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Quality and Adequacy of Dietary Intake in a Southern Urban Heart Failure Population

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Abstract

Background—Few studies have examined the quality and adequacy of dietary intake in patients attempting to limit sodium.

Objective—The aim of this study was to provide a comprehensive analysis of the dietary intake of persons with heart failure (HF) in the Southern United States who have been advised to limit their sodium intake.

Methods—Three-day food diaries were completed by 114 New York Heart Association class II and III persons with HF enrolled in a family partnership intervention study, which were reviewed by a dietitian and analyzed using validated nutritional software. The Harris-Benedict equation for sedentary adults was used to determine macronutrient intake adequacy. Demographic information and clinical data were obtained through patient report and medical record review.

Results—Dietary sodium ingestion ranged from 522 to 9251 mg/d (mean [SD], 2671 [1432] mg/d), with 38 (33.3%) individuals consuming the recommended 2000 mg/d or less in this sample (age, 28–78 years; 64.0% men; 57.0% African American). Mean (SD) caloric intake for the total sample was 1674 (636) kcal/d, with participants eating 99% of the recommended daily allowance (RDA) of protein, 63% of the RDA of carbohydrates, and 89% of the RDA of fat. Participants eating 2000 mg or less of sodium consumed significantly less calories ($P < .001$), protein ($P < .001$), carbohydrates ($P = .008$), and fat ($P < .001$), but not fiber ($P = .103$), compared with those consuming more than 2000 mg of sodium after adjusting for body mass index. When analyzed by amount of sodium consumption, persons ingesting 2000 mg or less of sodium per day ate

significantly less grains ($P = .001$) and meat and beans ($P = .004$) and had less intake of the micronutrients calcium ($P < .001$), zinc ($P = .002$), and thiamine ($P = .05$).

Conclusion—Only one-third of participants with HF who have been instructed on a low-sodium diet reported consuming the RDA of 2000 mg or less, indicating the need for further dietary instruction with a particular focus on modifying the Southern US diet.

Keywords

adult; diet; heart failure; self-care; sodium restricted

Restricting sodium intake is a mainstay for cardiovascular health and an essential for persons with heart failure (HF). In fact, dietary sodium restriction is arguably the most frequent self-care behavior recommended by all national and international guidelines^{1–11} for the estimated 5.7 million Americans and 23 million people worldwide living with HF.¹² This chronic and often end-stage cardiovascular disease creates both personal and societal burdens of high health resource utilization and associated costs.^{13,14} Frequent hospitalizations are central to this burden and have been attributed to nonadherence with the prescribed medical regimen and lifestyle modifications (eg, dietary sodium restriction, daily monitoring of weight and symptoms, and medication adherence).^{15–17}

Although restriction of dietary sodium has been one of the primary treatment recommendations, there is little evidence of how trying to adhere to a low-sodium diet may affect important aspects of nutrition. Understanding the overall nutritional status of persons following low-sodium diets may differ given the clinical characteristics (eg medications effects) or demographic characteristics such as gender; therefore, this study attempts to explore some of these factors. Although several studies have examined the quality and adequacy of dietary intake in those patients attempting to limit their intake, few have looked at the nutritional composition of those who do and do not achieve reduced intake.

The purpose of this study was to provide a comprehensive analysis of the dietary intake of persons with HF in the Southern United States who have been advised to limit their sodium intake. This includes an analysis of macronutrient and micronutrient intake, identification of frequently consumed high-sodium foods, and comparison of nutrient adequacy between persons adhering to the 2000 mg sodium restricted diet^{18–22} and those consuming more than this amount. Findings from this study will be compared with those from similar studies with recommendations for low-sodium food alternatives for patients with HF.

Background

Macronutrients

There is a definite gap in the literature when referring to nutrition adequacy in HF patients and macronutrients. Most of the focus has been on sodium, other electrolytes, and some micronutrients. Many of the following studies focused on cardiac cachexia, protein and calorie adequacy.

Aquilani et al²³ studied nutrition adequacy in 57 patients with HF, specifically calorie (determined through assessment of total calorie minus total calorie energy expenditure) and protein (determined through assessment of protein intake minus total nitrogen loss calculated via 24-hour urea nitrogen) adequacy. They found that 54.4% of their nonobese sample was malnourished and that 15.8% were both calorie and protein malnourished. When the investigators calculated calorie and nitrogen balance, 70.1% had a negative calorie balance and 9.6% a negative nitrogen balance, despite having near equal intakes when compared with healthy but sedentary controls. These findings were replicated a year later in

a similar study of 50 nonobese patients with stable HF.²⁴ Despite similar caloric intakes to healthy controls, the HF sample was still deficient when referenced to their measured total energy expenditure.

Recently, a positive relationship between carbohydrate intake and cardiovascular heart disease (CHD) has been suggested.²⁵ In CHD, dietary recommendations have shifted from the typical low-fat focus to an emphasis on increased polyunsaturated fats and low glycemic load in combination with reducing total caloric intake.²⁶ Although many studies recommend increasing polyunsaturated fats, specifically omega 3 fatty acids, and decreasing simple carbohydrates for persons with CHD, the translation to the HF population has not been established.²⁷

Micronutrients

When investigating the literature on the subject of micronutrients, the availability of research is diffuse with a multitude of different micronutrients from calcium to zinc. Large-scale trials have not been undertaken, but a few micronutrient deficiencies have been identified as possible contributors to increased heart disease. These include vitamin D, calcium, vitamin E, thiamine, potassium, selenium, magnesium, and zinc.²⁸

Used by the body to boost the absorption of calcium and phosphorus, vitamin D improves muscular function, moderates blood pressure, and contributes to anti-inflammatory responses. Furthermore, vitamin D has been shown to influence cardiac contractility and myocardial calcium homeostasis.²⁹ Mostly acquired from the skin's exposure to sunlight, vitamin D can also be found in the American diet in food items such as fish, fortified products (ie, milk, cereal), and mushrooms grown in ultraviolet light. Receiving much attention, vitamin D deficiency has been noted to be prevalent in every population, but especially in those with high melanin pigmentation.^{30–32} Persons with HF are also at risk for hypovitaminosis D because of their limited activity and tendency to remain housebound. Deficiency can lead to increased hypertension and cardiomyopathy.³³

Calcium and vitamin D are found in similar products. Calcium is naturally found in dairy products, some beef and fish, dark green vegetables, almonds, and in fortified products such as cereals and juices. Although calcium is used in building and maintaining bones and teeth, it also is instrumental in blood clotting, nerve function, and muscle contraction. This mineral can also maintain normal levels of blood pressure and stomach acid. Calcium deficiency can contribute to HF exacerbations owing to its function in heart muscle contraction.³⁴

Calcium deficiency is directly linked to vitamin D deficiency, in part because vitamin D is responsible for up-regulating calcium from intestinal absorption and from bone.³⁵ Therefore, a deficiency in vitamin D can lead to calcium deficiency if adequate levels are not consumed in the diet. Furthermore, calcium and vitamin D deficiency is common in elderly and HF patients because of low absorption caused by advanced age as well as decreased amounts of vitamin D produced by the skin³⁶; therefore, deficiencies in both can contribute to increased cardiac disease.^{37–40}

Vitamin E inhibits the oxidation of low-density lipoprotein cholesterol, prevents the development of atherosclerosis in experimental animals, and reduces the deleterious effects of hypoxia in both animals and humans. Vitamin E is found mostly in fortified products, nuts, and oils such as cereals and some margarine, wheat germ, and hazelnut. Vitamin E deficiency is rare and usually occurs in persons who cannot absorb dietary fat. Much research has been undertaken given the antioxidant function of vitamin E^{41,42}; however, randomized trials of supplementation have not demonstrated improved cardiovascular outcomes.⁴³

Thiamine, or vitamin B₁, is a catalyst in many chemical processes involving the heart, muscles, and nervous system. It is commonly found in most whole-grain products and those that are fortified, such as breakfast cereals. It can also be found in some lean meats such as pork, fish, and legumes, including soy. Deficiency in thiamine can cause beriberi, which presents in 2 different forms: wet and dry. Wet beriberi's symptoms are almost identical to those of acute congestive HF.⁴⁴ Thiamine deficiency, however, is rare in healthy individuals but is commonly found in alcoholics because of poor nutrition and the lost ability to absorb thiamine. Thiamine deficiency is also well documented in HF patients due to prolonged diuretic use.^{45–48}

The essential electrolyte potassium helps regulate acid-base balance, assists in protein synthesis and carbohydrate metabolism, and is essential in regulating electrical activity in the heart. This nutrient is ubiquitous and can be found in all meats and fish; vegetables including broccoli, tomatoes, and sweet and white potatoes; and fruits such as citrus, cantaloupe, and kiwi. Dairy products as well as nuts are also good sources of potassium. People who eat an adequate healthy diet are rarely deficient in potassium; however, medications for hypertension and HF, such as diuretics, can cause potassium loss.^{1,2}

Selenium plays a role in preventing cell damage and stimulates antibodies to enhance the effectiveness of vaccinations. Food sources for selenium highly depend on the soil in which it was grown or in the grains eaten by the animals. Meats, fish and shellfish, grains, eggs, and chicken are all good sources of selenium. Selenium deficiency–induced cardiomyopathy, also known as Keshan disease, can be reversed with rigorous supplementation.³ Although research is limited and inconsistent, selenium may contribute to cardiovascular disease and other diseases in which oxidative stress and inflammation play a role.^{49,50}

Magnesium is another important micronutrient for cardiovascular health. It is necessary for the transmission of nerve impulses, essential in the synthesis of proteins, involved in the formation of bones and teeth, and used in the proper functioning of certain enzymes and has been found to improve endothelial function in persons with HF.⁵¹ Magnesium can be found in food items such as seeds, nuts, cereals, and whole grains.

Magnesium deficiency may cause irregular heart rhythms and impaired glucose tolerance in patients with HF. Cardiovascular changes, rapid heartbeat, and ventricular arrhythmias can occur with moderate deficiency, and continued muscle contraction can occur with severe deficiency. Hypomagnesemia has also been found to cause cardiac failure in rats⁵² and may, in part, explain the muscle fatigue common in HF.⁵³ According to National Health and Nutrition Examination Survey data, substantial numbers of US adults fail to consume adequate magnesium, with a noted disparity between older age and minorities consuming less than the recommended amounts.⁵⁴ Although hypomagnesemia has been found to be a common nutrient deficiency in persons with HF,⁵⁵ serum magnesium alone does not appear to be an independent risk factor for death.⁵⁶

Zinc is important for cell division and helps maintain healthy hair and skin. It is essential for the activity of many enzymes, some of which are implicated in the regulation of fluid homeostasis, a critical element of HF management. Zinc can also act as an antioxidant, therefore reducing oxidative stress.⁵⁷ Dietary zinc can be found in items such as oysters, fortified cereal, lean beef, seeds, and peanuts. Heart failure may be associated with zinc deficiency through urinary loss secondary to diuretics, angiotensin-converting enzyme inhibitors, and angiotensin receptor blockers⁵⁸ or decreased absorption due to gastrointestinal edema, impaired motility, or intestinal zinc losses.⁵⁸ Zinc deficiency can also be a by-product of low protein intake and protein imbalance found in cachectic persons

with HF. Deficiency can lead to loss of taste, impaired appetite, diarrhea, hair loss, immunological abnormalities, delayed wound healing, decubitus ulcers, and other skin changes.

Methods

Data were collected from New York Heart Association class II and III persons with HF who participated in a family intervention study (N = 114 dyads) approved by the institutional review board of Emory University. Baseline patient data of only those with 3-day food records are reported here. Inclusion criteria for the patient were ability to read, write, and speak English; telephone access; optimal medication regimens; a low-sodium diet; ambulatory; and glomerular filtration rate greater than 30 mL/min.

Three-day food records were reviewed with the patient by a registered dietitian who prompted the participant for additional recall, greater details on preparation techniques, and condiments. The records were then analyzed using The Food Processor SQL version 10.2, ESHA Research, 2008, for frequency and type of food, macronutrient intake, sodium intake, and other micronutrient intake. Patient height, weight, and age were used to determine macronutrient intake adequacy using the Harris-Benedict equation for sedentary adults.⁵⁹ Before analysis, all data were reviewed for completeness, missing data, potential outliers, and assumptions of normality. The continuous variables of interest met the assumptions for normality and were described using means and standard deviations. Categorical and ordinal variables of interest were described by their counts and relative percentages. Multivariate analysis of covariance (MANCOVA) adjusting for either body mass index (BMI) or gender was performed on 3 groupings of multiple measures between the 2 sodium intake groups (< 2000 vs ≥ 2000 mg/d). Each MANCOVA controlled for the family-wise error rate at .05 significance level for the post hoc analyses of covariance.

The 3 measurement groupings per recommended daily allowance (RDA) were percentage of food component intake per RDA (calories, protein, carbohydrates, fiber, and fat), percentage of food group intake per MyPyramid RDA (grain, vegetables, fruit, milk, and meat and beans), and percentage micronutrient intake based on RDA (vitamin D, calcium, vitamin E, magnesium, zinc, potassium, selenium, and thiamine). Because all of these dietary intake percentages were skewed, the square-root transformation was applied to meet normality assumptions before each MANCOVA. Of note, although the United States Department of Agriculture has changed from the MyPyramid to the MyPlate campaign (www.ChooseMyPlate.gov) since this study was completed, the serving sizes used to analyze the data were not changed and all analysis and recommendations presented here remain consistent with current dietary guidelines.

Results

As presented in Table 1, participants ranged in age from 28 to 78 years, 64% were men, and 57% were black, with a mean (SD) ejection fraction of 27.1% (13.7%). Most patients completed a minimum of high school, with about half also completing some college or graduate school. Although 117 participants completed the study, this analysis was limited to 114 because 3 subjects were excluded because of reported consumption of less than 500 kcal and incomplete food records.

Dietary sodium ingestion ranged from 522 to 9251 mg/d (mean [SD], 2671 [1432] mg/d), with 38 (33.3%) consuming the recommended 2000 mg or less per day. The only significant differences seen between the groups were that subjects with sodium levels greater than 2000 mg constituted a higher percentage of men ($\chi^2 = 6.875$, $df = 1$, $P = .009$), fewer Hispanics

(Fisher exact test, $P = .042$), and a higher percentage of subjects with more than 5 years of HF ($\chi^2 = 4.236$, $df = 1$, $P = .040$).

Frequently consumed high-sodium foods as listed on Table 2 included fast-food sandwiches, luncheon meat, salad dressing, processed entrees, corn products such as grits and cornbread, pork sausage, bread, and pizza. Caloric intake ranged from 688 to 4207 kcal/d (mean [SD], 1674 [636] kcal/d). Participants ate 99% of the recommended amount of protein, 63% of the recommended carbohydrates, and 89% of recommended total fat (Table 3). After adjusting for BMI, participants eating 2000 mg or less of sodium also consumed significantly less calories, less protein, less recommended amounts of carbohydrates, and less fat, but not fiber, than those consuming greater than 2000 mg of sodium.

Analyses of the 3-day food record was undertaken evaluating each patient for the percentage consumed of each of the major food groups as recommended according to the MyPyramid Dietary Guidelines for Americans of 2005.⁶⁰ As reflected in Table 4, after adjusting for BMI, participants met the recommended RDA only of meat and beans while ingesting an average 73% of grains, half of RDA for vegetables and fruit, and only a quarter of the RDA for milk and dairy products. When analyzed by amount of sodium ingestion, persons ingesting less than 2000 mg of sodium per day ate significantly less grains and meat and beans, whereas no significant differences were found in ingestion of vegetables, fruits, or milk. These differences may be important in that persons eating the recommended 2000 mg or less of sodium consumed less high-sodium foods of prepared grains (bread products) and meats or beans that are often processed or prepared with added salt such as found in canned beans and prepared soups.

In analyzing the micronutrients, participants were evaluated based upon raw nutrient data and calculated percentage intake according to RDA based upon participant age and gender. As provided in Table 5, after adjusting for gender, the entire group of participants failed to ingest greater than 50% of the RDA for vitamin D, vitamin E, magnesium, and potassium, likely a reflection of the low consumption of vegetables, fruits, and milk. When micronutrients were compared in participants consuming more and less than 2000 mg of sodium, significant differences were found, with those consuming less than 2000 mg of sodium having lower calcium, zinc, and thiamine intake. No other clinical or demographic characteristics were related to lower sodium consumption.

Discussion

Only one-third of participants with HF who had been instructed on a low-sodium diet reported eating the recommended 2000 mg/d or less, indicating the need for further dietary instruction with a particular focus on elimination of high-sodium foods common in this Southern US sample. Although sodium restriction is a key element in dietary advice to persons with HF, this analysis of the typical Southern US diet reveals that persons with HF suffer from poor macronutrient and micronutrient intake as well.

The major sources of sodium intake among the US population are yeast breads, chicken and chicken mixed dishes, pizza, pasta and pasta dishes, cold cuts, condiments, Mexican mixed dishes, sausage, franks, bacon, ribs, regular cheese, grain-based desserts, soups, and beef and beef mixed dishes.⁶¹ Collectively, this group of foods contributes about 56% of the dietary sodium, or nearly 2000 mg per person per day.⁶² In our Southern population, the top 15 highest sodium foods were similar (refer to Table 2); however, these foods reflected the Southern US culture by including many corn and pork products, biscuits, and fried chicken. The Southern US population has a long history of eating what was available and “making do,” often the origin of many traditional Southern dishes today, such as greens. Greens are

tough, and to improve their taste, they are cooked with salted pork for hours; this produces “potlikker,” which is quite high in micronutrients that leach out of the vegetable. This was historically used as a nourishing drink and may still be thought of that way by many with cultural roots in the South.⁶³ Unfortunately, the current Southern US population still has groups experiencing moderate to high levels of poverty, and food insecurity, meaning that their access to adequate food is limited by lack of resources, is still a major concern.⁶⁴ Georgia is ranked third for low food security prevalence and eighth for very low security prevalence.⁶⁴ In many rural communities, there are no grocery stores, only convenience stores that normally do not sell fresh food such as produce and fresh meat. Although some may cultivate gardens, these tend to be small and would not provide 100% of the recommended daily intake. Also well documented, fast-food chain restaurants are well frequented and are the most prevalent source of sodium in this population.⁶⁴

Evaluation of the micronutrient intake reflected the poor intake of cereals, whole grains, fruits, and vegetables that has previously been noted in Table 4. Of note, consumption of most of the micronutrients ranged from less than 20% of the RDA for vitamin D to approximately 50% of the RDA for calcium and magnesium, whereas selenium and thiamin intake met American Dietetic Association guidelines. Zinc consumption may have been higher owing to the regional crop of peanuts. Very likely, the differences noted between persons ingesting greater than 2000 mg of sodium and those with intake of less than 2000 mg are due to caloric differences between groups, specifically attributed to consuming less dairy products and fortified cereals than those eating more than 2000 mg of sodium. Persons with HF who may feel good about achieving the low-sodium diet recommendation may not realize that their adherence is at the cost of missing key micronutrients.

Furthermore, the use of loop diuretics has an enormous impact of micronutrient homeostasis, with calcium, magnesium, selenium, zinc, and thiamine all affected by long-term diuretic use.^{65,66} Given the low dietary intake of calcium, magnesium, and zinc in this population (Table 5), treating patients with HF with a multivitamin, multimineral supplement may improve quality of life and health outcomes.⁶⁷

Limitations

There are few limitations to this study that are common in any study that includes self-reported dietary data. The format of acquiring 3-day food records relies on the participant to accurately record all food and drinks consumed during that period, which may have intended and unintended omissions. Food records could be an unusual representation of diet because participants simplify meals to make for easier recording or underreport because of the concern that study staff will be critical of intake. It is likely, however, that the in-depth review by the research dietitian reduced the impact of this limitation. Finally, the nutrient analysis software used in the study was limited to use of Food Processor SQL, which does not include values for all micronutrients.

Conclusions and Recommendations

Only one-third of participants with HF who have been instructed on a low-sodium diet ate 2000 mg or less, indicating the need for further dietary instruction with a particular focus on elimination of high-sodium foods common to the Southern United States. Patients having difficulty following a low-sodium diet or consuming sufficient calories and nutrients may need to be referred for sessions with a dietitian familiar with cultural and geographic nuances and alternatives. In addition, overall quality of the diet should be emphasized. Because higher sodium intake is associated with higher caloric intake, male gender, and fast-food, specific patient education strategies targeting these factors are warranted.

Alternatively, patients doing well consuming low-sodium foods may need to be assisted with choosing more nutrient-rich foods.

A targeted intervention in this population should not only investigate a healthy diet but also suggest ways to “make do” with what is available by altering seasonings as well as reducing portions or frequencies of typical higher sodium foods. Interventions should include an in-depth approach to overall diet quality and repetition. Reading food labels to find the lowest sodium products available is standard. Providing suggestions for community gardens or farmer’s markets in the area and more comprehensive nutrition education that includes cooking demonstrations could be innovative approaches to test. Although many patients receive some education on lowering sodium, many do not know how to cook,⁶⁸ often resorting to use of processed food products, or, as is the case often in the Southern United States, many do not know about alternatives to cooking without adding salt. Cooking demonstrations designed to not only demonstrate low-sodium, low-cost healthy recipe but also teach cooking techniques that will lower fat and sodium intake in this population may be of benefit.

Sodium restriction has long been the basis for lifestyle intervention in patients with HF. For decades, patients have been asked to lower their sodium by reducing the amount of salt they add to food.⁶⁹ In recent years, a shift to label reading and examining the amount of sodium found in processed foods has been a focus to reduce dietary sodium. In April 2010, the Institute of Medicine released a report targeting food manufacturers to reduce sodium in products and asked for federal regulation from the US Food and Drug Administration to change policies surrounding a safe amount of sodium and to begin a stepwise reduction.⁷⁰ This same discussion was held during the 2010 Dietary Guidelines Committee, and the new recommendation for sodium intake of 1500 mg/d for African Americans, people older than 50 years, and those with cardiac disease has been estimated to apply to nearly 50% of the US population, including children and most adults.⁶

Although acknowledging that this recommendation for such a low amount of sodium will be challenging to meet, the recommendations made by nurses, dietitians, and physicians should stay relatively the same: eat fresh produce, meats, and whole grains; continue to read nutrition facts labels; choose foods that are low in sodium per serving; dine out less; and cook at home more using minimally processed foods. More specific changes that the Southern US population could make include switching from canned vegetables to fresh or frozen without sauces and cooking vegetables such as greens without the salted pork by substituting with smoked turkey. Additional healthy substitution suggestions could include choosing baked potato instead of eating potato salad or fried potatoes; this would cut down the total fat intake. A sweet potato would be even more nutritious, providing a lower glycemic index, greater soluble fiber, and greater beta-carotene content. Patients could replace pork sausages and other pork products with those made from turkey breast, which would also cut total fat intake. They could also replace convenience foods with their more simple counterparts; for example, instead of choosing a prepackaged rice bowl, cook plain brown or white rice and season using pepper and lemon or perhaps herbs from a windowsill herb garden, which would decrease sodium intake considerably. Finally, emphasize label reading and perusing the food aisles for lower sodium replacement foods for typically high-sodium culprits.

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What's New and Important

- Only one-third of participants with heart failure (HF) who have been instructed on a low-sodium diet ate 2000 mg or less, indicating the need for further dietary instruction with a particular focus on elimination of high-sodium foods common to the Southern United States.
- Although sodium restriction is a key element in dietary advice to persons with HF, this analysis of the typical Southern US diet reveals that persons with HF suffer from poor macronutrient and micronutrient intake as well.
- Persons ingesting less than 2000 mg of sodium ate significantly less amounts of calories, protein, carbohydrates, fat, grains, milk products, meat and beans, calcium, zinc, selenium, and thiamine than did persons ingesting greater than 2000 mg of sodium.

TABLE 1

Demographics and Clinical Characteristics of the Sample

Variable	Overall (n = 114)	Sodium 2000 mg (n = 38)	Sodium >2000 mg (n = 76)
Age			
Mean (SD)	55.90 (10.34)	56.82 (11.96)	55.45 (9.47)
Median	56.0	56.0	56.0
Range	28–78	31–78	28–75
Number of hospitalizations due to HF in the past 6 mo	n = 107	n = 36	n = 71
Mean (SD)	0.94 (2.21)	0.89 (1.79)	0.97 (2.40)
Median	0.00	0.00	0.00
Range	0–15	0–10	0–15
Number of emergency visits due to HF in last 6 mo	n = 68	n = 23	n = 45
Mean (SD)	1.09 (1.79)	0.74 (0.86)	1.27 (2.10)
Median	1.00	1.00	1.00
Range	0–12	0–3	0–12
Variable, n (%)			
Men ^a	73 (64.0)	18 (47.4)	55 (72.4)
Married/domestic partner	67 (58.8)	25 (65.8)	42 (55.3)
Living alone	25 (21.9)	5 (13.2)	20 (26.3)
Race			
African American	65 (57.0)	21 (55.3)	44 (57.9)
White	49 (43.0)	17 (44.7)	32 (42.1)
Hispanic ^b	5 (4.4)	4 (10.5)	1 (1.3)
Highest education completed			
Tech/vocational school, high school, or less	59 (51.8)	15 (39.5)	44 (57.9)
College or postgraduate	55 (48.2)	23 (60.5)	32 (42.1)
Income	n = 109	n = 35	n = 74
<\$10 000	23 (21.1)	5 (14.3)	18 (24.3)
\$10 000–<\$15 000	16 (14.7)	5 (14.3)	11 (14.9)
\$15 000–<\$20 000	7 (6.4)	3 (8.6)	4 (5.4)
\$20 000–<\$25 000	7 (6.4)	1 (2.9)	6 (8.1)
\$25 000–<\$35 000	8 (7.3)	1 (2.9)	7 (9.5)
\$35 000–<\$50 000	11 (10.1)	5 (14.3)	6 (8.1)
\$50 000–<\$75 000	11 (10.1)	6 (17.1)	5 (6.8)
\$75 000	7 (6.4)	2 (5.7)	5 (6.8)
Don't know	9 (8.3)	4 (11.4)	5 (6.8)
Refused	10 (9.2)	3 (8.6)	7 (9.5)
Work status	n = 112	n = 37	n = 75
Full-time	11 (9.8)	3 (8.1)	8 (10.7)
Part-time or homemaker	11 (9.8)	6 (16.2)	5 (6.7)
Retired	27 (24.1)	7 (18.9)	20 (26.7)
Medical leave/disability	48 (42.9)	13 (35.1)	35 (46.7)

Variable	Overall (n = 114)	Sodium 2000 mg (n = 38)	Sodium >2000 mg (n = 76)
Not working but not retired	15 (13.4)	8 (21.6)	7 (9.3)
Length of time diagnosed with HF ^c	n = 113	n = 38	n = 75
0–6 mo	8 (7.1)	6 (15.8)	2 (2.7)
7 mo to 1.5 y	15 (13.3)	5 (13.2)	10 (13.3)
1.5–2 y	9 (8.0)	3 (7.9)	6 (8.0)
2–4 y	24 (21.2)	10 (26.3)	14 (18.7)
>5 y	57 (50.4)	14 (36.8)	43 (57.3)
Type of HF	n = 104	n = 33	n = 71
Systolic	54 (51.9)	16 (48.5)	38 (53.5)
Diastolic	18 (17.3)	8 (24.2)	10 (14.1)
Mixed	32 (30.8)	9 (27.3)	23 (32.4)
NYHA classification			
II	82 (71.9)	31 (81.6)	51 (67.1)
III	32 (28.1)	7 (18.4)	25 (32.9)

Abbreviations: HF, heart failure; NYHA, New York Heart Association.

^aMore men were in the sodium >2000 mg group ($\chi^2 = 6.875$, $df = 1$, $P = .009$).

^bMore Hispanics were in the sodium 2000 mg group (Fisher exact test, $P = .042$).

^cHigher percentage of length of time diagnosed with HF >5 years in the sodium >2000 mg group ($\chi^2 = 4.236$, $df = 1$, $P = .040$).

TABLE 2

Frequently Consumed High-Sodium Foods (N =114)

Food Type	n ^a	Sodium per Serving, mg ^b
Fast-food sandwiches	50	1115
Luncheon meat	29	865
Salad dressing	25	726
Corn products (grits, cornbread)	25	891
Processed entrees (boxed/frozen)	23	1197
Pork product excluding sausage	20	1068
Sausage, any kind	19	1068
Rice and processed rice products	19	1134
Sliced bread	17	714
Pizza, any kind	17	1461
Canned soup	16	1223
Hot dogs, any kind	16	1001
Biscuits	15	961
Fried chicken	15	1153
Canned beans	13	1365

^aNumber of times the type of food was listed in the food records.

^bMean milligrams of sodium for the types of foods listed.

TABLE 3

Comparison of Low- and High-Sodium-Intake Groups on Percentage of Food Component Intake per Recommended Daily Amount (Multivariate Analysis of Covariance [MANCOVA] Adjusted for Body Mass Index [BMI])

Model Effect	Pillai's Trace		
	$F_{5,107}$	Statistic ^a	P
Covariate: BMI	8.907		<.001
Sodium group (adjusted for BMI)	5.803		<.001
Nutrient ^b	Total (n = 114), Mean (SD)	Sodium 2000 mg (n = 38), Mean (SD)	Sodium >2000 mg (n = 76), Mean (SD)
Calories	71.85 (27.72)	58.80 (22.02)	78.38 (28.09)
Protein, g/d	99.24 (40.80)	84.40 (37.48)	106.66 (40.58)
Carbohydrates, g/d	63.27 (28.23)	55.40 (22.93)	67.21 (29.91)
Fiber, g/d	47.72 (26.65)	44.39 (26.24)	49.53 (26.87)
Fat, g/d	89.24 (44.76)	67.39 (34.46)	100.17 (45.49)
			$F_{1,111}$ Statistic ^a
			21.785
			17.888
			7.290
			2.699
			23.247
			<.001

Abbreviation: ANCOVA, analysis of covariance.

^aThe square-root transforms for every measure were used in the overall MANCOVA as well as for the post hoc ANCOVAs, which were also adjusted for the stated covariate.

^bThe means and standard deviations are reported for the original untransformed and unadjusted measures.

TABLE 4

Comparison of Low- and High-Sodium-Intake Groups on Percentage of Food Group Intake per MyPyramid Recommended Daily Amount (Multivariate Analysis of Covariance [MANCOVA] Adjusted for Body Mass Index [BMI])

Model Effect	Pillai's Trace		
	<i>F</i> _{5,106}	Statistic ^a	<i>P</i>
Covariate: BMI	2.639		.027
Sodium group (adjusted for BMI)	3.707		.004
Nutrient ^b	Total (n = 113), ^c Mean (SD)		
	Sodium	2000 mg (n = 37), Mean (SD)	Sodium >2000 mg (n = 76), Mean (SD)
Grain	73.20 (38.09)	57.95 (30.18)	80.63 (39.48)
Vegetables	50.00 (36.54)	43.62 (30.90)	53.11 (39.80)
Fruits	51.74 (55.05)	46.24 (48.49)	54.42 (58.09)
Milk	24.27 (20.68)	19.35 (15.09)	26.66 (22.62)
Meat and beans	101.12 (52.82)	81.59 (48.37)	110.63 (52.56)
			11.470 .001
			2.239 .137
			0.403 .527
			1.787 .184
			8.792 .004

Abbreviation: ANCOVA, analysis of covariance.

^aThe square-root transforms for every measure were used in the overall MANCOVA as well as for the post hoc ANCOVAs, which were also adjusted for the stated covariate.

^bThe means and standard deviations are reported for the original untransformed and unadjusted measures.

^cOne subject did not have data for his/her food group intake.

TABLE 5

Comparison of Low- and High-Sodium-Intake Groups on Micronutrient Intake Based on Percentage Intake of Recommended Daily Amount per Nutrient (Multivariate Analysis of Covariance [MANCOVA] Adjusted for Gender)

Model Effect	Pillai's Trace				
	<i>F</i> _{8,89} Statistic ^a	<i>P</i>			
Covariate: gender (male = 1, female = 2)	4.547	<.001			
Sodium group (adjusted for gender)	4.432	<.001			
Nutrient ^b	Total (n = 99), ^c Mean (SD)	Sodium 2000 mg (n = 30), Mean (SD)	Sodium >2000 mg (n = 69), Mean (SD)	<i>F</i> _{1,96} Statistic ^a	<i>P</i>
Vitamin D, µg	18.79 (18.13)	15.59 (12.72)	20.18 (19.95)	0.678	.412
Calcium, mg	51.99 (24.52)	39.43 (14.69)	57.45 (25.97)	17.428	<.001
Vitamin E, mg	28.21 (23.90)	24.30 (17.23)	29.91 (26.21)	1.142	.288
Magnesium, mg	47.23 (27.02)	47.25 (32.57)	47.23 (24.49)	0.373	.543
Zinc, mg	69.39 (31.27)	57.19 (29.54)	74.69 (30.70)	10.426	.002
Potassium, mg	38.90 (16.59)	33.99 (12.95)	41.04 (17.60)	2.478	.119
Selenium, µg	111.15 (63.84)	95.44 (46.09)	117.98 (69.37)	1.196	.277
Thiamine (B ₁), mg	103.11 (78.18)	84.82 (53.50)	111.06 (85.89)	3.952	.050

Abbreviation: ANCOVA, analysis of covariance.

^aThe square-root transforms for every measure were used in the overall MANCOVA, as well as for the post hoc ANCOVAs, which were also adjusted for the stated covariate.

^bThe means and standard deviations are reported for the original untransformed and unadjusted measures.

^c14 subjects did not have data on vitamin D and 1 additional subject was missing data on selenium.