Socioeconomic Status and Electrolyte Intake in Black Adults: The Pitt County Study

Ann M. Gerber, PhD, Sherman A. James, PhD, Alice S. Ammerman, DrPH, Nora L. Keenan, MPH, Joanne M. Garrett, PhD, David S. Strogatz, PhD, Pamela S. Haines, DrPH

Introduction

As noted in several recent reviews, socioeconomic status (SES) is inversely associated with mean blood pressure and the prevalence of hypertension. This inverse association has been observed among Blacks in the initial screening of the Hypertension Detection and Follow-up Program and in a number of smaller, geographically dispersed community studies. It is not yet clear what combination of biological, psychosocial, or environmental factors contributes to this relationship. Diet may be among the important environmental factors that influence the inverse relationship between SES and blood pressure.

The objectives of this report are to describe the distribution of dietary intakes of sodium, potassium, and calcium among Black men and women and to determine whether intake of these nutrients varies by SES. This report is part of the Pitt County Study, which was designed to investigate psychosocial and dietary influences on the development of hypertension in young and early middle-aged Black adults residing in an eastern North Carolina community. This community is part of a larger area within the southeastern United States known to have high mortality from stroke and other hypertension-related disorders.

A variety of nutritional factors, including intake of sodium, potassium, and calcium, have been associated with blood pressure level, although intracommunity comparisons are, in general, less likely to demonstrate significant effects than studies that examine diverse, multi-country experiences. While most studies have not explicitly investigated differences in electrolyte intake by SES, variations in food consumption patterns or macronutrient intake by educational level and income have been reported. Increased incomes are associated with greater consumption of meats, fruits and vegetables, and dairy products. This is consistent with data from the Second National Health and Nutrition Examination Survey (NHANES II), which indicated that young adults below the poverty level consumed less potassium and calcium than those above the poverty level. Sodium intake per 1000 calories did not differ by poverty status.

The nutrient intake–economic status relationships investigated in these national surveys and community-based populations were not consistently stratified by race. However, large sample surveys of nutritional status and dietary behavior in the United States have shown lower...
intakes of potassium, calcium, and magnesium in Blacks compared to Whites. Differences in calcium intake between Blacks and Whites may be due to a higher overall prevalence of lactase deficiency among Blacks in the United States. In addition, Langford et al. reviewed the diet–blood pressure relationship and concluded that the lower dietary intake of potassium and possibly calcium among US Blacks may be a major factor in explaining their well-known excess risk for hypertension. Little is known about whether these nutritional determinants of blood pressure vary by SES among Blacks. This report is intended to help clarify the latter issue and, in doing so, facilitate more careful planning of dietary interventions to reduce risk for hypertension in US Blacks.

**Methods**

**Study Population**

The study population is composed of a community-based sample of 25- to 50-year-old Black men and women residing in Pitt County, NC, in 1988. The sampling design identified housing units through an area probability sample. Area segments of housing units were selected with probabilities proportional to the expected number of Blacks residing in each area. All age-eligible men and women within selected housing units were invited to participate in the study. A major sampling objective was to obtain an economically heterogeneous sample. Eighty percent of the eligible sample of 2225, or 1784 adults, agreed to be interviewed.

**Variables**

Information concerning each participant’s education, occupation, and other health and psychosocial characteristics was obtained from a personal interview conducted in the home. Physical measurements included blood pressure, height, weight, and the circumference of the waist and hips. SES was defined by a composite index based on the participant’s educational level and most recent occupation. A composite index was created because previous research in a neighboring county indicated that education alone was not an adequate measure of overall economic resources. The number of years of formal education completed was divided into three categories: less than high school graduate, high school graduate, and greater than high school. Using Hollingshead rankings of job prestige, occupation was grouped into unskilled, semi-skilled, and skilled/white collar categories. Three levels of SES were created from the cross-classification of education and occupation categories (Table 1).

Dietary information was collected via an interviewer-administered food frequency questionnaire adapted from a standardized instrument developed by Block et al. Dietary assessment focused on the portion size and the frequency with which certain foods were consumed during the previous year. The food list, portion size distributions, and nutrient composition values were derived from Block’s standardized instrument. The instrument was modified somewhat to reflect regional and ethnic food choices known to characterize southern Black populations.

In reliability studies, the correlation between repeated administrations of Block’s standardized instrument was 0.70 for each nutrient. The validity of the standardized instrument was also judged to be adequate with nutrient correlations ranging from 0.5 to 0.7 when food frequency dietary data were compared to three 4-day food records. Food frequency data were converted to nutrients consumed per day (in mg) for each individual. In addition to calculated values of energy, potassium, and calcium, two estimates of sodium intake were used. The first measure included only the sodium consumed in food. The second measure, enhanced sodium, included both food sodium and an estimate of discretionary table salt use. Table salt use was estimated as 0%, 15%, or 30%, respectively, of the individual’s food sodium if they said they either rarely/never, sometimes, or often/always added salt to their food. Sodium ratios were also calculated. Individuals with missing data (n = 104) were excluded from the analysis.

Questions concerning other factors that may influence food choices and attitudes that reflect knowledge of diet and health principles included the number of times in a typical week that the participant ate out, the change in use of salt during the last 5 to 10 years (more, same, less), and perceptions about whether diet affects risk for disease.

**Statistical Analysis**

The relationship between nutrient intake and SES was assessed by estimating nutrient intake means within each socioeconomic status category by weighted co-variate analysis using a multiple linear regression model. Two indicator variables were used to categorize high and medium SES with low SES as the referent group. Men and women were analyzed separately because of the expected greater caloric intake among men. Weighted analyses were performed to take into account the sampling strategy as well as nonresponse. The multivariable analyses of the relation between SES and electrolytes also included age and total caloric intake. Levels of other determinants of consumption and nutritional attitudes were also characterized by strata of socioeconomic status.

**Results**

Little difference was noted in mean age, waist-to-hip ratio (WHR), and energy intake by level of SES among men (Table 2). Body mass index (BMI) was higher among men with high SES than low SES. Lower SES women were older than those in the other groups. BMI, WHR, and energy intake decreased with increasing SES among women, possibly because of the differences in age among the groups. As expected, the mean energy intakes of men exceeded those of women.

Table 3 shows that sample mean intakes of sodium and enhanced sodium for men and women were near or above the upper limit of the “estimated safe and ad-
TABLE 2—Means and Standard Errors of Selected Characteristics by Sex and Socioeconomic Status (SES): Pitt County, NC, 1988

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total</th>
<th>SES1</th>
<th>SES2</th>
<th>SES3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>641</td>
<td>230</td>
<td>207</td>
<td>204</td>
</tr>
<tr>
<td>Weighted %</td>
<td>34.5</td>
<td>34.9</td>
<td>30.6</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>35.0 ± 0.4</td>
<td>35.5 ± 0.6</td>
<td>34.7 ± 0.5</td>
<td>35.0 ± 0.7</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.3 ± 0.2</td>
<td>26.2 ± 0.3</td>
<td>26.1 ± 0.3</td>
<td>26.8 ± 0.3</td>
</tr>
<tr>
<td>WHR</td>
<td>0.89 ± 0.01</td>
<td>0.89 ± 0.01</td>
<td>0.89 ± 0.01</td>
<td>0.89 ± 0.01</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>2427 ± 74</td>
<td>2451 ± 108</td>
<td>2530 ± 131</td>
<td>2283 ± 94</td>
</tr>
</tbody>
</table>

**Women**

| Number          | 1039  | 442  | 296  | 301  |
| Weighted %      | 39.7  | 29.4 | 30.9 |
| Age             | 35.5 ± 0.3 | 37.1 ± 0.5 | 34.6 ± 0.4 | 34.1 ± 0.4 |
| BMI (kg/m²)     | 29.4 ± 0.3 | 30.3 ± 0.5 | 29.1 ± 0.6 | 28.5 ± 0.4 |
| WHR             | 0.85 ± 0.01 | 0.87 ± 0.01 | 0.85 ± 0.01 | 0.83 ± 0.01 |
| Energy (kcal)   | 1822 ± 43 | 1918 ± 58 | 1784 ± 60 | 1736 ± 69 |

Note: SES1 = low; SES2 = middle; SES3 = high; BMI = body mass index; WHR = waist-to-hip ratio.

TABLE 3—Means and Standard Errors for Sodium, Potassium, and Calcium Intake by Sex, Comparing Pitt County, NC, Study Population with 1980 US RDAs for Adults

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Pitt County, NC</th>
<th>1980 RDAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>3618 ± 116</td>
<td>2801 ± 67</td>
</tr>
<tr>
<td>Enhanced sodium</td>
<td>4310 ± 139</td>
<td>3175 ± 80</td>
</tr>
<tr>
<td>Potassium</td>
<td>2704 ± 79</td>
<td>2097 ± 45</td>
</tr>
<tr>
<td>Calcium</td>
<td>664 ± 22</td>
<td>563 ± 14</td>
</tr>
</tbody>
</table>

Note: Intake is expressed as mg/day.

²Range of estimated safe and adequate daily intakes.

TABLE 4—Means of Sodium, Potassium, Calcium, Sodium to Potassium, and Sodium to Calcium Ratios, Adjusted for Age and Energy by Sex and SES: Pitt County, NC, 1988

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>SES1</th>
<th>SES2</th>
<th>P* value</th>
<th>SES3</th>
<th>P* value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>3694</td>
<td>3766</td>
<td>.20</td>
<td>3734</td>
<td>.34</td>
</tr>
<tr>
<td>Enhanced sodium</td>
<td>4476</td>
<td>4469</td>
<td>.93</td>
<td>4377</td>
<td>.19</td>
</tr>
<tr>
<td>Potassium</td>
<td>2662</td>
<td>2794</td>
<td>.02</td>
<td>2677</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Calcium</td>
<td>652</td>
<td>692</td>
<td>.05</td>
<td>709</td>
<td>.02</td>
</tr>
<tr>
<td>Sodium/potassium</td>
<td>1.42</td>
<td>1.36</td>
<td>.13</td>
<td>1.32</td>
<td>.003</td>
</tr>
<tr>
<td>Sodium/calcium</td>
<td>6.00</td>
<td>5.72</td>
<td>.23</td>
<td>5.65</td>
<td>.06</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>2836</td>
<td>2847</td>
<td>.81</td>
<td>2861</td>
<td>.61</td>
</tr>
<tr>
<td>Enhanced sodium</td>
<td>3252</td>
<td>3219</td>
<td>.48</td>
<td>3194</td>
<td>.38</td>
</tr>
<tr>
<td>Potassium</td>
<td>2062</td>
<td>2151</td>
<td>.02</td>
<td>2191</td>
<td>.004</td>
</tr>
<tr>
<td>Calcium</td>
<td>533</td>
<td>597</td>
<td>.005</td>
<td>597</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sodium/potassium</td>
<td>1.42</td>
<td>1.37</td>
<td>.11</td>
<td>1.35</td>
<td>.03</td>
</tr>
<tr>
<td>Sodium/calcium</td>
<td>5.67</td>
<td>5.45</td>
<td>.004</td>
<td>5.25</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note: SES1 = low; SES2 = middle; SES3 = high. Intake is expressed as mg/day.

*From one-degree of freedom F-statistic of beta coefficient from dummy variable for SES where SES1 is the reference.


equate daily dietary intakes” levels recommended as part of the 1980 Recommended Dietary Allowances (RDAs).37 In addition, mean potassium was in the low range of recommended intake, particularly when considering the high general sodium intake and the fact that mean calcium intake fell below the RDA.

After adjusting for differences in age and energy intake among the SES groups, there was no consistent association between SES and sodium intake as measured by either food sodium or enhanced sodium (Table 4). Potassium and calcium intake increased with increasing SES for both men and women, with significantly (P < .05) higher intakes in the middle and high SES groups compared with the low SES group. Sodium to potassium and sodium to calcium ratios also decreased with increasing SES for both sexes. Similar results were found for the ratios when using enhanced sodium as the measure of sodium intake.

The distribution of potential determinants of nutrient consumption by level of SES are summarized in Table 5. Low SES respondents were more likely to live in large households (>5 persons). As expected, the proportion of men and women eating meals outside the home increased with increasing SES. For both sexes, those in the higher SES groups were more likely to agree with the statement that diet affects disease risk.

Men and women in the low SES group were more likely to report a high level of table salt use than those with higher SES. Men were more likely than women to salt food at the table. Both men and women in the low SES group were less likely to perceive their salt intake as high. This last finding was not observed for women.

Discussion

Based on the 1980 RDA recommendations,37 the distribution of electrolytes among Black adults in the Pitt County Study indicates lower than desirable calcium and potassium intakes and higher than desirable sodium intakes. Male study participants had a higher mean sodium intake and lower calcium and potassium intakes than 25- to 54-year-old Black and White men in NHANES II, which assessed dietary intake by 24-hour recall.24 Sodium intake was also higher among women participants; however, calcium...
and potassium intakes were similar. Sodium and potassium intakes in the Pitt County Study population were greater than those reported for Black men and women in Evans County in 1961. A variety of factors may account for differences among these population studies, including secular trends, variation in dietary assessment instruments, and regional differences in food consumption.

Within the Pitt County Study population, Black men and women with high SES consumed more potassium and calcium and had lower sodium to potassium and sodium to calcium ratios than did those with low SES. These SES differences in electrolyte intake are consistent with the well-known inverse association between SES and hypertension.4 However, the small magnitude of the differences in dietary intake across the SES categories (5% to 10%) in this study population is also consistent with literature reporting limited variation in dietary intake within populations compared to differences observed between populations.16

Potential problems in the assessment of dietary intake include inflated variance estimates due to greater intra- vs interindividual variability. This could lead to an underestimation of the statistical significance of the differences among SES groups.19

Reasons that dietary intakes vary by SES are complex and involve many social and cultural processes. Not only do income, purchasing power, and access to food differ across SES, but access to and use of nutritional information probably differs by educational level. In addition, culture exerts a major influence on the selection, consumption, and use of the available food supply. In this study, persons with high SES were more likely to believe that diet affects disease, to report less sodium consumption than in the past and less use of salt at the table. Approximately 70% of the study population did not consider their salt intake to be high. Given the overall high sodium consumption in this population, such a perception may warrant special attention in any community-based nutrition education program.

Large household size and the consumption of calories away from home have also been related to the intake of less healthy diets. Compared to those with high SES, individuals with low SES were more likely to live in larger households but were less likely to consume foods away from home. The contrasting relations that household size (inverse) and the number of times respondents eat out per week (direct) have with SES may help explain the lack of variation in sodium intake across the groups.

In conclusion, the differences in electrolyte intake by socioeconomic status observed in this population are consistent with the frequently reported inverse association between SES and hypertension. In this study population, a large percentage of individuals believed that diet influences risk for disease, but a much smaller percentage consumed the recommended level of these nutrients, reported reducing their salt intake over time, or considered their current salt intake to be too high. Therefore, health promotion efforts that target dietary behaviors in this and similar communities may need to develop population-based strategies to change food consumption patterns in the community as a whole. This will require an understanding of the social and cultural norms that sustain certain dietary behaviors at the individual level as well as an understanding of how local economic factors influence dietary options. Public health strategies that more effectively educate high-risk populations about the role of diet in cardiovascular diseases are clearly warranted.

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References
7. Syme SL, Oakes TW, Friedman GD, Feldman R, Siegelaub AB, Collen M. Social


30. Hollingshead AB. Four factor index of social status (unpublished working paper). New Haven, Conn: Department of Sociology, Yale University; 1975.


