

Normotensive Salt Sensitivity

Effects of Race and Dietary Potassium

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Abstract—Normotensive salt sensitivity, a putative precursor of hypertension, might be quite frequent in African Americans (blacks) and less frequent in Caucasian Americans (whites), but only when dietary potassium is deficient and not when maintained well within the normal range. We tested this hypothesis in 41 metabolically controlled studies of 38 healthy normotensive men (24 blacks, 14 whites) who ate a basal diet low in sodium (15 mmol/d) and marginally deficient in potassium (30 mmol/d) for 6 weeks. Throughout the last 4 weeks, NaCl was loaded (250 mmol/d); throughout the last 3, potassium was supplemented (as potassium bicarbonate) to either mid- or high-normal levels, 70 and 120 mmol/d. Salt sensitivity, defined as an increase in mean arterial blood pressure ≥ 3 mm Hg with salt loading, was deemed “moderate” if increasing ≤ 10 mm Hg and “severe” if increasing more. When dietary potassium was 30 mmol/d, salt loading induced a mean increase in blood pressure only in blacks ($P < 0.001$), and salt sensitivity occurred in most blacks but not whites (79% vs 36% ($P < 0.02$)). Supplementing potassium only to 70 mmol/d attenuated moderate salt sensitivity similarly in blacks and whites; 120 mmol/d abolished it, attenuated severe salt sensitivity, which occurred in a quarter of affected blacks, and suppressed the frequency and severity of salt sensitivity in blacks to levels similar to those observed in whites. These observations demonstrate that in most normotensive black men but not white men, salt sensitivity occurs when dietary potassium is even marginally deficient but is dose-dependently suppressed when dietary potassium is increased within its normal range. Such suppression might prevent or delay the occurrence of hypertension, particularly in the many blacks, in whom dietary potassium is deficient. (*Hypertension*. 1999;33:18-23.)

Key Words: sodium, sensitivity ■ potassium ■ hypertension ■ African Americans

In normotensive as well as hypertensive subjects, blood pressure can be judged to be “salt-sensitive” when observed to vary directly and substantially with the net intake of sodium chloride.¹⁻³ From both a clinical and public health perspective, the phenomenon of normotensive salt sensitivity may be important. Not only is normotensive salt sensitivity a likely and possibly common precursor of hypertension,³⁻⁵ but the phenomenon might be susceptible to dietary suppression, which could prevent or delay its progression to hypertension (vide infra). If normotensive salt sensitivity is a common precursor of hypertension, the frequency of the phenomenon might be predicted to be quite high in blacks and higher than that in whites because hypertension is quite frequently found in blacks and less frequently in whites.⁶ Indeed, normotensive salt sensitivity is said to be found more frequently in blacks than in whites.²

However, when dietary sodium chloride has been loaded in nonextreme amounts, its pressor effect in normotensive blacks has varied widely and could not be demonstrated in several studies.⁷⁻⁹ Because dietary potassium can modulate the pressor effect of dietary sodium chloride,^{10,11} such variability might reflect the large extent to which dietary potas-

sium may have differed among studies. Dietary potassium in blacks is likely to be less than that in whites and in many blacks may be deficient.¹²⁻¹⁵ This could explain why salt sensitivity has been found to occur more frequently in blacks than whites,¹⁶ and seemingly in most blacks,¹⁷ only when dietary potassium has not been controlled. Thus, normotensive salt sensitivity might be quite frequent in blacks and less frequent in whites, but only when dietary potassium is less than well within the normal range. We report a positive test of this hypothesis.

Methods

Subjects and Setting

In 38 healthy normotensive men (blood pressure $< 140 / < 90$ mm Hg; 24 blacks, 14 whites), ages 31 to 65 years, we conducted 41 studies in the General Clinical Research Center at University of California San Francisco Moffitt Hospital, each study lasting 6 weeks. One black subject was studied 3 times and another twice, both subjects each time with a different protocol. Subjects were on no medications, had no history or clinical evidence of acute or chronic disease, and were within 30% of their ideal body weight. Physical activity was limited to daily walks on the center's one floor. The study protocol was approved by the Committee on Human Research at the Univer-

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sity of California, San Francisco, and all subjects gave written informed consent.

Diets

When the protocol was started, an “ideal body weight” was determined for each patient on the basis of their height, weight, and dietary history. This value was used to determine the total calories and the specific dietary and supplemental intake of sodium and potassium. Throughout the 6-week period of each study, each patient ate a constant amount of a nutritionally adequate “basal” whole-foods diet providing, per 70 kg of body weight: 15 mmol of sodium, 30 mmol of potassium, and 14 mmol of calcium. The composition of the diet and the schedule of meals provided were like those previously published.¹⁸ For the initial 2-week period of each study, only the basal diet was ingested. Throughout the last 4-week period, sodium chloride was loaded (250 mmol/d per 70 kg) both by adding 115 mmol directly to the food and by administering 120 mmol in capsules ingested 3 times daily with meals. Throughout the final 3-week period of salt loading, all subjects received 1 of 4 schedules of orally administered potassium bicarbonate given as 10 mmol capsules: schedule A: 40 mmol of KHCO₃, days 21 to 28, placebo, days 29 to 42 (n=13); schedule B: 40 mmol of KHCO₃, days 21 to 42 (n=13); schedule C: 90 mmol of KHCO₃, days 21 to 42 (n=10, all black); schedule D: placebo, days 21 to 42, time controls (n=5, all black).

Throughout each study, each subject took the same number of identically appearing capsules and was not informed of their contents. To supplement dietary potassium, we chose KHCO₃ because it lacks chloride. Potassium-rich foods like fruits and vegetables contain little chloride. Supplemental dietary chloride can have its own pressor effect, as demonstrated in 2 genetic rat models of hypertension,^{19,20} even when supplemented as KCl.²⁰

Blood Pressure Measurements

The daily blood pressure was taken as the average of 5 measurements made every 4 hours from 6 AM to 10 PM with a DINAMAP vital signs

monitor (Critikon Inc) in the nondominant arm. For each measurement, 5 readings of blood pressure were taken at 1-minute intervals and the last 4 readings averaged. The subjects lay quietly supine for the 15-minute period immediately before and during the 5-minute period of each measurement and neither smoked nor ate throughout this 20-minute period and the 45-minute period beforehand.

Salt sensitivity was defined as a salt-induced increase of mean arterial blood pressure (MAP) of ≥3 mm Hg.^{21,22} Because a major objective of the current study was to compare in blacks and whites the extent to which dietary potassium can affect the pressor effect of dietary salt, we elected to make such comparison in subjects with comparable degrees of salt sensitivity, as initially assessed at a dietary intake of potassium of 30 mmol/d. The salt-induced increase in MAP was <10 mm Hg in all of the salt-sensitive white subjects but in only three quarters of the salt-sensitive black subjects. Accordingly, we divided the subjects with salt sensitivity into 2 groups, “moderate” and “severe,” depending on whether their salt-induced increase in blood pressure was or was not <10 mm Hg. Salt-induced changes in MAP were measured by subtracting the average daily MAP of the last 2-day period of salt restriction from the average daily MAP of the last 2 days of the first week of salt loading. The average MAP of the last 2 days of the 3 subsequent 7-day periods was used to assess the influence of the different potassium dosage schedules.

Laboratory Measurements

Body weights of each subject were measured daily at 6 AM. Spontaneously voided urine was collected daily over 24-hour periods and analyzed for Na⁺, K⁺, Cl⁻, Ca²⁺, and creatinine. Serum concentrations of Na⁺, K⁺, Cl⁻, total and ionized Ca²⁺, and creatinine were measured on the last 2 days of each dietary period in venous blood sampled without a tourniquet.

Statistical Analysis

Statistical analyses included ANOVA, paired and unpaired *t* tests, χ^2 , Fisher exact test, and linear regression analysis. All calculations were

TABLE 1. Effect of Salt Loading on Blood Pressure and Certain Metabolic Variables in 24 Black and 14 White Normotensive Men on Marginally Deficient Potassium Intake

Outcome Variables	Low Salt, Low K ⁺		High Salt, Low K ⁺		Change		Cumulative Change (7 Days)	
	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites
SBP, mm Hg	115±6.5	111±5.7	124±8.8*	116±7.1	8.8±6.7*‡	2.9±5.4		
DBP, mm Hg	64.3±6.2	63.9±6.6	69.9±8.5	65.3±7.5	5.6±5.4†‡	1.4±4.3		
MAP, mm Hg	81.2±5.2	79.9±5.5	87.8†±8.0	81.9±6.5	6.6±5.7†§	2.0±4.4		
Body weight, kg	79.1±14.2	74.3±14.3	81.0±14.1	75.8±14.5	1.9±0.9‡	1.6±0.8‡		
Urine volume, mL/d	2041±635†	1649±308	2852±576	2945±215			4408±2482*‡	6897±2035‡
Urine Na ⁺ , mmol/d	11.3±6.3	8.3±6.3	218.4±34.4	234.6±19.4			1047±154*‡	1195±141‡
Urine Cl ⁻ , mmol/d	16.2±8.7	19.3±18.5	227.3±34.1	240.0±56.3			1104±156*‡	1250±157‡
Urine K ⁺ , mmol/d	22.1±6.1	24.1±4.8	26.7±16.6	23.5±4.4			24.7±36.1§	12.9±41.6
Urine Ca ²⁺ , mmol/d	3.79±1.94	4.09±1.48	5.4±2.31	6.01±2.15			9.33±7.04‡	10.4±5.41‡
Urine creatinine, mmol/d	14.2±2.35	13.1±1.90	13.8±2.59	13.2±2.87			-0.22±9.09	1.85±8.81
Serum K ⁺ , mmol/L	4.0±0.2	3.9±0.2	3.8±0.2	3.8±0.2	-0.2±0.3§	-0.2±0.2¶		
Ionized Ca ²⁺ , mmol/L	2.5±0.1	2.5±0.05	2.6±0.05	2.5±0.1	0.05±0.05	0.0±0.0		
Serum creatinine, μmol/L	97±18	88±18	88±18	88±18	-9±9	0±0		
Plasma renin activity, ng/mL per hour	4.7±2.3†	6.1±1.5	1.3±3.3	1.5±1.4	-3.4±2.0‡	-4.6±2.8‡		

Values are mean±SD. Low Salt, Low K⁺ indicates dietary intake of Na⁺ and K⁺ of 15 and 30 mmol/d, respectively, for a period of 14 days; High Salt, Low K⁺, NaCl intake was increased to 250 mmol/d for a period of 7 days. Values given in Low Salt, Low K⁺ and High Salt, Low K⁺ columns are average values calculated from the last 2 daily values of each study period. Values in Change column indicate changes in these average values with salt loading. Values in the Cumulative Change column indicate cumulative change in urinary excretion of designated variable from its average value calculated from the last 2 daily values of the Low Salt, Low K⁺ period through the period of salt loading. All urine values are weight-corrected to 70 kg of body weight.

Black vs white: **P*<0.01, †*P*<0.05; Low Salt vs High Salt: ‡*P*<0.001, §*P*<0.01, ¶*P*<0.05.

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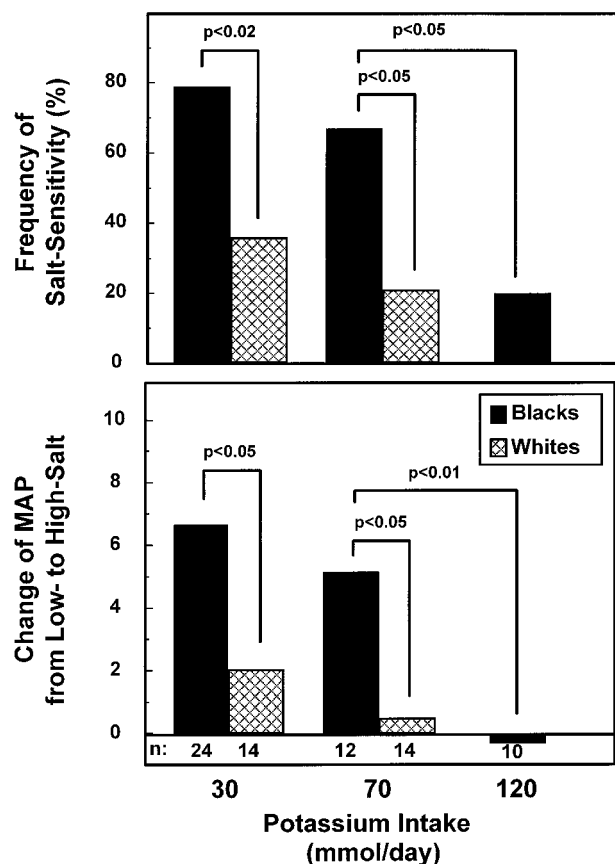


Figure 1. Effect of potassium intake on frequency of salt sensitivity and pressor response to salt loading in normotensive black men and white men. Throughout initial 7-day period of salt loading in all study subjects, potassium intake was set at 30 mmol/d, then increased to either 70 or 120 mmol/d for subsequent 7-day period of salt loading. Depicted average salt-induced change in MAP is taken as a measure of each racial group's average pressor response to salt loading.

performed with SigmaStat, Jandel Scientific Software, version 2.0, Jandel Corp, or Primer, version 3.02, McGraw-Hill, Inc.

Results

Blacks and whites did not differ in average age (39 vs 38 years) or in body mass index; none was obese. At the end of the initial 2-week study period, the blood pressures of the blacks and whites were not different, the serum concentrations of Na^+ , K^+ and Cl^- were normal, and, like the urinary excretions of these electrolytes, not different between blacks and whites. Predictably, plasma renin activity was lower in blacks (Table 1).

Baseline ideal body weight did not predict the pressor response to salt loading ($r=0.05$, $P=0.75$). Salt loading induced a significant increase in both systolic blood pressure (SBP) and diastolic blood pressure (DBP) in blacks, as a group, but not in whites (Table 1). Salt sensitivity occurred in 79% of the blacks versus 36% of the whites ($P<0.02$) (Figure 1). Over the initial 7-day period of salt loading, the urinary excretion of K^+ increased in blacks but not in whites, and the cumulative increases in urinary Na^+ , Cl^- , and volume in whites exceeded those in blacks (Table 1). Among all subjects, the cumulative urinary excretion of K^+ with salt

loading was highly predictive of the change in serum K^+ ($r=-0.58$, $P<0.001$).

Over the initial 7-day period of salt loading, body weight increased similarly in black and white subjects. Among all subjects, the increase in weight correlated negatively with the cumulative increase in both the urinary excretion of Na^+ and Cl^- during salt loading ($r=-0.41$, $P<0.01$). Among all subjects, the salt-induced change in body weight was a significant predictor of the increase in MAP ($r=0.48$, $P<0.001$).

In the 12 blacks and 14 whites in whom potassium intake was initially supplemented for 7 days to a mid-normal level (70 mmol/d, schedules A and B), blood pressure fell only in blacks as a group (Table 2), although remaining less in whites (Table 2). In both groups, the serum concentration and urinary excretion of K^+ increased to a similar extent, as did the urinary excretion of Na^+ (Table 2). In the 10 black subjects in whom dietary potassium was supplemented for 7 days to a high-normal intake (120 mmol/d, schedule C), SBP and DBP also decreased [-7.7 ± 6.6 ($P<0.001$)/ -5.2 ± 5.5 mm Hg ($P<0.01$)], the salt-induced increase in MAP became less than that observed in blacks supplemented to 70 mmol/d (Figure 1), weight loss was greater with the greater supplement (-1.1 ± 0.5 kg, $P<0.01$), and the frequency of salt sensitivity became the same as that observed in whites supplemented to 70 mmol (Figure 1).

In blacks and whites, salt loading alone induced a similar increase in urinary Ca^{2+} , and supplementing potassium to 70 mmol/d for 1 week induced a similar magnitude of reversal. When KHCO_3 was continued for another 2 weeks (schedule B), the reversal continued, but not when KHCO_3 was discontinued (2.11 ± 6.46 vs 15.3 ± 10.5 mmol/14 days, $P<0.001$). In the 10 blacks in whom KHCO_3 was supplemented to 120 mmol/d for 21 days (schedule C), the cumulative reduction in urinary Ca^{2+} excretion was greater than that occurring in subjects supplemented to 70 mmol/d for 21 days (schedule B) (-59.0 ± 21.6 vs -18.2 ± 17.0 mmol/21 day, $P<0.001$), and urinary Ca^{2+} excretion decreased to a value less than that occurring at the end of the low NaCl period (2.9 ± 1.2 vs 3.9 ± 2.3 mmol/d, $P<0.07$).

Salt sensitivity was moderate in 18 subjects (5 whites, 14 blacks) and severe in 5 subjects (all black).

Supplementing dietary potassium to a mid-normal intake (70 mmol/d) attenuated moderate salt sensitivity in both blacks and whites within 1 week, and to the same extent (Figure 2). In the 5 subjects in whom this intake was continued after 1 week, the attenuation persisted, and the cumulative urinary excretion of Na^+ remained unchanged. By contrast, when supplementation was discontinued, blood pressure increased progressively (ANOVA, $P<0.05$) (Figure 2); the cumulative urinary excretion of Na^+ decreased and became less than that in the subjects in whom supplemental potassium was continued (-339 vs 44 mmol/14 days, $P<0.03$). Supplementing potassium to a high-normal intake (120 mmol/d) abolished moderate salt sensitivity in the 5 black subjects so affected (Figure 2).

In all 5 black subjects in whom salt loading was continued without KHCO_3 supplementation, (schedule D) neither SBP

TABLE 2. Effect of Increasing Potassium Intake to 70 mmol/d on Blood Pressure and Certain Metabolic Variables in 12 Black and 14 White Salt-Loaded Normotensive Men

Outcome Variables	High Salt, Low K ⁺		High Salt, Normal K ⁺		Change		Cumulative Change (7 Days)	
	Blacks	Whites	Blacks	Whites	Blacks	Whites	Blacks	Whites
SBP, mm Hg	126±7.7*	116±7.1	121±8.0†	112±6.7	-4.9±5.6	-2.5±3.5		
DBP, mm Hg	70.7±7.4	65.3±7.5	67.4±7.0	63.4±8.2	-3.3±4.3¶	-1.9±2.6		
MAP, mm Hg	89.2±7.1‡	81.9±6.6	85.3±6.7	79.8±7.2	-3.9±4.5¶	-2.1±2.7		
Body weight, kg	83.7±16.4	75.8±14.5	83.3±16.4	75.2±14.3	-0.4±0.5**	-0.6±0.7¶		
Urine volume, mL/d	3044±690	2945±215	3226±1090	2810±401			971±2936	-367±1754
Urine Na ⁺ , mmol/d	221±24.6	235±19.4	230±28.2	231±27.4			134±187**	118±177**
Urine Cl ⁻ , mmol/d	236±28.7	240±56.3	234±21.5	243±32.7			54.8±175	135±381
Urine K ⁺ , mmol/d	24.8±6.7	23.5±4.4	54.1±10.2§	56.2±7.2§			119±35.3§	144±32.4§
Urine Ca ²⁺ , mmol/d	4.54±1.78	6.01±2.15	3.59±1.3	4.54±1.57			-3.54±5.2**	-5.43±5.8¶
Urine creatinine, mmol/d	14.6±1.63	13.2±2.87	14.2±1.6	13.0±2.59			4.2±15.2	-1.03±4.25
Serum K ⁺ , mmol/L	3.7±0.2	3.8±0.2	4.0±0.2	4.0±0.2	0.3±0.2§	0.2±0.2**		
Ionized Ca ²⁺ , mmol/L	2.6±0.05	2.5±0.1	2.6±0.05	2.5±0.1	0.0±0.05	0.0±0.05		
Serum creatinine, μmol/L	97±18	88±18	97±18	88±18	0±1	0±0		
Plasma renin activity, ng/mL per hour	2.0±1.7	1.5±1.4	2.4±1.5	2.6±2.0	0.4±1.6	1.0±1.3		

Values are mean±SD. High Salt, Low K⁺ indicates dietary intake of Na⁺ and K⁺ of 250 and 30 mmol/d, respectively, for a period of 14 days; High Salt, Normal K⁺, K⁺ intake was increased to 70 mmol/d for a period of 7 days. Values in High Salt, Low K⁺ and High Salt, Normal K⁺ columns are average values calculated from the last 2 daily values of each study period. Values in Change column indicate changes in these average values with potassium bicarbonate supplementation. Values in Cumulative Change column indicate cumulative change in urinary excretion of designated variable from its average value calculated from the last 2 daily values of High Salt, Low K⁺ period through period of potassium supplementation. All urine values are weight-corrected to 70 kg of body weight.

Black vs white: *P<0.001, †P<0.01, ‡P<0.05; High Salt, Low K⁺ vs High Salt, Normal K⁺: §P<0.001, ¶P<0.01, **P<0.05.

nor DBP changed significantly throughout the final 3-week period of salt loading.

In the 1 black subject studied 3 times and in whom salt sensitivity was severe, highly reproducible, and stable over a 3-week period when potassium was not supplemented, potassium supplementation induced a clear-cut, dose-dependent, antipressor effect (Figure 3).

Linear regression analysis reveals that the modulation of salt sensitivity by dietary potassium, as indicated by the change in MAP from its salt-induced peak to the end of the study, was predicted by changes in the urinary excretion of K⁺ (r=-0.54, P<0.001) and Ca²⁺ (r=0.39, P<0.02) and changes in the serum concentrations of K⁺ (r=-0.55, P<0.001) and Cl⁻ (r=0.62, P<0.001) and the final serum concentrations of K⁺ (r=-0.54, P<0.001) and Cl⁻ (r=0.42, P<0.02).

Discussion

The current observations demonstrate that when dietary potassium was set at a marginally deficient intake similar to that habitually ingested by many blacks (30 mmol/d), dietary salt loading induced a significant increase in blood pressure in healthy normotensive black men but not in healthy normotensive white men. The current observations further demonstrate that at this potassium intake, salt sensitivity occurred in the great majority of normotensive black men but in only a minority of the normotensive white men. In a quarter of the affected blacks but in none of the whites, salt sensitivity was severe, as judged by a salt-induced increase in blood pressure of >10 mm Hg.

Increasing the dietary intake of potassium by only 40 mmol/d to a mid-normal level of 70 mmol/d significantly attenuated the pressor effect of salt in blacks but was without effect in whites as a group. However, this increase in dietary potassium attenuated moderate salt sensitivity in both blacks and whites, and in each to a similar extent. The attenuation persisted in both unless dietary potassium was returned to the marginally deficient intake, whereupon the attenuation rapidly disappeared. However, only increasing dietary potassium to a high-normal intake of 120 mmol/d abolished moderate salt sensitivity and induced sustained attenuation of severe salt sensitivity. Only this dietary intake of potassium reduced the frequency and severity of salt sensitivity in blacks to the same levels as those observed in whites, when in whites the intake was increased to 70 mmol/d. These observations demonstrate that over a mainly normal range, dietary potassium modulated the pressor effect of dietary salt in both normotensive black and white men and determined whether salt sensitivity was expressed in most or few blacks and in more blacks than whites.

Lesser increases of dietary potassium might have induced greater antipressor effects had they been initiated at the start of dietary salt loading, or beforehand rather than well after the onset of its pressor effect. In fact, in those studies in which dietary potassium has been controlled at normal intakes ranging from 60 to 100 mmol/d throughout dietary salt loading, dietary intakes of salt as great as 400 and 600 mmol/d have failed to induce either a mean pressor effect in groups of either black or white normotensive men^{8,9,23,24} or a statistically greater frequency of salt sensitivity in normo-

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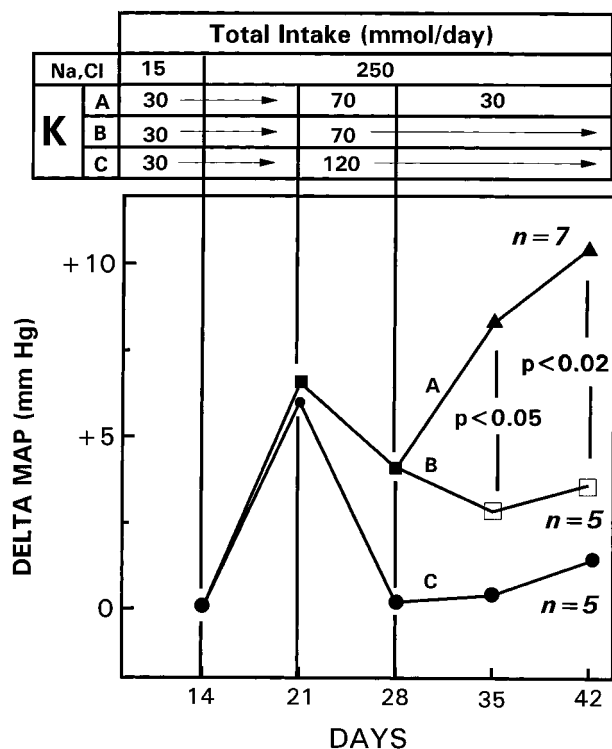


Figure 2. Effect of different potassium intakes on moderate normotensive salt sensitivity. Data of subjects given either schedules A or B are combined for the 21- to 28-day period because with either schedule during that period they received identical amounts of supplemental potassium bicarbonate (40 mmol/d).

tensive black men.³ By contrast, in 2 studies of inner-city normotensive black men in which no mention is made of either assessment or supplementation of dietary potassium, dietary NaCl loading induced a substantial pressor effect^{16,17}; when normotensive whites were also studied, the frequency of salt sensitivity was found to be greater in blacks.¹⁶ The dietary intake of potassium has been found to be less in inner-city blacks than whites.^{15,25} In aggregate, the current and previous observations suggest that in many normotensive blacks but in relatively few normotensive whites, a marginally deficient dietary intake of potassium might permit expression of salt sensitivity that a greater potassium intake might prevent and might thereby also prevent or delay the occurrence of hypertension. Furthermore, in a substantial number of normotensive blacks, and in fewer normotensive whites, it seems likely that just a “normal” dietary intake of potassium is deficient in that it is not sufficient to suppress expression of salt sensitivity. In some, attainment of that suppression with dietary potassium may require an intake well into the high-normal range, the upper boundary of which remains to be defined.

Depending on whether dietary potassium is either restricted or supplemented, the natriuretic response to salt loading in normal men can be either blunted or enhanced, respectively.^{11,26,27} In the current study, when dietary potassium was marginally deficient, the salt-induced increase in body weight predicted the salt-induced increase in SBP and DBP, and the increase in body weight correlated negatively with the urinary excretion of sodium and chloride. Salt

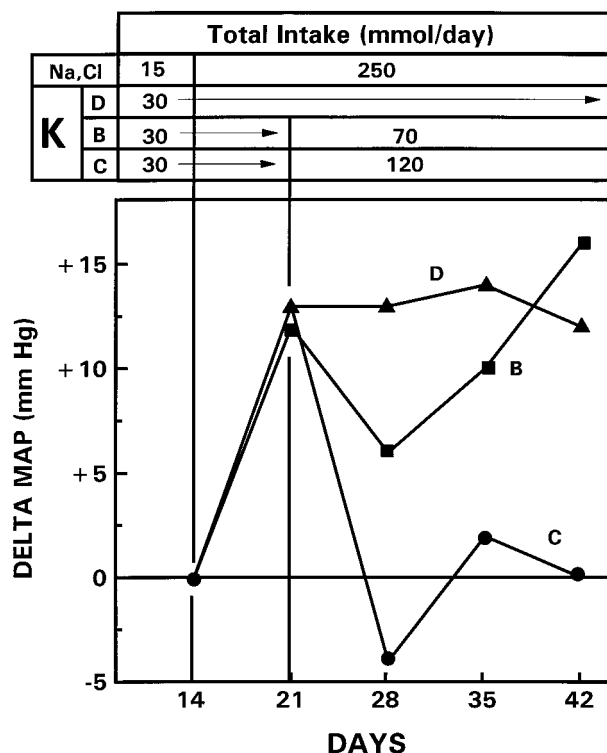


Figure 3. Effect of different potassium intakes on severe normotensive salt sensitivity in a single subject.

loading induced not only a lesser increase in urinary excretion of sodium in blacks than in whites, as previously observed,^{8,28} but also an increase in the urinary excretion of potassium only in blacks, despite their prior and ongoing marginally deficient dietary intake of potassium. By augmenting an already extant if modest potassium depletion, the kaliuresis induced by dietary salt loading in blacks could further blunt their renal excretion of salt and thereby enhance its pressor effect.²⁹

While salt loading was continued in both black and white men with moderate salt sensitivity, decreasing dietary potassium from 70 to 30 mmol/d was promptly attended by not only a progressive increase in blood pressure but also by a sustained decrease in the urinary excretion of sodium. An increase in blood pressure would of itself be expected to induce an increase in the urinary excretion of sodium.²⁹ Thus, the decrease in sodium excretion observed indicates that even a modestly deficient dietary intake of potassium can strongly enhance the renal retention of dietary salt²⁶ and thereby its pressor potential in salt-sensitive normotensive men.

Orally administered KHCO_3 but not KCl has a hypocalciuric, calcium-retaining effect.^{30–32} In our study, KHCO_3 dose-dependently reversed and ultimately abolished the hypercalciuric effect of NaCl loading. In those who are salt sensitive and in whom dietary calcium is suboptimal, as in the subjects studied, dietary replenishment of calcium may reduce blood pressure.^{33,34} Accordingly, a calcium-retaining effect of KHCO_3 might have contributed to its reversal of the pressor effect of dietary NaCl. Similarly, the abundant K^+ and HCO_3^- -yielding anions (such as citrate) in fruits and vegetables could mediate the hypocalciuric³⁵ and calcium-retaining effects of these foods and thereby contribute to their

antipressor effect³⁶ and to its enhancement by calcium-rich products.³⁶

The current observations complement those recently reported that demonstrated that in normotensive black men who were salt sensitive but not in normotensive white men who were not, a marginally deficient dietary intake of potassium reversibly enhanced vasopressor responsiveness to sympathetic stress induced either by experimental cold or mental stress.¹⁸ Normalizing dietary potassium with KHCO_3 abolished the enhancement even after salt loading had doubled it. Because such enhanced sympathetic vasopressor responsiveness reportedly predicts later increases in resting blood pressure with the occurrence of hypertension,^{37,38} the enhancement may be yet another potassium-suppressible precursor of hypertension.¹⁸

Acknowledgments

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