secondary analysis of the DASH-sodium trial to determine the BP-lowering effects of (1) sodium reduction alone, (2) the DASH diet alone in strata of high or low sodium, and (3) both interventions across strata of baseline SBP or DBP. We hypothesized that the effects of either or both lifestyle interventions would be greater among participants with a higher baseline BP. We were especially interested in the effects of these interventions among those with the highest level of baseline BP.

Methods

The DASH-Sodium trial was a randomized trial conducted between September 1997 through November 1999, sponsored by the National Heart, Lung, and Blood Institute. The trial was initiated by investigators at 4 clinical centers within the United States (Baltimore, Maryland; Boston, Massachusetts; Durham, North Carolina; Baton Rouge, Louisiana). Detailed methods have been published elsewhere (2). The DASH-Sodium trial was conducted as a follow-up to the DASH trial to determine the effects of sodium reduction on BP alone and in combination with the DASH diet. DASH-Sodium compared the effects of consuming three different sodium levels in the context of either the DASH diet or a control diet, typical of what many Americans eat, i.e. potassium, magnesium, and calcium intakes at the 25th percentile and average macronutrient profile of the US population. Institutional Review Boards at each center approved the original study protocol including subsequent analyses. Written, informed consent was provided by all participants.

Participants

The DASH-Sodium trial included adults, aged 22 years and older, with a SBP of 120 to 159 mmHg and DBP of 80 to 95 mmHg, based on the average BP across three screening visits. Persons with a prior diagnosis of heart disease, renal insufficiency, poorly controlled dyslipidemia, diabetes mellitus or heart failure were excluded from participation (2). The trial also excluded persons taking antihypertensive agents or insulin, and persons drinking more than 14 alcoholic drinks a week.

Dietary Interventions

The trial tested two dietary factors, namely, dietary patterns and sodium levels. Participants were fed one of two dietary patterns (parallel design: DASH or control diet) and each of three sodium levels (crossover design: low, medium, or high). The DASH diet emphasized fruits, vegetables, and low-fat dairy foods with reduced intake of saturated fat, total fat, and cholesterol. The DASH diet included whole grains, poultry, fish, and nuts, and was reduced in red meat, sweets, and sugar-containing beverages. The control diet was typical of what many Americans eat (1).

Participants on either the DASH or control diets were fed each of three sodium levels: low, medium, and high (50 mmol or 1150 mg, 100 mmol or 2300 mg, and 150 mmol or 3450 mg, respectively, at 2100 kcal). The high level reflected average sodium intake in the US. The medium level corresponded to prevailing sodium recommendations, while the lower level represented a level that might further lower BP. The levels of sodium intake were indexed to total energy requirements of each participant. A detailed composition of the diets may be found in Online Table 1 (4).

All meals and snacks were provided to participants. The participants' main meal (lunch or dinner) was consumed at the study centers under observation, while their remaining study meals were consumed off-site. Caloric intake was adjusted throughout the trial to keep participant weight constant. All participants underwent a two-week run-in period, during which they ate the high sodium-control diet. Then they were randomized to either the DASH or control diet. On their assigned diet, participants consumed low, medium, or high sodium levels, each for 30 days. The order of sodium assignment was randomized, following a crossover design. Each of the sodium levels were separated by, on average, 5-day washout periods during which participants ate their usual diets. The intervention periods were completed by >98% of participants (2).

Blood pressure and covariate measurements

Consistent with the original DASH-Sodium trial, SBP was the primary outcome of this ancillary study. DBP was a secondary outcome. Both DBP and SBP were measured at the same time with random-zero sphygmomanometers, while participants were seated. BP was measured at three visits during the screening phase and at two visits during the 2-week run-in period. The average of these 5 measurements served as a baseline for this study. BP was also measured at five clinic visits during the last 9 days of each intervention period (at least two during the final 4 days). Baseline SBP was organized in a priori strata <130, 130-139, 140-149, and ≥150 mmHg based on commonly used values to classify individuals. Baseline DBP was also organized in the following *a priori* strata: <80 mmHg, 80-84 mmHg, 85-89 mmHg, and ≥90 mmHg. Because eligibility for the trial is based on the 3 screening visits and because baseline is the average of BP at the 3 screening visits and 2 run-in visits, some participants had a baseline BP below (or above) the eligibility cut points of the trial (i.e. <130 or ≥160 mmHg systolic or <80 or >95 mmHg diastolic).

Other population characteristics were determined via questionnaire, laboratory specimens, and physical examination. Body mass index (BMI) was derived from measured height and weight.

Statistical analysis

We used means (SD) and proportions to describe baseline population characteristics by diet assignment, overall and across 4 strata of baseline SBP (<130, 130-139, 140-149, ≥150 mmHg). Furthermore, the following contrasts were of interest: (1) low versus high sodium, separately in the control and DASH diets (sodium effect alone); (2) DASH versus control diets, separately at the high and low sodium levels (DASH effect alone); and (3) the low sodium-DASH diet versus the high sodium-control diet (combined effect).

For the first comparison (low versus high sodium), we used the crossover design of the trial to compare SBP measured at the end of the low sodium period with SBP measured at the end of the high sodium period within the same participant. These analyses were performed via generalized estimating equation (GEE) regression models with a Huber and White robust variance estimator (5), which conservatively assumed an exchangeable working correlation matrix. All analyses were adjusted for age, female sex, black race, and baseline BMI to address potential imbalances introduced by the stratified analysis.

The second and third comparisons involved the parallel design of the trial. For these analyses, we compared change in SBP from baseline to the end of either the high or low sodium period using linear regression. As above, all analyses were adjusted for age, female sex, black race, and baseline BMI.

Differences between baseline SBP strata were determined using interaction terms in models restricted to the two baseline SBP strata being compared. The <130 mmHg stratum served as a reference group. Trends across categories were determined using the median baseline SBP value within each of the baseline SBP strata and treating it as a continuous variable in an interaction term with the diet of interest.

In secondary analyses, we examined the effects of sodium reduction, DASH versus control, or both interventions on DBP in strata of baseline DBP values (<80 mmHg, 80-84 mmHg, 85-89 mmHg, and ≥90 mmHg). The <80 mmHg stratum served as a reference group for comparisons across strata. Trends across categories were determined using the median baseline DBP value corresponding to each DBP stratum as above. All analyses were conducted with Stata version 14.0 (Stata Corporation, College Station, Texas). Missing data were minimal and evenly distributed throughout dietary interventions and time periods throughout the study.

Results

Baseline characteristics

Baseline characteristics of the 412 study participants are shown in Table 1. There were no significant differences between participants assigned the control or DASH diet overall. Among those assigned the control diet, age and proportion of women were higher in higher strata of baseline SBP. Among those assigned the DASH diet, age, proportion of women, and proportion black were higher in higher strata of baseline SBP. There were no clear trends in BMI across strata of baseline SBP in either arm.

Low versus high sodium intake

Among those assigned to the control arm, reducing sodium intake from high to low levels was associated with reductions in SBP of -3.20 (95% CI: -4.96,-1.44), -8.56 (95% CI: -10.70,-6.42), -8.99 (95% CI: -11.21,-6.77), and -7.04 (95% CI: -12.92,-1.15) mmHg in strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg, respectively) (Table 2). The trend across strata was statistically significant ($P = 0.004$).

Among those assigned to the DASH diet, reducing sodium intake from high to low levels was associated with reductions in SBP of -0.88 (95% CI: -2.07, 0.30), -3.29 (95% CI: -4.71,-1.88), -4.90 (95% CI: -7.25,-2.55), and -10.41 (95% CI: -15.54,-5.28) mmHg in strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg, respectively) (Table 2). This trend was also statistically significant ($P < 0.001$).

DASH versus control diets

During the high sodium feeding period, the DASH diet compared to the control diet significantly changed SBP by -4.47 (95% CI: -6.64,-2.29), -4.26 (95% CI: -6.72,-1.80), -4.72 (95% CI: -8.25,-1.19), and -10.63 (95% CI: -18.86,-2.41) mmHg in strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg, respectively) (Table 3). However, there was no significant trend across strata ($P = 0.66$).

Similarly, during the low sodium feeding period, the DASH diet compared to the control diet changed SBP by -2.36 (95% CI: -4.61,-0.11), 0.92 (95% CI: -1.47, 3.31), -0.55 (95% CI: -4.03, 2.93), and -14.13 (95% CI: -25.61,-2.64) in strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg, respectively) without evidence of a trend across strata ($P = 0.29$).

Low sodium-DASH diet versus high sodium-control diet

The mean SBP across strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg) was 116, 124, 131, and 130 mmHg on the low sodium-DASH diet versus 123, 133, 141, and 152 mmHg on the high sodium-control diet (Figure 1A). Compared with the high sodium-control diet, the low sodium-DASH diet lowered SBP by -5.30 (95% CI: -7.66,-2.94), -7.48 (95% CI: -10.11,-4.84), -9.70 (95% CI: -13.34,-6.06), and -20.79 (95% CI: -30.88,-10.69) mmHg across strata of baseline SBP (<130, 130-139, 140-149, and ≥150 mmHg, respectively) (Supplement Table S2). Furthermore, there was evidence of a trend for greater reduction in SBP across strata of higher baseline SBP (*P* trend <0.001).

Secondary Outcome: Diastolic Blood Pressure

Analyses were repeated examining the effects of sodium reduction, the DASH diet (versus control), and both dietary interventions on DBP across strata of baseline DBP (Online Tables 3-5). The pattern of DBP change by baseline DBP was virtually identical to that of SBP. Figure 1B displays DBP values on low sodium-DASH diet and high sodium-control diets.

Discussion

In this trial, which enrolled adults with pre- or stage 1 hypertension, the combination of reduced sodium intake and the DASH diet lowered SBP throughout the range of SBP, with progressively greater reductions at higher levels of baseline SBP (Central Illustration). Among persons with baseline SBP ≥150 mmHg, mean SBP reduction was striking, (i.e., >20 mmHg). In both the control and DASH diet, reducing sodium from high to low levels alone lowered SBP with progressively greater reductions at higher SBP. Meanwhile, the effects of the DASH diet differed by level of sodium. At the high sodium level, the DASH diet compared to the control diet lowered SBP in each stratum, but without a significant trend by baseline SBP; at the low sodium level, the effects of the DASH diet in the four strata of baseline SBP were inconsistent. These findings demonstrate that the individual and combined effects from both sodium reduction and the DASH diet are profound particularly in hypertensive persons with higher BP.

In children and adults, trials have shown that lowering dietary salt intake lowers BP (6, 7). Trials often report effects overall or in non-hypertensive and hypertensive individuals. However, individual studies and meta-analyses provide scant information about the effects of sodium reduction by level of baseline BP and at high levels of BP. Analyses that stratify by hypertension status will differ from baseline BP analyses, underestimating the effect of sodium intake on BP. Among the few trials that have examined populations with more extreme baseline hypertension, one intervention trial of untreated adults with severe hypertension (mean SBP/DBP of 176/96 mmHg), showed that sodium reduction (80 mmol/d compared to typical diet) decreased SBP by 5 mmHg (8). Similarly, a randomized feeding study by Pimenta et al in adults with uncontrolled hypertension despite using 3 or more antihypertensive agents (mean BP 146/84 mmHg) demonstrated that sodium reduction (50 mmol/d compared to 250 mmol/d) decreased SBP by 22 mmHg (9). Likewise, early analyses of the DASH trial and the DASH-Sodium trial did not stratify by hypertension severity. Thus, while the magnitude of BP lowering from either DASH or sodium reduction in those with baseline hypertension was greater than those without baseline hypertension, it was not as impressive as these other studies. In contrast, our current findings in the SBP ≥150 mmHg group are virtually identical to the studies above.

The original DASH trial demonstrated that compared with control, DASH reduced SBP by 5.5 mm Hg overall and by 11.4 mm Hg among participants with hypertension at baseline (1,10,11). The sodium level of this trial was ~3 g per day (1). To place our results in context, compared to placebo, angiotensin-converting enzyme inhibitors reduce SBP by 12 mm Hg, beta blockers reduce SBP by 13 mm Hg, and calcium-channel blockers reduce SBP by 16 mm Hg (Central Illustration)(12). Similarly, the U.S. Food and Drug Administration recommends a minimum SBP-lowering effect of 3 to 4 mm Hg for new antihypertensive agents (13). Although we did not observe a higher magnitude of reduction among participants with a baseline SBP between 140 and 149, we did find a substantially greater reduction among those with a baseline SBP ≥150 mm Hg. The fact that the DASH diet with low sodium reduced BP compared with the control diet with high sodium reinforces the importance of modifying a dietary pattern when attempting to lower BP with diet. Although it has been hypothesized that potassium may be a particularly important nutrient in the DASH diet (14), unmeasured nutrients likely act synergistically via complex processes (15).

This study has limitations. Adults with chronic kidney disease, medication-treated hypertension, medication-treated diabetes, and heart failure were excluded from participation, which could affect generalizability. The study also excluded adults with a SBP >160 mmHg during screening visits. As a result, we cannot determine the effects of these interventions in persons with stage 2 hypertension. However, it is reasonable to speculate that BP reduction would be at least as great. Furthermore, there were fewer participants in the highest SBP stratum, (i.e., ≥150 mmHg), than other strata, which increases susceptibility to confounding, particularly with regards to parallel comparisons. While we did not observe imbalances in baseline characteristics and all our comparisons were adjusted for a number of baseline covariates, residual confounding is possible. Another limitation is study duration – the sodium intervention only lasted 4 weeks. Recent evidence suggests that BP effects from sodium reduction may not reach their full magnitude at 4 weeks (15). Finally, the study was not of sufficient size or duration to determine the effects of the interventions on cardiovascular events.

This study also has several strengths. It utilized a randomized design, included a diverse study population, and maintained high diet adherence and follow-up rates. Furthermore, BP was assessed by masked observers in triplicate with a standardized protocol, thereby increasing precision and minimizing bias. Finally, the impact of weight change was minimized by maintaining isocaloric feeding throughout the study.

Our findings have both clinical and public health implications. In participants with hypertension, the DASH diet with low sodium, compared to the control diet with high sodium, lowered SBP by nearly 10 mmHg among those with a baseline SBP of 140-149 mmHg and >20 mmHg among those with a baseline SBP ≥150 mmHg. SBP levels between 140-159 mmHg represent the majority of patients with hypertension (16). Thus, our findings suggest that most adults with uncontrolled BP can experience substantial reductions in SBP from dietary changes alone, reinforcing the importance of lifestyle interventions in the management of hypertension. The SBP reductions observed in those with pre-hypertension are lesser than those with hypertension, but still should lower the risk of subsequent CVD (17,18).

In conclusion, the combination of low sodium intake and the DASH diet was associated with substantially greater reductions in SBP among participants with a higher SBP at baseline compared with the combination of high sodium intake and the control diet. These findings reaffirm the importance of lifestyle interventions among adults with uncontrolled SBP. Further research is needed to determine the magnitude of SBP reduction that might be achieved in persons with SBP ≥160 mmHg and in other conditions including chronic kidney disease and congestive heart failure.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations

DASH	Dietary Approaches to Stop Hypertension
GEE	generalized estimating equation
CI	confidence interval
SBP	systolic blood pressure
DBP	diastolic blood pressure

Perspectives

Competency in Patient Care

In adults with pre-hypertension, stage I hypertension and baseline systolic blood pressure ≥150 mm Hg, the combination of the DASH diet and restriction of sodium intake can achieve substantial (>20 mmHg) reductions in blood pressure.

Translational Outlook

Future studies should determine the magnitude of BP reduction that can be achieved in patients with more severe hypertension and in those with heart failure and kidney disease.

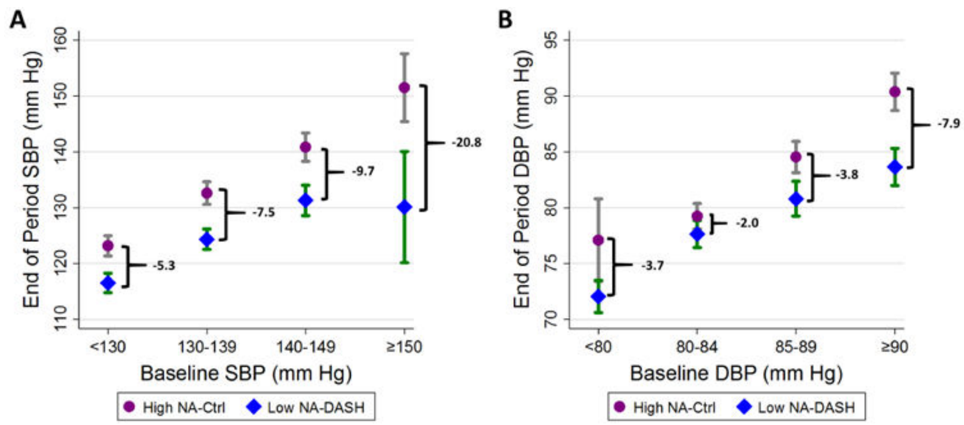
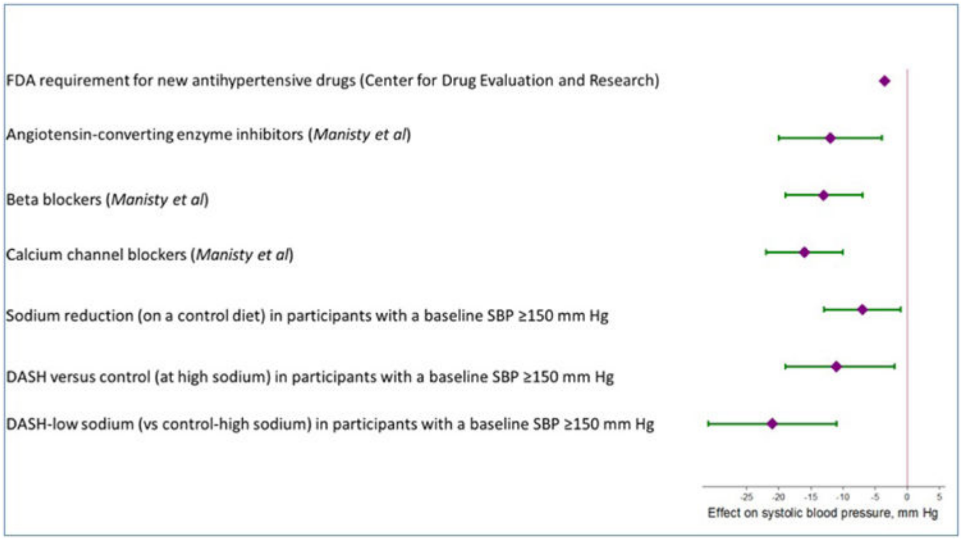


Figure 1. The Combined Effects of Low Sodium and the DASH Diet according to Blood Pressure

Mean end of period systolic blood pressure measurements (mmHg) by strata of (A) baseline systolic blood pressure (<130, 130-139, 140-149, ≥150 mmHg) or (B) baseline diastolic blood pressure (<80, 80-84, 85-89, ≥90 mmHg). Mean blood pressure values are presented by (1) the high sodium-control diet (circle) or (2) the low sodium-DASH diet (diamond). Differences between diets were determined using linear regression comparing baseline changes in systolic or diastolic blood pressure adjusted for age, female sex, black race, and baseline body mass index. Bars represent 95% confidence intervals. SBP represents systolic blood pressure. DBP represents diastolic blood pressure.



Central Illustration. The Blood Pressure (BP) Effects of the DASH Diet

Sodium reduction, alone or combined, compared to average BP effects of anti-hypertensive drug therapies and the FDA requirement for new antihypertensive drugs. Estimates for anti-hypertensive drug classes are taken from Manisty et al 2013. The FDA requirement for new antihypertensive drugs is take from a committee meeting of the Center for Drug Evaluation and Research (2014)

Table 1

Baseline characteristics overall and by blood pressure strata according to diet assignment

		Baseline Systolic Blood Pressure (mmHg)			
	Overall	**<130**	**130-139**	**140-149**	**≥150**
Control	**N = 204**	**N = 72**	**N = 65**	**N = 53**	**N = 14**
Age, yr	49.1 (10.4)	45.3 (8.7)	48.3 (10.7)	52.4 (9.9)	59.0 (8.8)
Women, %	111 (54.4)	32 (44.4)	37 (56.9)	32 (60.4)	10 (71.4)
Black, %	115 (56.4)	37 (51.4)	40 (61.5)	32 (60.4)	6 (42.9)
Blood pressure, mmHg					
Systolic	135.4 (9.4)	125.7 (3.2)	134.7 (3.1)	144.4 (3.0)	154.5 (2.7)
Diastolic	85.8 (4.1)	84.0 (3.5)	85.7 (3.8)	87.2 (4.1)	89.8 (4.2)
Body mass index, kg/m^2	29.5 (5.0)	29.7 (4.8)	29.7 (5.4)	29.7 (4.6)	27.9 (6.0)
Body mass index ≥30, %	82 (40.2)	25 (34.7)	28 (43.1)	24 (45.3)	5 (35.7)
DASH	**N = 208**	**N = 76**	**N = 69**	**N = 51**	**N = 12**
Age, yr	47.4 (9.6)	43.6 (7.1)	47.8 (9.2)	49.5 (10.5)	59.2 (8.6)
Women, %	123 (59.1)	39 (51.3)	37 (53.6)	37 (72.5)	10 (83.3)
Black, %	119 (57.2)	41 (53.9)	40 (58.0)	30 (58.8)	8 (66.7)
Blood pressure, mmHg					
Systolic	134.2 (9.6)	124.6 (3.6)	133.8 (2.9)	144.1 (2.9)	154.4 (3.5)
Diastolic	85.6 (4.8)	83.5 (4.0)	86.3 (4.5)	87.9 (4.9)	85.3 (6.0)
Body mass index, kg/m^2	28.8 (4.7)	28.7 (4.1)	29.6 (4.7)	28.4 (5.1)	27.4 (5.3)
Body mass index ≥30, %	78 (37.5)	27 (35.5)	30 (43.5)	18 (35.3)	3 (25.0)

Table 2

Effect of low versus high sodium on systolic blood pressure in the context of control and DASH diets.

		Reducing Sodium (Low versus High)			
Baseline SBP	**N** *	**Mean Difference in SBP (95% CI)** **	***P within strata***	***P versus <130 mmHg stratum***	***P trend*** ***
In Control Diet					
<130 mmHg	70	-3.20 (-4.96,-1.44)	<0.001	*Ref*	0.004
130-139 mmHg	64	-8.56 (-10.70,-6.42)	<0.001	<0.001	
140-149 mmHg	53	-8.99 (-11.21,-6.77)	<0.001	<0.001	
≥150 mmHg	13	-7.04 (-12.92,-1.15)	0.02	0.20	
In DASH Diet					
<130 mmHg	75	-0.88 (-2.07, 0.30)	0.14	*Ref*	<0.001
130-139 mmHg	68	-3.29 (-4.71,-1.88)	<0.001	0.01	
140-149 mmHg	49	-4.90 (-7.25,-2.55)	<0.001	0.003	
≥150 mmHg	12	-10.41 (-15.54,-5.28)	<0.001	<0.001	

*Numbers do not entirely add to 204 for control or 208 for DASH due to missing measurements.

**Adjusted for age, female sex, black race, and baseline body mass index

***Based on median value in each baseline systolic blood pressure category.

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Table 3

Effect of DASH versus control diets on systolic blood pressure according to baseline systolic blood pressure

		DASH versus Control			
Baseline SBP	**N***	**Mean Difference in SBP (95% CI)****	***P within strata***	***P versus <130 mmHg stratum***	***P trend*****
At High Sodium Level					
<130 mmHg	143	-4.47 (-6.64,-2.29)	<0.001	*Ref*	0.66
130-139 mmHg	130	-4.26 (-6.72,-1.80)	0.001	0.78	
140-149 mmHg	99	-4.72 (-8.25,-1.19)	0.01	0.88	
≥150 mmHg	25	-10.63 (-18.86,-2.41)	0.02	0.04	
At Low Sodium Level					
<130 mmHg	141	-2.36 (-4.61,-0.11)	0.04	*Ref*	0.29
130-139 mmHg	129	0.92 (-1.47, 3.31)	0.45	0.05	
140-149 mmHg	100	-0.55 (-4.03, 2.93)	0.76	0.31	
≥150 mmHg	24	-14.13 (-25.61,-2.64)	0.03	0.001	

*Numbers do not entirely add to 412 due to missing measurements.

**Adjusted for age, female sex, black race, and baseline body mass index

***Based on median value in each baseline systolic blood pressure category.