mg/dl) and HDL cholesterol (>40 mg/dl), was an accurate predictor of LDL phenotype in a high-risk outpatient population. However, approximately 20% of phenotype B patients would be missed by this cutoff, assuming that the detection of these patients was a priority.

1. Austin MA, King MC, Vranizan KM, Krauss RM. Atherogenic lipoprotein phenotype. A proposed genetic marker for coronary heart disease risk. *Circulation* 1990;82:495–506.

2. Coresh J, Kwiterovich PO Jr. Small, dense low-density lipoprotein particles and coronary heart disease risk: a clear association with uncertain implications. *JAMA* 1996;276:914–915.

3. Otvos JD, Jeyarajah EJ, Bennett DW, Krauss RM. Development of a proton nuclear magnetic resonance spectroscopic method for determining plasma lipoprotein concentrations and subspecies distributions from a single, rapid measurement. *Clin Chem* 1992;38:1632–1638.

4. NCEP Expert Panel. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA* 2001;285:2486–2497.

5. Gaziano JM, Hennekens CH, O'Donnell CJ, Breslow JL, Buring JE. Fasting triglycerides, high-density lipoprotein, and risk of myocardial infarction. *Circulation* 1997;96:2520–2525.

6. Jeppesen J, Hein HO, Suadicani P, Gyntelberg F. Triglyceride concentration and ischemic heart disease: an eight-year follow-up in the Copenhagen Male Study. *Circulation* 1998;97:1029–1036.

7. Cullen P. Evidence that triglycerides are an independent coronary heart disease risk factor. *Am J Cardiol* 2000;86:943–949.

8. McNamara JR, Campos H, Ordovas JM, Peterson J, Wilson PW, Schaefer EJ. Effect of gender, age, and lipid status on low density lipoprotein subfraction distribution. Results from the Framingham Offspring Study. *Arteriosclerosis* 1987;7:483–490.

9. Boizel R, Benhamou PY, Lardy B, Laporte F, Foulon T, Halimi S. Ratio of triglycerides to HDL cholesterol is an indicator of LDL particle size in patients with type 2 diabetes and normal HDL cholesterol levels. *Diabetes Care* 2000;23:1679–1685.

A Further Subgroup Analysis of the Effects of the DASH Diet and Three Dietary Sodium Levels on Blood Pressure: Results of the DASH-Sodium Trial

George A. Bray, MD, William M. Vollmer, PhD, Frank M. Sacks, MD, Eva Obarzanek, PhD, Laura P. Svetkey, MD, and Lawrence J. Appel, MD, for the DASH Collaborative Research Group

This study presents an extensive analysis of the effects on blood pressure (BP) of changes in sodium intake over a wide array of subgroups, including joint subgroups defined by age and hypertension status, race or ethnicity and hypertension status, and gender and race or ethnicity. Participants were given 3 levels of sodium (50, 100, and 150 mmol/2,100 kcal) for 30 days while consuming the Dietary Approaches to Stop Hypertension (DASH) diet (rich in fruits, vegetables, and low-fat dairy) or a more typical American diet. Within each diet and subgroup, there was a general pattern such that the lower the sodium level, the greater the mean reduction in BP. Sodium reduction from 100 to 50 mmol/2,100 kcal generally had twice the effect on BP as reduction from 150 to 100 mmol/2,100 kcal. Age had a strong and graded influence on the effect of sodium within the typical and DASH diets, respectively: −4.8 and −1.0 mm Hg systolic for 23 to 41 years, −5.9 and −1.8 mm Hg for 42 to 47 years, −7.5 and −4.3 mm Hg for 48 to 54 years, and −8.1 and −6.0 mm Hg for 55 to 76 years. The influence of age on the effect of sodium reduction was particularly strong in nonhypertensive patients: −3.7 mm Hg systolic for <45 years and −7.0 mm Hg for >45 years with the typical diet and −0.7 and −2.8 mm Hg with the DASH diet. Reduced sodium intake and the DASH diet should be advocated for the prevention and treatment of high BP, particularly because the benefits to BP strengthen as subjects enter middle age, when the rate of cardiovascular disease increases sharply. ©2004 by Excerpta Medica, Inc.

(Am J Cardiol 2004;94:222–227)

From Pennington Biomedical Research Center, Baton Rouge, Louisiana; Kaiser Permanente Center for Health Research, Portland, Oregon; Harvard School of Public Health and the Brigham and Women's Hospital, Boston, Massachusetts; the National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, Maryland; the Duke Hypertension Center and Sarah W. Stedman Nutrition and Metabolism Center, Duke University Medical Center, Durham, North Carolina; and the Welch Center for Prevention, Epidemiology and Clinical Research, Johns Hopkins Medical Institutions, Baltimore, Maryland.

This study was supported by cooperative agreements and grants from the National Institutes of Health, National Heart, Lung, and Blood Institute, Bethesda, Maryland (HL57173, HL57114, HL57190, HL57139, HL03857, HL57156), and the General Clinical Research Center Program of the National Center for Research Resources, Bethesda, Maryland (RR02635, RR00722).

Dr. Bray's address is: Pennington Biomedical Research Center, 6400 Perkins Road, Baton Rouge, Louisiana 70808. E-mail: brayga@pbrc.edu.

Manuscript received January 19, 2004; revised manuscript received and accepted March 25, 2004.

Two recent trials have shown that changing dietary patterns and sodium intake can significantly affect blood pressure (BP). In the Dietary Approaches to Stop Hypertension (DASH) trial,[1] a diet rich in fruits, vegetables, and low-fat dairy products and reduced in total and saturated fat content (the DASH diet) significantly reduced systolic and diastolic BP relative to a more typical American diet.[2] The average sodium intake in that trial was held constant (approximately 135 mmol/day) at levels slightly less than the current average American intake. The subsequent DASH-So-

0002-9149/04/$–see front matter
doi:10.1016/j.amjcard.2004.03.070

TABLE 1 Mean ± SD BP in Participants Eating the Control Diet and the DASH Diet at Three Levels of Dietary Sodium, by Baseline Characteristics

			Systolic BP by Sodium Level (mm Hg)			Diastolic BP by Sodium Level (mm Hg)		
Characteristic	Diet	n	Higher	Intermediate	Lower	Higher	Intermediate	Lower
Nonhypertensive	Control	121	12 ± 9	125 ± 7	122 ± 6	81 ± 6	81 ± 6	79 ± 6
	DASH	123	122 ± 9	121 ± 9	120 ± 9	79 ± 6	78 ± 7	78 ± 6
Stage 1 hypertension	Control	83	141 ± 11	139 ± 12	133 ± 11	86 ± 7	85 ± 6	82 ± 6
	DASH	85	134 ± 11	133 ± 12	129 ± 11	84 ± 7	84 ± 7	82 ± 6
African-American	Control	115	134 ± 12	131 ± 12	126 ± 10	84 ± 7	82 ± 6	80 ± 6
	DASH	119	128 ± 11	127 ± 12	125 ± 11	82 ± 7	81 ± 8	80 ± 6
Non–African-American	Control	89	131 ± 11	129 ± 12	127 ± 10	83 ± 7	82 ± 6	81 ± 6
	DASH	89	125 ± 11	124 ± 11	123 ± 10	80 ± 7	80 ± 7	79 ± 6
Men	Control	93	131 ± 11	127 ± 10	125 ± 9	84 ± 7	82 ± 6	81 ± 6
	DASH	85	125 ± 11	124 ± 11	123 ± 10	81 ± 7	81 ± 7	80 ± 6
Women	Control	111	135 ± 12	133 ± 13	127 ± 11	83 ± 7	82 ± 7	80 ± 6
	DASH	123	128 ± 11	127 ± 13	124 ± 11	81 ± 7	80 ± 7	79 ± 7
Age ≤45 yrs	Control	75	128 ± 10	126 ± 9	123 ± 7	83 ± 7	83 ± 6	80 ± 6
	DASH	97	125 ± 11	124 ± 11	124 ± 10	81 ± 7	81 ± 7	81 ± 7
Age >45 yrs	Control	129	136 ± 12	133 ± 13	128 ± 11	84 ± 7	82 ± 7	80 ± 6
	DASH	111	129 ± 12	127 ± 12	124 ± 11	80 ± 7	80 ± 7	79 ± 6
Income <$45,000 k	Control	118	134 ± 12	132 ± 13	127 ± 11	83 ± 7	82 ± 7	80 ± 6
	DASH	111	127 ± 12	126 ± 13	125 ± 12	80 ± 7	80 ± 8	79 ± 7
Income ≥$45,000 k	Control	80	131 ± 11	127 ± 9	125 ± 9	84 ± 7	82 ± 5	81 ± 6
	DASH	93	126 ± 10	125 ± 11	123 ± 9	82 ± 6	81 ± 7	80 ± 5
Education ≤high school	Control	42	136 ± 13	132 ± 12	128 ± 11	84 ± 8	82 ± 6	79 ± 6
	DASH	28	131 ± 11	129 ± 12	128 ± 12	81 ± 7	80 ± 8	79 ± 7
Education > high school	Control	161	132 ± 11	130 ± 11	126 ± 10	83 ± 7	82 ± 6	80 ± 6
	DASH	179	126 ± 11	125 ± 12	123 ± 10	81 ± 7	81 ± 7	80 ± 6
No family history of hypertension	Control	71	132 ± 11	129 ± 10	125 ± 9	84 ± 6	83 ± 6	80 ± 6
	DASH	58	129 ± 12	126 ± 11	124 ± 11	81 ± 6	79 ± 6	79 ± 6
With family history of hypertension	Control	133	133 ± 12	131 ± 13	127 ± 11	83 ± 7	82 ± 7	80 ± 6
	DASH	150	126 ± 11	125 ± 12	124 ± 10	81 ± 7	81 ± 8	80 ± 6
BMI ≥30 kg/m^2	Control	82	134 ± 12	131 ± 12	127 ± 10	83 ± 6	82 ± 6	79 ± 6
	DASH	78	126 ± 11	126 ± 12	125 ± 10	81 ± 7	80 ± 7	80 ± 6
Nonobese (BMI <30 kg/m^2)	Control	122	132 ± 12	130 ± 12	126 ± 10	84 ± 7	83 ± 6	81 ± 6
	DASH	130	127 ± 11	126 ± 12	123 ± 11	81 ± 7	81 ± 7	79 ± 7
Alcoholic drinks <1 drink/wk	Control	116	135 ± 12	133 ± 12	128 ± 11	84 ± 7	83 ± 6	80 ± 6
	DASH	116	127 ± 12	126 ± 12	124 ± 12	81 ± 7	81 ± 7	79 ± 6
Alcoholic drinks ≥1 drink/wk	Control	88	130 ± 11	127 ± 10	125 ± 9	83 ± 6	81 ± 6	80 ± 6
	DASH	92	127 ± 10	126 ± 11	124 ± 9	81 ± 7	80 ± 8	80 ± 6
Waist: high risk (>102 cm men or >88 cm women)	Control	124	133 ± 12	130 ± 12	127 ± 10	83 ± 6	82 ± 6	80 ± 6
	DASH	113	127 ± 12	126 ± 12	124 ± 11	81 ± 7	80 ± 7	79 ± 6
Waist: normal risk (≤102 cm men or ≤88 cm women)	Control	80	133 ± 12	130 ± 12	126 ± 10	84 ± 7	83 ± 7	81 ± 7
	DASH	95	127 ± 11	125 ± 11	124 ± 10	81 ± 7	81 ± 7	80 ± 7
Baseline urinary sodium excretion <140	Control	96	133 ± 11	131 ± 12	127 ± 10	83 ± 7	82 ± 6	80 ± 6
	DASH	104	128 ± 12	127 ± 12	125 ± 11	81 ± 7	81 ± 7	80 ± 7
Baseline urinary sodium excretion ≥140	Control	108	132 ± 12	130 ± 12	126 ± 10	83 ± 7	82 ± 6	80 ± 6
	DASH	104	126 ± 11	124 ± 12	122 ± 10	80 ± 7	80 ± 7	79 ± 6

BMI = body mass index.

dium trial was an efficacy trial designed to assess the main and interactive effects of the DASH diet and reduced sodium intake on BP.[3] Participants were randomly assigned to eat either the DASH diet or a typical American diet; within each diet arm, they consumed each of 3 sodium intake levels according to a crossover design. Sodium reduction and the DASH diet each caused statistically significant and clinically relevant reductions in BP overall[4] and in key prespecified subgroups[5] that were defined by hypertension status at baseline, race or ethnicity, gender, and age. The present report presents an extensive analysis, not previously published, of the effects on BP of changes in sodium intake and the DASH diet in key subgroups a priori identified as having clinical importance and in joint subgroups (age and hypertension status, race or ethnicity and hypertension status, and gender and race or ethnicity).

• • •

A detailed description of the trial design and methods has been published.[3] Briefly, 412 participants with systolic BP ranging from 120 to 159 mm Hg and diastolic BP ranging from 80 to 95 mm Hg were enrolled. After a 2-week run-in period during which participants ate the control diet at the higher sodium level, participants were randomly assigned to either the DASH diet or a control diet typical of what many Americans consume. Within their assigned diets, there were three 30-day feeding periods, each with a different sodium level presented in random order. The 3 sodium levels (higher, intermediate, and lower) had targets of 150, 100, or 50 mmol/day (in the 2,100-kcal version of the diets). The higher sodium level, which reflects typical consumption in the United States, was 50% higher than the intermediate level, which was the upper limit of current national recommendations.

BP was measured by trained staff members using a random-zero sphygmomanometer at 3 visits during screening, at 2 visits during the 2-week run-in, and on 5 of the last 9 days of each of the 3 feeding periods. A pair of BP measurements was taken on each day and averaged. Baseline BP was the average of the 5 pairs of BP values before beginning the assigned diets. The end-of-feeding BP was the average of the 5 pairs of BP values obtained at the end of each 30-day feeding period. Hypertension status was defined as systolic BP of ≥140 mm Hg and/or diastolic BP of ≥90 mm Hg.

We used generalized estimating equations to fit baseline and end-of-feeding BP as a function of diet (DASH vs control), sodium level, and subgroup indicators and their interactions. The linearity of the effects of sodium within the control diet or the DASH diet was assessed by comparing the change in sodium from the higher to the intermediate level of sodium with the change from the intermediate to the lower level of sodium. All analyses were performed using the xtgee procedure in Stata, release 5 (StataCorp LP, College Station, Texas) and, except for Table 1, included adjustment for site and feeding cohort. Because of reduced sample size, especially in subgroups jointly defined by >1 factor, power was limited. Therefore, we report p values from 0.05 to 0.10 in addition to p values <0.05 to help readers better evaluate the consistency of the results.

The achieved mean sodium levels of the participants, as estimated from urinary sodium excretion, were 65, 107, and 142 mmol/day at the lower, intermediate, and higher sodium levels, respectively. Table 1 lists unadjusted mean (SD) systolic and diastolic BP for the subgroups defined by hypertension status and by demographic, anthropometric, and other key baseline characteristics at each diet and sodium combination. Table 2 lists the estimated effects of changes in sodium on systolic BP and diastolic BP when eating the control or DASH diet in clinically important subgroups. Each subgroup variable is examined separately, so that, for instance, the effects in hypertensive and nonhypertensive patients are not adjusted for race, gender, age, or obesity. The results are listed for the overall effect of going from the higher to the lower sodium level and for the effect of going from the higher to the intermediate sodium level and from the intermediate to the lower sodium level.

Reducing sodium intake consistently resulted in mean reductions in systolic and diastolic blood BP across all subgroups (Table 2). With the control diet, BP changes from the higher to the lower sodium level were all significant, and mean reductions ranged from about 5 to 8 mm Hg for systolic BP and from 2 to 4 mm Hg for diastolic BP; mean BP reductions were

TABLE 2 Estimated Effects of Sodium Reduction* on BP by Diet Arm for Subgroups of DASH-Sodium Participants Defined by a Single Characteristic

	n		Systolic BP						Diastolic BP					
			Control			DASH			Control			DASH		
Characteristic	Control	DASH	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher
Nonhypertensive	121	123	−5.6†	−3.4†	−2.2†	−1.7‡	−0.6	−1.1	−2.8†	−2.0†	−0.8§	−1.1‡	−0.3	−0.8
Hypertensive	83	85	−8.3†	−6.2†	−2.1‡	−5.0†	−3.3†	−1.6§	−4.4†	−2.9†	−1.5†	−2.5†	−2.0†	−0.5
Non-African-American	89	89	−5.0†	−3.0†	−2.1‡	−2.2.†	−1.3	−0.9	−2.2†	−1.6†	−0.6	−1.3‡	−1.0§	−0.3
African-American	115	119	−8.0†	−5.7†	−2.2†	−3.6†	−2.1†	−1.5‡	−4.5†	−3.0†	−1.5†	−1.9†	−1.0‡	−0.9§
Women	111	123	−7.5†	−5.8†	−1.7‡	−4.0†	−2.4†	−1.6‡	−3.7†	−2.8†	−0.8§	−1.7†	−1.2‡	−0.5
Men	93	85	−5.7†	−3.1†	−2.6†	−1.7§	−0.7	−0.9	−3.2†	−1.9†	−1.4‡	−1.6†	−0.7	−0.8
≤45 yrs	75	97	−5.3†	−3.9†	−1.4	−1.4§	−0.1	−1.3	−2.8†	−2.6†	−0.2	−1.1‡	−0.6	−0.5
>45 yrs	129	111	−7.5†	−5.0†	−2.6†	−4.5†	−3.2†	−1.3§	−3.8†	−2.3†	−1.6†	−2.2†	−1.3†	−0.8§
Not obese	122	130	−6.6†	−4.6†	−2.0†	−3.7†	−2.2†	−1.6‡	−3.5†	−2.3†	−1.2‡	−1.8†	−1.3†	−0.5
Obese$^{\|}$	82	78	−6.9†	−4.6†	−2.3†	−1.8‡	−1.1	−0.7	−3.5†	−2.6†	−0.9	−1.3‡	−0.5	−0.8

*Pairwise contrasts between sodium levels are displayed. Example: for the lower versus higher sodium contrast, the estimated mean BP at the higher sodium level is subtracted from the corresponding value at the lower sodium level.
$^{\dagger}p < 0.01$; $^{\ddagger}p < 0.05$; $^{\S}p < 0.10$.
$^{\|}$Obesity defined as a body mass index ≥30 kg/m^2.

about half as much for those who ate the DASH diet. These reductions were achieved in a stepwise manner in the control and DASH diets; that is, there were reductions in going from the higher to the intermediate sodium level and from the intermediate to the lower sodium level. For the control diet, mean reductions in systolic BP associated with changes involving the intermediate sodium level were statistically significant in all but 1 subgroup (≤45 years). In view of the significance of the overall sodium contrasts of the higher versus the lower sodium level and the consistent trends across subgroups, we attribute the lack of statistical significance of many of the intermediate contrasts to a lack of statistical power.

We observed a pattern of approximately twice as much mean BP reduction in going from the intermediate to the lower sodium level as from the higher to the intermediate sodium level across the subgroups. This pattern was demonstrated by the effect sizes themselves and by their statistical significance and was particularly evident for the control diet. In every patient on the control diet, and for systolic and diastolic BP, the p value for the contrast between the intermediate and the lower sodium level was <0.01. The effect sizes for this contrast generally ranged across the subgroups from 3 to 6 mm Hg for systolic BP and 2 to 3 mm Hg for diastolic BP. This "nonlinearity," indicating more BP reduction from the intermediate to the lower sodium level than from the higher to the intermediate sodium level, was significant for the cohort as a whole ($p < 0.02$ for systolic BP and $p < 0.05$ for diastolic BP) and significant or nearly so for approximately half the subgroups (data not shown). Similar trends were observed for the DASH diet, although none of the contrasts were statistically significant (data not shown).

Table 3 lists BP changes in joint subgroups defined by race or ethnicity and hypertension status, gender and race or ethnicity, and age and hypertension status. Data are also listed for subgroups defined by quartiles of age. Because of the much reduced sample sizes, the analyses presented in Table 3 are inherently more variable and hence have less statistical power than the analyses shown in Table 2. Despite the reduced sample sizes, the same patterns emerged. Reducing sodium intake reduced BP, and there was a pattern for these reductions to be greater in going from the intermediate to the lower sodium level than from the higher to the intermediate level. Also of note is the generally greater BP reduction from reducing sodium with increasing quartile of age in the control and DASH diets: −4.8 and −1.0 mm Hg systolic BP for 23 to 41 years; −5.9 and −1.8 mm Hg for 42 to 47 years; −7.5 and −4.3 mm Hg for 48 to 54 years, and −8.1 and −6.0 mm Hg for 55 to 76 years.

Figures 1 and 2 display the estimated joint effects on systolic BP of the DASH diet and sodium reduction for 2 joint subgroups. In each case, the value for the control diet, the higher sodium combination, is the raw observed mean, and all of the other points are estimated on the basis of the models as described in the methods. The pattern that emerged was consistent and

TABLE 3 Estimated Effects of Sodium Reduction* on BP by Diet Arm for Subgroups of DASH-Sodium Participants Defined by 2 Characteristics

	n		Systolic BP						Diastolic BP					
			Control			DASH			Control			DASH		
Characteristic	Control	DASH	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher	Lower vs Higher	Lower vs Intermediate	Intermediate vs Higher
Non–African-American, nonhypertensive	56	57	−4.0†	−1.9§	−2.2‡	−1.4	−0.7	−0.7	−1.4‡	−1.2§	−0.3	−1.2§	−0.5	−0.7
Non–African-American, hypertensive	33	32	−6.8†	−4.8†	−1.9	−3.7†	−2.3§	−1.4	−3.3†	−2.1‡	−1.2	−1.6§	−2.0‡	−0.5
African-American nonhypertensive	65	66	−6.9†	−4.7†	−2.2‡	−2.0‡	−0.5	−1.5	−4.0†	−2.7†	−1.3‡	−1.0	−0.2	−0.8
African-American, hypertensive	50	53	−9.4†	−7.0†	−2.3‡	−5.7†	−4.0†	−1.7	−5.2†	−3.4†	−1.7‡	−3.1†	−2.1†	−1.0
Women, non–African-American	33	37	−4.1†	−4.4†	−0.3	−3.4†	−1.3	−2.1	−0.9	−2.0‡	1.1	−1.1	−0.8	−0.3
Women, African-American	78	86	−9.0†	−6.4†	−2.5†	−4.2†	−2.9†	−1.3	−4.9†	−3.2†	−1.6†	−2.0†	−1.4‡	−0.6
Men, non–African-American	56	52	−5.6†	−2.3‡	−3.4†	−1.4	−1.3	−0.1	−2.9†	−1.4§	−1.5‡	−1.4‡	−1.2§	−0.2
Men, African American	37	33	−5.9†	−4.4†	−1.5	−2.2	0.1	−2.2§	−3.8†	−2.7†	−1.1	−1.8‡	−0.1	−1.8‡
≤45 yrs, nonhypertensive	33	37	−3.7†	−2.6‡	−1.1	−0.7	0.4	−1.1	−1.5‡	−1.7‡	0.2	−0.5	−0.2	−0.3
≤45 yrs, hypertensive	78	86	−9.0†	−6.9†	−2.1	−2.6‡	−0.8	−1.8	−6.0†	−5.0†	−1.1	−2.1‡	−1.3	−0.8
>45 yrs, nonhypertensive	56	52	−7.0†	−4.1†	−2.9†	−2.8†	−1.6	−1.2	−3.8†	−2.3†	−1.5‡	−1.6‡	−0.4	−1.3‡
>45 yrs, hypertensive	37	33	−8.0†	−6.0†	−2.1‡	−6.7†	−5.1†	−1.6	−3.8†	−2.2†	−1.6‡	−2.8†	−2.5†	−0.3
23−41 yrs, quartile1	53	61	−4.8†	−3.6†	−1.2	−1.0	0.8	−1.8§	−2.4†	−2.7†	0.3	−0.9	0.0	−1.0
42−47 yrs, quartile2	22	36	−5.9†	−3.7†	−2.2‡	−1.8§	−1.3	−0.5	−3.4†	−2.1†	−1.3§	−1.4‡	−1.4‡	0.1
48−54 yrs, quartile3	68	62	−7.5†	−5.3†	−2.1‡	−4.3†	−2.6‡	−1.7	−4.2†	−2.6†	−1.6‡	−1.8‡	−0.9	−0.8
55−76 yrs, quartile4	61	49	−8.1†	−5.2†	−2.8†	−6.0†	−4.3†	−1.7	−3.7†	−2.2†	−1.5‡	−2.8†	−1.6‡	−1.2

*Pairwise contrasts between sodium levels are displayed. Example: for the lower vs higher sodium contrast, the estimated mean BP at the higher sodium level is subtracted from the corresponding value at the lower sodium level.
†$p < 0.01$; ‡$p < 0.05$; §$p < 0.10$.

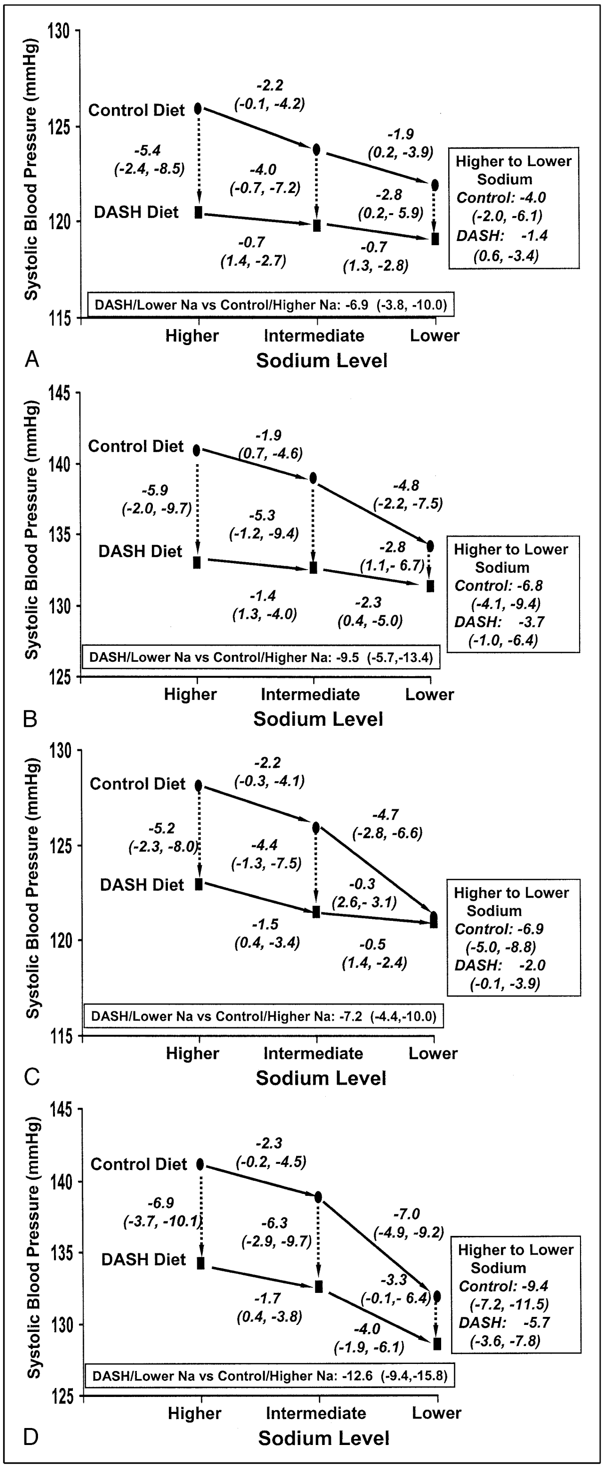

FIGURE 1. Systolic BP and change in systolic BP (95% confidence intervals) in nonhypertensive and stage 1 hypertensive patients eating the DASH diet or a control diet at 3 levels of sodium (Na) intake stratified by race or ethnicity and hypertension status: *(A)* non–African-American, nonhypertensive patients; *(B)* non–African-American, hypertensive patients; *(C)* African-American, nonhypertensive patients; *(D)* African-American, hypertensive patients.

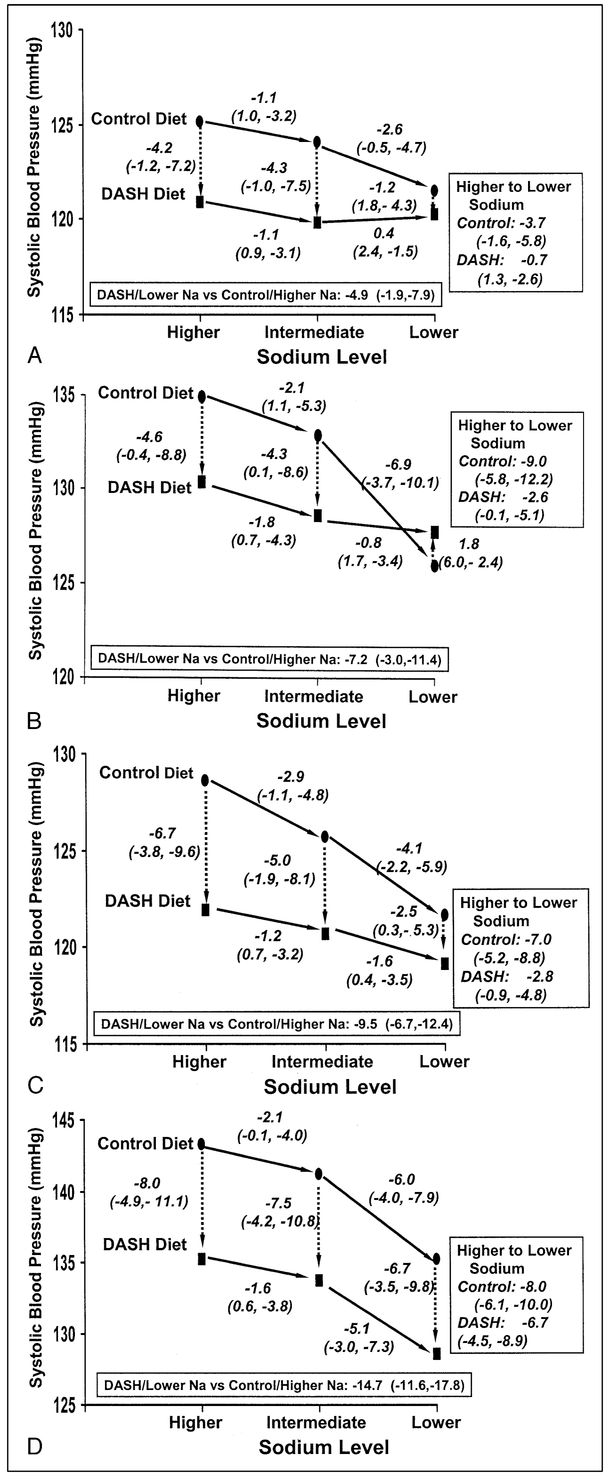

FIGURE 2. Systolic BP and change in systolic BP (95% confidence intervals) in nonhypertensive and stage 1 hypertensive patients eating the DASH diet or a control diet at 3 levels of sodium (Na) intake stratified by age and hypertension status. *(A)* ≤45 years of age, nonhypertensive patients; *(B)* ≤45 years of age, hypertensive patients; *(C)* ≥45 years of age, nonhypertensive patients; *(D)* ≥45 years of age, hypertensive patients.

mimicked that reported previously overall. In almost all subgroups, at the higher and intermediate levels of sodium intake, the DASH diet produced a clinically important and statistically significant reduction in systolic BP, and trends for reduced systolic BP were observed at the lower sodium level. In addition, reducing sodium intake reduced BP within each dietary pattern. The DASH effects were not fully additive to the sodium effects, such that the BP-reducing effects of sodium reduction were more pronounced in those on the control diet than the DASH diet, and the effect of the DASH diet was more pronounced at the higher 2 sodium levels than at the lowest sodium level. Finally, in all subgroups, the greatest BP was seen in those who ate the control diet at the higher sodium level, whereas with rare exception the lowest BP was observed in those who ate the DASH diet at the lower sodium level.

• • •

This report has provided a more extensive subgroup analysis of data from the DASH-Sodium trial than previous publications.[4,5] The pattern of response remains consistent with previous reports. First, within each diet, the lower the sodium level, the greater the mean reduction in BP. Second, the DASH diet resulted in lower mean BP at each sodium level. Third, the joint effect of the DASH diet and reduced sodium intake augment each other but are less than fully additive. Finally, age had a strong and graded influence on the effect of sodium reduction on BP in those eating the control diet or the DASH diet. Hence, it is reasonable to speculate that adherence to the combination of the DASH diet and reduced sodium intake might blunt the well-documented increase in BP that occurs with age.

1. Sacks FM, Obarzanek E, Windhauser MM, Svetkey LP, Vollmer WM, McCullough M, Karanja N, Lin P-H, Steele P, Proschan MA, et al, for the DASH Investigators. Rationale and design of the Dietary Approaches to Stop Hypertension Trial (DASH)—a multicenter controlled-feeding study of dietary patterns to lower blood pressure. *Ann Epidemiol* 1995;5:108–118.

2. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Windhauser MM, Pao-Hwa L, et al, for the DASH Collaborative Research Group. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;336:1117–1124.

3. Svetkey LP, Sacks FM, Obarzanek E, Vollmer WM, Appel LJ, Lin PH, Karanja NM, Harsha DW, Bray GA, Aickin M, et al. The DASH Diet, Sodium Intake and Blood Pressure Trial (DASH-Sodium): rationale and design. *J Am Diet Assn* 1999;8(suppl):S96–S104.

4. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, Obarzanek E, Conlin PR, Miller ER, Simons-Morton D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *N Engl J Med* 2001;344:3–10.

5. Vollmer W, Sacks FM, Ard J, Appel LJ, Bray GA, Simons-Morton DG, Conlin PR, Svetkey LP, Erlinger TP, Moore TJ, et al. Effects of dietary patterns and sodium intake on blood pressure: subgroup analysis of the DASH-Sodium trial. *Ann Intern Med* 2001;135:1019–1028.

Effects of Race and Health Insurance on the Rates of Pacemaker Implantation for Complete Heart Block in the United States

Haitham Hreybe, MD, and Samir Saba, MD

Although indicated for adults with complete heart block, pacemaker implantation is not always practiced. There are gross discrepancies by race, type of health insurance coverage, and size of hospital of admission in the utilization of pacemakers. ©2004 by Excerpta Medica, Inc.

(Am J Cardiol 2004;94:227–229)

We sought to analyze a nationally representative database to evaluate trends in pacemaker implantation in patients admitted with a primary diagnosis of complete heart block (CHB) in the United States from 1996 to 2001. We also examined the influence of such factors as age, race, gender, hospital size, and type of health insurance coverage on the rates of implantation in this population. Our study hypothesis was that demographic factors pertaining to race,[1,2] gender,[3] and socioeconomic status continue to affect health care delivery, as reflected by the utilization of permanent pacemakers for the treatment of CHB.[4,5]

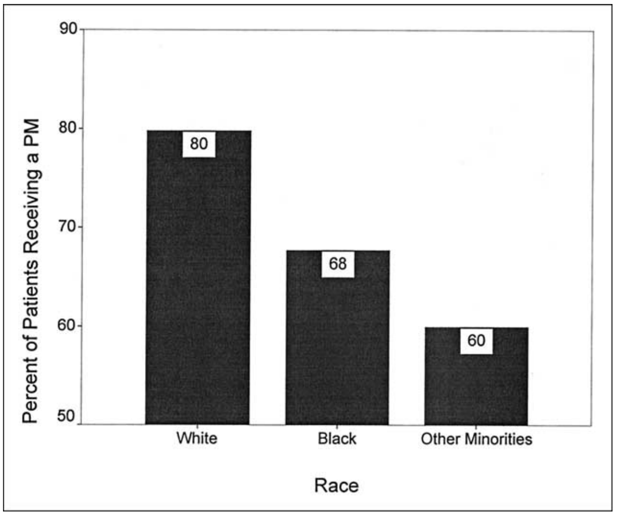

FIGURE 1. Percentage of patients admitted to the hospital with a primary diagnosis of CHB and surviving to discharge who received pacemakers (PMs), stratified by race. Note the higher pacemaker utilization rate among white patients.

• • •

The National Hospital Discharge Survey, started in 1965, represents an effort by the Centers for Disease Control and Prevention to document hospital utilization in the United States and to detect trends in the

From the Department of Internal Medicine and the Cardiovascular Institute, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania. Dr. Saba's address is: Division of Cardiac Electrophysiology, University of Pittsburgh Medical Center, 200 Lothrop Street, B535 PUH, Pittsburgh, Pennsylvania 15213. E-mail: sabas@msx.upmc.edu.

Manuscript received February 6, 2004; revised manuscript received and accepted March 24, 2004.

0002-9149/04/$–see front matter
doi:10.1016/j.amjcard.2004.03.071