SODIUM AND POTASSIUM INTAKES OF THE U.S ADULT POPULATION AGE 18 YEARS AND OLDER: NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY 1999 – 2000 and 2001 – 2002

Jessica L. Cogley DiTommaso

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Committee:

Younghee Kim, Advisor

Nancy Boudreau

Dawn Hentges

ABSTRACT

Dr. Younghee Kim, advisor

High sodium and low potassium intakes have been linked to hypertension. Americans consume higher than recommended amounts of sodium and lower than recommended amounts of potassium. The new dietary reference intake (DRI) values for sodium are 1500 mg/day for men and women ages 19-50 years, 1300 mg/day for men and women ages 50 to 70 years of age, and 1200 mg/day for men and women >70 years of age. The very first DRI for potassium is set at 4700 mg/day of potassium for both men and women >18 years of age.

The data of 6,135 persons aged 18 years and older from NHANES 1999-2000 and 2001-2002 were analyzed in this study to assess sodium and potassium intakes of Americans. The variables were gender, age, ethnicity, annual household income, education level, and body mass index (BMI). The statistical software, SUDAAN was used to control the weights of the samples, and least square of means were calculated to control the confounding factors.

The mean daily sodium intakes (mean ± SEM) for White male, Black male, Mexican male and White female, Black female and Mexican female were 4253±59, 3760±81, 3678±95, 3008±59, 2828±93, 2704±50 mg/day, respectively, and the mean potassium intakes were 3338±51, 2673±56, 3017±67, 2477±50, 2064±55, 2336±45 mg/day, respectively. The percentage of people consuming less than the recommended amount of sodium, 1500 mg/day, for white male, Black male, Mexican male and White female, Black female and Mexican female were 4.9%, 11.3%, 9.6%, 12.4%, 20.4%, 17.8%, respectively, and the percentage of people consuming more than the recommended amount of potassium, 4700 mg/day, were 15.7%, 10.1%, 12.5%, 3.6%, 2.3%, 3.2%, respectively. The intakes of sodium and potassium of Americans were significantly higher and lower than the recommended amounts, and there were significant differences with regard to gender and ethnicity.

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CHAPTER 1: INTRODUCTION

Overview

In a nation so focused on speed and efficiency, convenience has become an important practice in everyday life in the United States. Convenience has especially taken its toll on the nutritional quality of life for Americans. The age of home cooked meals that took hours to prepare from scratch has been replaced by fast food restaurants, soups in a can, instant mashed potatoes, and frozen dinners. These convenience food options are usually calorie dense, high in sodium, and low in potassium. Americans choosing unhealthy nutritional lifestyles increase the risk of chronic illnesses, such as hypertension, cardiovascular disease, stroke, osteoporosis, cancer, diabetes, and renal dysfunction.

The Standing Committee on the Scientific Evaluation of Dietary Reference Intakes (DRI), Food and Nutrition Board of the National Academy of Science, has released new reference values for sodium and potassium. The Sodium DRI has been lowered from 2 g/day to 1.5 g/day for both men and women ages 18-50 years.[1] The potassium DRI of 4.7 g/day for both men and women ages 18+ years is the first established potassium DRI.[2]

Current dietary sodium intakes of Americans exceed dietary recommendations, and potassium intakes are far below the dietary recommendations. In a study by Hajjar et al., using data from the NHANES III survey, daily dietary intake of sodium was reported as high as 3.3 ± 0.02 g/day and daily dietary intake of potassium was low at 2.7 ± 0.01 g/day in relation to the recommended dietary guidelines, which at that time were 2 g/day for sodium and no specific guideline for potassium intake.[3] These values represented that Americans consumed more sodium and less potassium than recommended. High sodium and low potassium intakes are associated with the development of hypertension.

This study was different from previous studies because it focused on the current sodium and potassium consumption of Americans from the recent 1999-2000 and 2001-2002 NHANES data in relation to the newly released DRI's for sodium and potassium.

Statement of the Problem

Americans are consuming consistently high levels of sodium and low levels of potassium and according to literature, these dietary habits are positively correlated with the development of hypertension. Hypertension affects 24 percent of U.S. adults, approximately 43 million. There is a higher prevalence of hypertension in adults 50 years of age and older.[4] Overall, if an individual does not already have hypertension by age 55, there is a 90 percent chance of developing hypertension in one's life time.[1] Lower systolic and diastolic blood pressure was associated with increased daily potassium consumption, and higher systolic blood pressure was associated with higher daily sodium consumption.[5] Currently, there is no data showing sodium and potassium intakes of Americans compared to the new dietary recommendations.

The Dietary Approaches to Stop Hypertension (DASH) found that a combination diet, which consisted of 3 g/day of dietary sodium and 4.7 g/day of dietary potassium in the form of fruits, vegetables, low-fat dairy products, whole grains, lean meats and low sugar items, decreased blood pressure in both hypertensive and non-hypertensive individuals. Systolic and diastolic blood pressure was reduced by 5.5 mm Hg and 3.0 mm Hg when individuals were on the combination diet in relation to the control diet.[6] On the other hand, the DASH study found the control diet, which was what many Americans typically consumed at 3 grams of daily dietary sodium and 1.7 grams of daily dietary potassium, had the least effect on lowering blood pressure in both hypertensive and non-hypertensive individuals.[6]

Significance of the Study

Sodium and potassium intake influences overall health and the development of chronic illness, namely hypertension. Various factors, such as age, gender, ethnicity, body mass index, and dietary intake influence sodium and potassium intakes. Due to the high prevalence of hypertension in the U.S. population, the new DRI's recommend decreasing sodium and increasing potassium intakes. Since the release of the new DRI's for sodium and potassium, sodium and potassium intakes of Americans have not been evaluated. The evaluation of sodium and potassium intakes of Americans in relation to the new DRI's will reveal the disparities within the population.

Objectives of the Study

The purpose of this study was to determine the mean sodium and potassium intakes of the U.S. adult population, 18 years of age and older based on the National Health and Nutrition Examination Survey (NHANES) 1999 – 2000 and 2001 – 2002.

The objectives of the study were:

1. To determine the mean sodium and potassium intakes in different age (18-29, 30-39, 40-49, 50-59, 60-69, 70+ years), gender, and race/ethnicity groups (White, Black, Mexican American).
2. To determine the percentage of the population consuming greater than the DRI for sodium and less than the DRI for potassium among different age (18-29, 30-39, 40-49, 50-59, 60-69, 70+ years), gender, and racial/ethnicity groups (White, Black, Mexican American).
3. To determine the mean sodium and potassium intakes in different Body Mass Index groups (<18 kg/m^2, ≥18 - <25 kg/m^2, ≥25 – <30 kg/m^2, ≥30 kg/m^2).

CHAPTER II: REVIEW OF THE LITERATURE

Sodium, Potassium and Hypertension

Hypertension is defined as a systolic blood pressure greater than or equal to 140 mm Hg or a diastolic blood pressure greater than or equal to 90 mm Hg.[2,7] Approximately 2/3 of the U.S. population over the age of 65 has hypertension; however, it is a health condition that almost everyone "will have at some point in their lives."[7] Prolonged hypertension poses a higher risk for stroke, cardiovascular disease, diabetes, and renal disease.[2,7,8] Excess weight, insufficient potassium intake, excessive alcohol consumption, suboptimal dietary patterns, and physical inactivity can influence blood pressure.

Increased sodium chloride intake is associated with elevated blood pressure. Individuals, who already have hypertension, diabetes, and chronic kidney disease, along with older persons and Black Americans, tend to be more sensitive to the effects of sodium chloride on blood pressure.[9-14] Individuals with the greatest reductions in blood pressure in response to reduced sodium intake are considered "salt sensitive," and those with little or no reduction in blood pressure are considered "salt resistant."[2] Salt sensitivity is most frequently seen in non-hypertensive Black individuals than non-hypertensive White individuals.[9,-11]

Dietary potassium intake strongly influences the incidence of salt sensitivity as seen in a metabolic study conducted by Schmidlin et al.[9,12,13] A basal diet was given to 24 African American and 14 Caucasian non-hypertensive men, which included 1.2 g/day of potassium and 0.7 g/day of sodium. Before potassium supplementation, 79 percent of the Black men and 26 percent of the White men were considered salt sensitive. After increasing the dietary potassium intake from 1.2 g/day to 2.7 g/day, over half of the Black men still remained salt sensitive. However, only one-fifth of the White men were considered salt-sensitive. When dietary potassium intake was increased further to 4.7 g/day, salt sensitivity in Black individuals was reduced to 20 percent. This was also

seen in White salt sensitive participants. To further emphasize the effect of dietary potassium intake on salt sensitivity, another metabolic study of 16 non-hypertensive Black participants reported that a dietary intake of 6.6 g/day of potassium resolved salt sensitivity completely in all of the subjects.[13]

Several trials have found that reducing dietary sodium intake to less than 1.75 g/day is associated with greater overall blood pressure reductions and systolic blood pressure reductions in adults over 40 years of age.[14,15] Evidence from observational studies indicated a significantly positive association between sodium intake and blood pressure from both across-population and within-population studies.[16] Cross-population studies indicated lower blood pressure and hypertension when habitual sodium intake was below 1.2 to 2.3 g/day; however, blood pressure and hypertension increased when habitual intake was higher.[17] The Interstalt Cooperative Research Group conducted a large observational study of 52 populations across 32 countries that measured urinary sodium and blood pressure in 10,079 men and women 20 to 59 years of age.[17] Urinary excretion ranged from 0.0046 g/day to 5.6 g/day and a significant linear relationship was found between urinary sodium excretion and systolic blood pressure.[18] Across the populations in this study, sodium intake was associated with an increase in blood pressure as age increased. Within the populations, the association was even stronger between urinary sodium/potassium ratio and blood pressure.[17] A higher urinary potassium excretion of 2 grams was associated with a 2.5 mm Hg decrease in systolic blood pressure and a 1.5 mm Hg decrease in diastolic blood pressure.[18] Several analyses have found that the potential benefits from “population-wide application of therapies,” like sodium reduction, would have a significant impact in the United States. For example, if the entire population reduced its systolic blood pressure by 3 mm Hg, there would be an 8 percent decrease in stroke mortality and a 5 percent decrease in coronary heart disease mortality.[18] Reducing diastolic blood pressure by 2 mm Hg would decrease the prevalence

of hypertension by 17 percent, reduce the risk of stroke by 15 percent, and reduce the risk of coronary heart disease by 6 percent.[19]

On average, blood pressure increases with elevated sodium intake and reduced potassium intake. Blood pressure is more strongly correlated with the sodium/potassium ratio than either sodium or potassium alone.[18,20] Increased potassium intake has been shown to increase urinary sodium excretion, reducing extracellular volume to equilibrium. This is the important anti-hypertensive component of potassium, especially in hypertensive individuals.[2] So far, all of the available evidence indicates that increased potassium consumption lowers blood pressure levels.[21,22]

Sodium

Sodium is essential to the maintenance of extracellular volume and serum osmolality. Sodium determines the extracellular fluid volume, membrane potential of cells, and active transport of molecules across cell membranes.[23,24] Of the total sodium in the body, 95 percent is found in extracellular fluid compartments, such as plasma, interstitial fluid, and five percent is stored intracellularly in muscle.[25] The human body requires a minimum amount of 0.18 g/day of sodium to replace regular sodium losses.[26]

Dietary Sources of Sodium

Sodium is most commonly consumed as sodium chloride or table salt, which comprises 90 percent of the total sodium intake in the United States.[27,28] Sodium is also found as an ingredient or additive in foods in the form of sodium bicarbonate (baking soda), sodium citrate (antacids), monosodium glutamate (soy sauce), sodium nitrite, sodium acid pyrophosphate, sodium phosphate, sodium carbonate, or sodium benzoate.[2] Approximately 12 percent of sodium is consumed in unprocessed food,[28] such as celery, milk, and shellfish. About 77 percent of the total sodium consumed is found in processed and canned foods, such as luncheon meats, canned

vegetables, processed cheese, potato chips, most baked goods, breakfast cereals, and condiments. The remaining 11 percent of the total sodium consumed is either added during cooking or consumed from tap water, depending on the geographic location in the United States.[29]

In processed foods, sodium chloride, sodium benzoate, and sodium bisulfate increase shelf life, control unwanted bacterial growth, strengthen gluten, and act as leavening agents.[30] The sodium content of commonly consumed foods are shown in Table 1.

Table 1. Equivalent Amounts of Food Items Providing up to 4 grams of Sodium[31]

Foods	Equivalent Amount
Hot Dog	1 small
Lunchmeat	1 slice
Bacon	4 slices
Cooked Pork Sausage	1 ½ ounces
Ham or Corned Beef	1 ½ ounces
Regular Canned Tuna	1 ½ ounces
Cottage Cheese	1 cup
Cheese	2 ounces
Pretzels	20 small
Thin-Crust Cheese Pizza	¼ of 12 inch pie
Regular Canned Vegetables	2 servings (½ cup each)
Dill Pickle	½ large
Potato Chips	1 ounce (approximately 20)
Beef Broth or Vegetarian Vegetable Soup	2/3 cup
Tomato, Chicken Gumbo, Cream of Celery Soup	½ cup
Cream of Mushroom Soup	1/3 cup
Salt	¼ teaspoon
Soy Sauce	¼ teaspoon
Catsup	2 1/3 tablespoons
Mustard, Chili Sauce, Barbecue Sauce	2 tablespoons
Tarter Sauce	4 2/3 tablespoons
French Dressing	2 tablespoons
Olives	4 medium
Sweet Pickle Relish	4 tablespoons

Dietary Reference Intake of Sodium

The 2004 edition of DRI's for sodium recommends that young adults consume 1.5 g/day, men and women 50 through 70 years of age consume 1.3 g/day, and men and women age 71 and older consume 1.2 g/day. Older and elderly adults consume less sodium because their energy intake is lower. A Tolerable Upper Level Intake (UL) has been set at 2.3 grams of sodium per day; however, it is not a recommended to consume more sodium than the DRI recommends as there is no health benefit.[2]

Potassium

Potassium is the major intracellular cation and is required for normal cellular function in the body. Approximately 85 percent of dietary potassium is absorbed in the gastrointestinal tract in healthy individuals,[23] and the majority (77-80 percent) of it is filtered through the kidneys where it is reabsorbed, while a small amount actually reaches the distal tubule in the kidney to be excreted in the urine.[2]

Dietary Sources of Potassium

The richest dietary sources of potassium are leafy green vegetables, fruit from vines, root vegetables, spinach, cantaloupe, brussel sprouts, mushrooms, bananas, oranges, grapefruit, and potatoes.[32,33] In unprocessed foods, such as fruits and vegetables, potassium is in the form of potassium bicarbonate or citrate. In processed foods, potassium is in the form of potassium chloride.[2] For example, one teaspoon of salt substitute currently contains between 440 and 2800 mg of potassium chloride.[32,34,35] The potassium content of commonly consumed foods are shown in Table 2.

Table 2. Potassium Rich Foods [2,31]

Foods (raw)	Potassium (mg)	Serving Size
Spinach	840	1 cup
Brussel Sprouts	250	½ cup
Mushrooms	550	1 cup
Bananas	470	1 medium
Grapefruit	230	½ of large
Oranges	200	1 small
Canteloupe	315	1/6 of large
Potatoes	600	1 with out skin

Dietary Reference Intakes for Potassium

According to the 2004 edition of DRI's, the first DRI of potassium for all adults aged 19 years and older is 4.7 g/day. This intake level, primarily from food, should maintain lower blood pressure and decrease the adverse effects of sodium chloride on blood pressure. A Tolerable Upper Intake Level was not determined because excess potassium is excreted through the urine.[2] Presently, potassium intake in the United States is lower than the DRI with a mean intake of 2.9 to 3.2 g/day for men and 2.1 to 2.3 g/day for women among different age groups.[2]

Sodium, Potassium, Gender and Age

The average sodium consumption for American men ranges from 3.1 to 4.7 g/day and for American women a range from 2.3 to 3.1g/day.[2] In a study conducted by Hajjar et al., using NHANES III data, it was reported that both sodium and potassium consumption were higher in men than in women.[3] Fang et al. reported in their study that the mean potassium intake in men was 2,444.3 mg/day and in women was 1,862.1 mg/day, P <0.001.[36] Fruits and vegetables are rich sources of potassium and Steptoe et al. found that women, age 18-70, consumed an average of 3.58 servings of fruit and vegetables and men in the same age group consumed 3.74 servings, indicating less potassium intake among women than men.[37]

Sodium intake is at its highest in the middle age groups and then decreases as age increases in adults due to decreased energy consumption.[2,38] A six year study conducted by Stables et al., from 1991-1997, found a small increase in fruit and vegetable consumption between younger and older age groups. In the 1991 study, the average daily fruit and vegetable servings reported among the four age groups, 18-34, 35-49, 50-64, and ≥65 years were as follows: 3.47, 3.77, 3.89, and 4.23, respectively. Then in the 1997 study, the average daily fruit and vegetable servings reported among the four age groups, 18-34, 35-49, 50-64, and ≥65 years were as follows: 3.54, 3.73, 3.94, and 4.29, respectively.[39] In a study conducted by Tucker et al., 345 men and 562 women between the ages of 69 and 97 reported the average fruit and vegetable intakes as 4.7 servings per day for men and 5.3 servings per day for women.[40]

Examining sodium and potassium intake through the lifespan is more precise by expressing intake as a ratio; sodium intake (mmol/day) to potassium intake (mmol/day). Children under one year of age have a median sodium/potassium ratio of less than one, and then the ratio rapidly rises to just over 2 for children 4 to 8 years of age. Into adulthood, the ratio remains above two, but then it drops slightly in middle- and older-aged adults.[2]

Sodium, Potassium and Race/Ethnicity

According to Gebers et al., "Culture exerts a major influence on the selection, consumption, and use of the available food supply."[41] African Americans consume more sodium and less potassium than other ethnic groups among Americans.[3] Morris et al. conducted a study with 24 black and 14 white normotensive men to see the effect of salt-sensitivity in relation to dietary potassium intake. The results of the study showed that when potassium was deficient in the diet, salt-sensitivity was observed in the Black men but not the White men.[9] African Americans have the lowest intake of potassium among all ethnicities in America and a high prevalence of

hypertension and salt-sensitivity; therefore, they would significantly benefit from an increased intake of potassium.[2]

In a 1988 study conducted by Gebers et al., 1784 adult Black men and women from Pitt County, North Carolina, ranging in age from 25 to 50 years, were interviewed. The mean sodium intake of the participants was near or above the upper limit of 1100-3300 mg/day recommended by the 1980 Recommended Dietary Allowances. The mean potassium intake was also well below the 1,875-5,625 mg/day recommended by the 1980 Recommended Dietary Allowances. The 25 to 50 year old Black male participants in this study had higher mean sodium intake and lower mean potassium intake than the 25 to 54 year old Black and White men who participated in the NHANES II survey conducted from 1976 to 1980. Sodium intake was higher among the Black female participants, and potassium intake was comparable to that of women in the NHANES II survey.[41]

Dietary Approaches to Stop Hypertension (DASH)

Consuming a healthy diet is an essential key in reducing the risk of developing hypertension in non-hypertensive individuals and in lowering blood pressure in hypertensive individuals.[1,7] The core of the DASH diet is comprised of an abundance of fruit and vegetables. Low-fat dairy products, reduced saturated fat and reduced total fat foods are also emphasized. The diet also includes whole grains, poultry, fish, nuts and low amounts of fat, red meat, sweets, and sugared beverages. This diet is recommended for individuals with hypertension or those at risk for developing hypertension because it is rich in many micronutrients, but specifically rich in potassium, and low in sodium.[7,4] The DASH Diet was derived from two key studies, the DASH and the DASH-Sodium studies.[1]

The DASH study tested nutrients as they occurred together in food.[1] It involved 459 adults (50 percent women, 60 percent Black, and 27 percent hypertensive) with systolic blood pressures

less than 160 mm Hg and diastolic blood pressures less than 80 to 95 mm Hg. The DASH study compared three meal plans, each of which consisted of 3,000 mg/day of sodium, and their effect on blood pressure. The control diet was similar to the nutrients of a typical American diet. The fruit and vegetable diet was similar to the control diet; however, more fruit and vegetable servings were emphasized. The third meal plan was the combination diet, later to be known as the DASH diet. The combination diet emphasized a balance of fruit, vegetables, low-fat dairy products, whole grains, lean meat and reduced sugar intake. The fruit and vegetable and DASH meal plans were found to reduce blood pressure within the first two weeks; however, the DASH meal plan had the greatest effect, specifically on those who already had hypertension.[1,6]

The DASH-Sodium study tested the effect of reduced sodium intake on blood pressure.[1,42] Of the 412 total enrolled participants in the DASH-Sodium study, 40 percent were White, 57 percent were Black, 57 percent were women, and 41 percent were hypertensive.[1,43] Participants were randomly assigned to a 7-day cycle menu of either the DASH Diet or a diet similar to that of the typical diet consumed by many Americans at one of 5 calorie levels; 1,600, 2,100, 2,600, 3,100, and 3,600 kilocalories.[44] In addition, each participant was randomly assigned to one of three controlled sodium diets for a month; a sodium level that reflected the typical intake of a U.S. adult (3,450 mg/day), an intermediate level of sodium, which reflected the UL recommendations of sodium in the U.S. (2,400 mg/day),[45] and a lower level of sodium (1,150 mg/day).[1,43,44] Overall, the DASH-Sodium study found that decreased dietary sodium intake in both meal plans reduced blood pressure; however, decreased sodium intake on the DASH meal plan lowered blood pressure more than the other meal plan. The largest blood pressure reduction was seen in participants who were consuming the DASH diet with 1,150 mg/day of dietary sodium.[1,44] Of all the participants in the DASH-Sodium study, Black individuals were the only participants that had blood pressure reductions which were statistically significant.[4]

NHANES 1999-2000 and 2001-2002

Overview

The National Health Survey Act was passed in 1956, which permitted the development of a survey that would pertain to the physical and mental health of the United States. In response to the act, the National Center for Health Statistics (NCHS), a subsidiary of the U.S. Public Health Service, conducted seven surveys that included an interview and physical examination.[46]

In the 1960's, the first three of the seven surveys were conducted. From 1960 to1962, the National Health and Examination Survey I (NHES I) was conducted, which focused mainly on chronic disease in adults. NHES II occurred from 1963 to 1965 and NHES III from 1966 to 1970, which looked at the growth and development of children.[46] The effect of nutrition on health became a focus in 1970; therefore, the NCHS established the National Nutrition Surveillance System to study the nutritional status of the U.S. population. The National Nutrition Surveillance System was combined with the National Health and Examination Survey to form the National Health and Nutrition Examination Survey (NHANES). Four surveys have been conducted since 1970; NHANES I, NHANES II, the Hispanic Health and Nutrition Examination Survey (HHANES) and NHANES III. These surveys were designed to extensively collect information on a sample of civilian, non-institutionalized individuals two months of age and older regarding demographics, physical and mental health, dietary lifestyle, and laboratory data.[46]

After combining with the Continuing Survey of Food Intakes by Individuals (CSFII), the NHANES survey became a continuous survey in 1999. The data collected from the survey are now released to the public every two years via the worldwide web and are described by the years such as, NHANES 1999-2000, NHANES 2001-2002, NHANES 2003-2004. It is strongly encouraged to combine two or more cycles of the survey so as to increase the sample size, analytic options, and statistical reliability.[47]

Data Collection

The data collection for NHANES 1999-2000 and NHANES 2001-2002 was conducted in the very same way as the previous NHANES studies were obtained. The participants either visited the Mobile Examination Center (MEC) if they were able or were interviewed at home if they were unable to visit the MEC. During the home interviews, trained staff administered standardized questionnaires that included the Household Screener Questionnaire, Family Questionnaire, Household Adult Questionnaire, and the Household Youth Questionnaire. Information regarding socioeconomic characteristics, anthropometric measurements, dietary intakes, reproductive history and sexual behavior, dietary supplement and medication usage, tobacco, alcohol and drug use, physical activity, and medical conditions was collected. In addition to the questionnaires, laboratory data were also collected in the home. Participants were asked to fast for 10-16 hours prior to the morning of the blood draw or six hours prior to a blood draw in the evening. Participants who were able to visit the MEC underwent an extensive medical examination that included urine specimens, blood sample, height, weight, fundus photography, x-rays, electrocardiography, ultrasonography, and allergy and glucose tolerance testing. The MEC Adult Questionnaire, MEC Youth Questionnaire, MEC Proxy Questionnaire, dietary recall, and food frequency questionnaires were administered in addition to the medical exam.[48]

Design

The NHANES 1999-2000 and NHANES 2001-2002 were also designed the same way as the previous NHANES surveys for sampling. The sample design was a stratified, multi-stage, probability-based cluster sample of households throughout the U.S. The first stage consisted of selecting 81 primary sampling units (PSU's), which were mostly individual counties, and 89 NHANES survey sites were established within the PSU's. In the second stage, area sample segments were defined as city or suburban blocks or combinations of blocks. Samples of

households and certain group quarters, such as dormitories, were selected in the third stage. Sub-samples of the households and dormitories were designated for screening in order to obtain the desired number of sample persons and households that are representative of the United States' population. The fourth and final stage consisted of sampling individual persons within the sample households and dormitories. All eligible persons within a household were sub-sampled based on sex, age, and ethnicity. Children age two months to five years; individuals 60 years of age and over, Black individuals, Mexican American individuals, and pregnant women were over-sampled in order to effectively study medical conditions that were prevalent in these groups.[48]

Sample weights were necessary for NHANES 1999-2000 and NHANES 2001-2002 data analysis due to its complex design and over-sampling of specific subpopulations. Sample weights mathematically adjust the over-sampled subgroup proportions to be in alignment with national population estimates. Since participants were not randomly sampled, weighting procedures had to be utilized so that the statistical analysis results were not misinterpreted.[48]

CHAPTER III: METHODS

Subjects

The sample for this study included 6,135 participants 18 years of age and older derived from a sample of 19,759 participants in the NHANES 1999-2000 and NHANES 2001-2002 survey. Participants were excluded from this study if they were pregnant, had congestive heart failure, coronary artery disease, angina/angina pectoris, have or had cancer, a stroke, or a heart attack. The purposes for these exclusions were either that the capacity for effective normal metabolism was impaired in these specific cases or dietary habits had potentially changed. Participants were grouped according to age, gender, ethnicity, and Body Mass Index (BMI).

Within the sample of 6,135 participants, there were 3,099 males, and 3,036 females. The age group of 18-29 years included 1,761 participants, 30-39 years included 1,031 participants, 40-49 years included 1,152 participants; 50-59 years included 745 participants, 60-69 years included 756 participants, and ≥70 years included 690 participants. Among the different race/ethnicity groups, 2,991 participants were classified as Non-Hispanic White; 1,343 as Non-Hispanic Black; and 1,801 participants as Mexican American. The groups according to Body Mass Index (kg/m^2) included 85 participants in the <18 group, 2,114 in the ≥18 - <25 group, 2,095 in the ≥25 - <30 group, and 1,841 participants in the >30 BMI group. This study was approved by the Bowling Green State University Human Subject Review Board and given a project number of H05T094GX4.

Data Collection

The data were obtained from results of the NHANES 1999-2000 and NHANES 2001-2002 survey questionnaires and MEC exams. Information from the questionnaires provided data regarding gender, age, race/ethnicity, pregnancy status, and medical conditions. The MEC examination, which included an adult questionnaire, proxy questionnaire, 24-hour dietary recall and

dietary food frequency, provided information regarding body mass index (BMI) and 24 hour dietary recall.

Design

Factors, such as age, gender, and race/ethnicity that might influence sodium and potassium intake of the study sample from NHANES 1999-2000 and NHANES 2001-2002 were studied. The association between sodium and potassium intake and Body Mass Index was also studied.

Age groups were 18-29 years of age, 30-39 years of age, 40-49 years of age, 50-59 years of age, 60-69 years of age and ≥70 years of age. The race/ethnicity groups included: White, Black, and Mexican American. Body Mass Index (BMI) groups included <18 kg/m^2, ≥18 - <25 kg/m^2, ≥25 - <30 kg/m^2, and ≥30 kg/m^2.

Statistical Methods

The data were analyzed by the Statistical Consulting Center at Bowling Green State University using SUDAAN. This statistical software program specifically analyzes data from complex sampling designs, such as NHANES 1999-2000 and NHANES 2001-2002, which was a stratified multistage probability design.

Analysis of covariance was used to compare the mean sodium intakes among various groups, using age, BMI, household income, and physical activities as the covariates. If differences were found, then Tukey's multiple comparison procedure was used to find where the differences were. Both the analysis of covariance and Tukey's multiple comparison procedure were run using $\alpha = 0.05$.

CHAPTER IV: RESULTS

Mean Daily Sodium Intake of Adult Americans

Gender and Race/Ethnicity

The comparisons of the mean daily sodium intake among gender groups and race/ethnicity groups are shown in Table 3 and Figures 1 and 2. Overall, there were higher levels of mean sodium consumption in the males compared to those of the females across the race/ethnicity groups combined (p = 0.0000) and within each race/ethnicity group. There were also significant differences seen across the race/ethnicity groups for the males (p = 0.0000) and the females (p = .0153). The White males consumed a significantly higher amount of sodium than the Black and Mexican American males. The White females consumed a significantly higher amount of sodium than the Mexican American females.

Table 3. Mean ± SEM Daily Sodium Intake (mg/day) of Adult Americans by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male					
	4150 ± 50	4253 ± 59	3760 ± 82[a]	3678 ± 95[a]	0.0000
n	(3099)	(1505)	(680)	(914)	
Female					
	2958 ± 52	3009 ± 59[a]	2828 ± 93[ab]	2704 ± 50[b]	0.0153
n	(3036)	(1486)	(663)	(887)	
p-value	0.0000	0.0000	0.0000	0.0000	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when α= 0.05.
3. Adjusted by age, BMI, household income, and physical activity.

Age

Overall, the mean daily sodium intake declined as age increased in all of the gender and race/ethnicity groups. Table 4 and Figure 3 show the differences in sodium intake among the

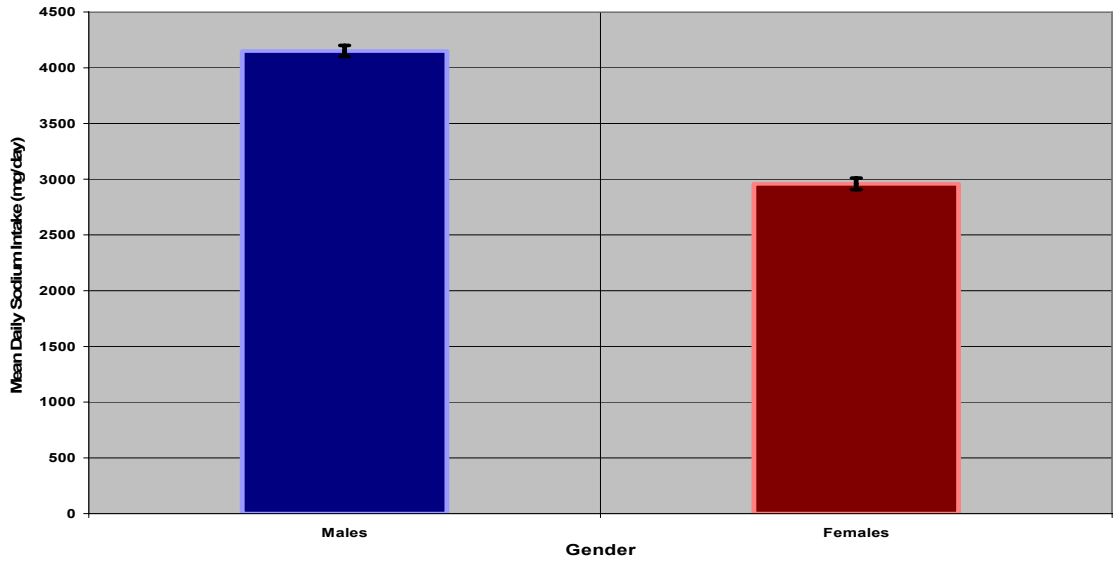

Figure 1. Mean Daily Sodium Intake of Adult Americans by Gender.

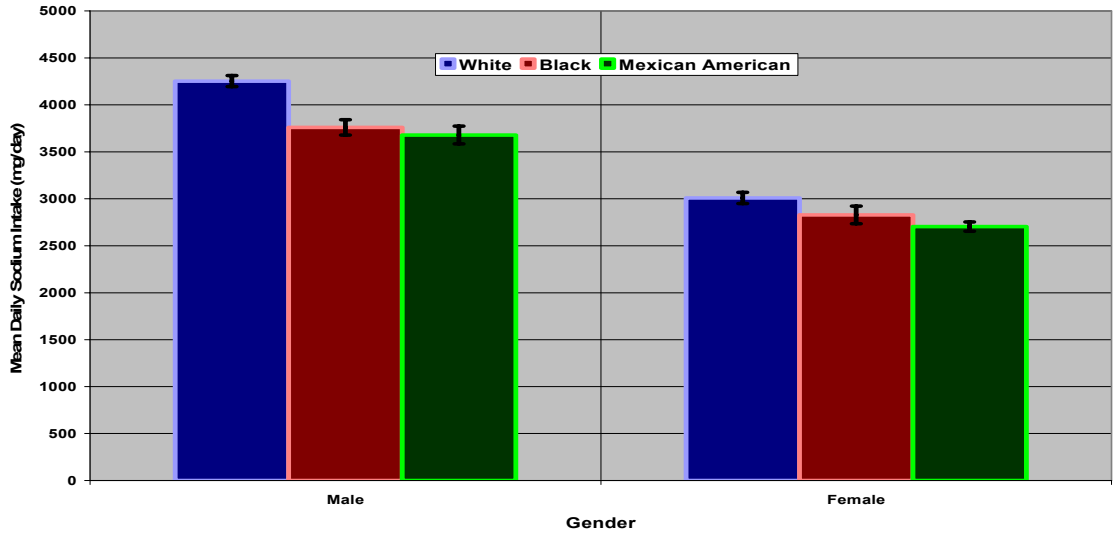

Figure 2. Mean Daily Sodium Intake of Adult Americans by Gender and Race/Ethnicity.

gender and race/ethnicity groups with regard to age. There were significant differences found among all the male age groups (p = 0.0000), as the 18-29 and 30-39 year age groups consumed significantly higher amounts of sodium than the 60-69 and 70+ year age groups. There were significant differences in the mean sodium intakes among the White male age groups (p = 0.0000) as the 18-29, 30-39, 40-49, and 50-59 year age groups consumed significantly higher amounts of sodium than those in the 70+ year age groups. There were also significant differences in the mean

sodium intakes among the Black male age groups (p = 0.0000) as the 30-39 year age group consumed a significantly higher amount of sodium than the 50-59, 60-69, and 70+ year age groups. There were significant differences found in the mean sodium intakes of the Mexican American male age groups (p = 0.0000), as the 18-29, 30-39, 40-49, and 50-59 year age groups consumed significantly higher amounts of sodium compared to the 70+ year age group.

Among all the female age groups, there were significant differences found (p = 0.0002) as the 70+ year age group consumed a significantly lower amount of sodium than the 18-29 and 30-39 year age groups. There were also significant differences found in the mean sodium intakes of the White female age groups (p = 0.0025). The 18-29 year age group consumed a significantly higher amount of sodium than those in the 70+ year age group. There were significant differences found among the Black female age groups (p = 0.0056) in that the 18-29 and 30-39 year age groups consumed significantly higher amounts of sodium than those in the 60-69, and 70+ year age groups. The 70+ year age group consumed the least amount of sodium compared to all the other Black female age groups. There were no significant differences in the mean daily sodium intakes among the Mexican American female age groups (p = 0.1487).

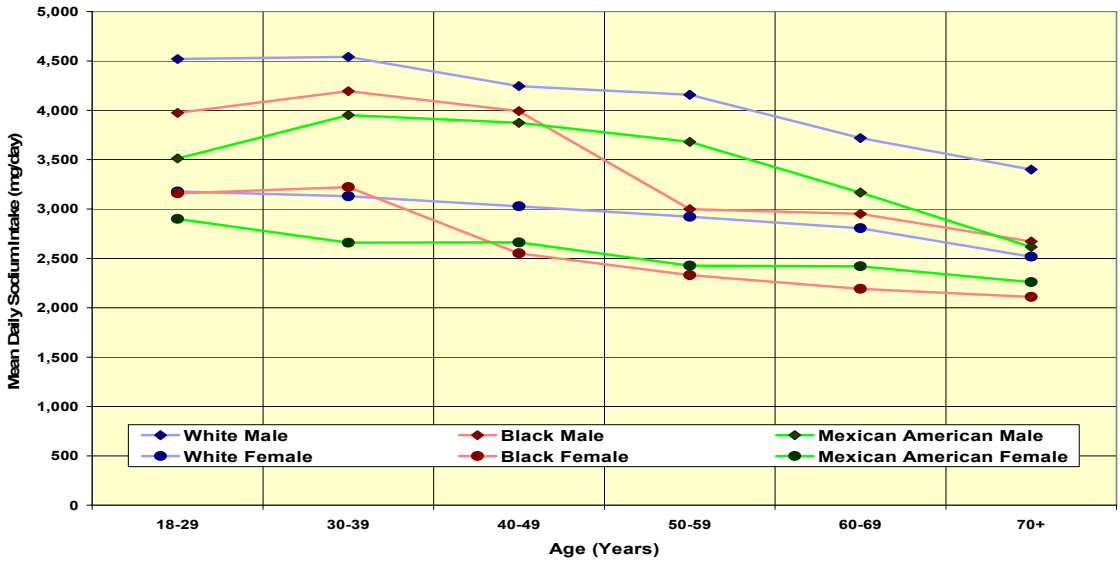

Figure 3. Mean Daily Sodium Intake of Adult Americans by Age, Gender and Race/Ethnicity.

Table 4. Mean ± SEM Daily Sodium Intake (mg/day) of Adult Americans by Age (years), Gender and Race/Ethnicity.[2,3]

Gender	Age	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	18-29	4354 ± 98[a]	4521 ± 130[a]	3974 ± 171[ab]	3513 ± 146[a]
	30-39	4441 ± 107[a]	4541 ± 140[a]	4194 ± 174[a]	3953 ± 151[a]
	40-49	4172 ± 124[ab]	4246 ± 151[a]	3992 ± 173[ab]	3874 ± 212[a]
	50-59	3987 ± 92[ab]	4158 ± 114[a]	2999 ± 204[b]	3681 ± 185[a]
	60-69	3595 ± 162[bc]	3719 ± 188[ab]	2951 ± 203[b]	3167 ± 203[ab]
	70+	3260 ± 97[bc]	3401 ± 105[b]	2672 ± 376[b]	2617 ± 163[b]
p-value		0.0000	0.0000	0.0000	0.0000
Female					
n		(3036)	(1486)	(663)	(887)
	18-29	3163 ± 88[a]	3179 ± 92[a]	3159 ± 200[a]	2900 ± 81[a]
	30-39	3117 ± 97[a]	3131 ± 122[ab]	3222 ± 188[a]	2659 ± 95[a]
	40-49	2939 ± 99[ab]	3029 ± 119[ab]	2552 ± 135[ab]	2663 ± 106[a]
	50-59	2819 ± 84[ab]	2922 ± 94[ab]	2331 ± 143[ab]	2427 ± 186[a]
	60-69	2708 ± 94[ab]	2806 ± 109[ab]	2192 ± 115[b]	2421 ± 145[a]
	70+	2457 ± 99[b]	2518 ± 124[b]	2110 ± 168[c]	2261 ± 191[a]
p-value		0.0002	0.0025	0.0056	0.1487

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by BMI, household income, and physical activity.

Body Mass Index

The analysis of covariance indicated that there were significant differences in the mean sodium consumption of the four BMI groups for the males overall ($p = 0.0434$), the White males ($p = 0.0245$), and the Black females ($p = 0.0343$). When Tukey's multiple comparison procedure was

run to find the significant differences in the above groups, no significant differences were found in any of the three groups. This was due to the very large standard error of the mean and small sample size for the BMI group, <18 kg/m^2. Figure 4 and Table 5 show the results of the mean daily sodium intakes of the gender and race/ethnicity groups with regard to BMI.

Table 5. Mean ±SEM Daily Sodium Intake (mg/day) of Adult Americans by Body Mass Index (kg/m^2), Gender and Race/Ethnicity.[2,3]

Gender	BMI	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	<18	4834 ± 626[a]	5297 ± 788[a]	3075 ± 472[a]	2895 ± 666[a]
	≥18 - <25	4114 ± 82[a]	4199 ± 106[a]	3802 ± 153[a]	3831 ± 132[a]
	≥25 - <30	4041 ± 82[a]	4130 ± 90[a]	3757 ± 209[a]	3610 ± 139[a]
	≥30	4402 ± 99[a]	4560 ± 117[a]	3885 ± 166[a]	3623 ± 157[a]
p-value		0.0434	0.0245	0.4432	0.3547
Female					
n		(3036)	(1486)	(663)	(887)
	<18	2975 ± 197[a]	3043 ± 224[a]	2403 ± 404[a]	3722 ± 810[a]
	≥18 - <25	2866 ± 48[a]	2867 ± 54[a]	3029 ± 143[a]	2774 ± 111[a]
	≥25 - <30	2960 ± 89[a]	3002 ± 101[a]	2898 ± 190[a]	2631 ± 87[a]
	≥30	3008 ± 83[a]	3129 ± 98[a]	2625 ± 76[a]	2674 ± 104[a]
p-value		0.4219	0.1176	0.0343	0.5902

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, household income, and physical activity.

Mean Daily Sodium Intake per 1000 Kilocalories of Adult Americans

Gender and Race/Ethnicity

Although not statistically significant, the females had a higher mean daily sodium intake per 1000 kilocalories than the males. Table 6 and Figures 5 and 6 show the comparisons of the mean daily sodium intake per 1000 kilocalories among the gender and race/ethnicity groups.

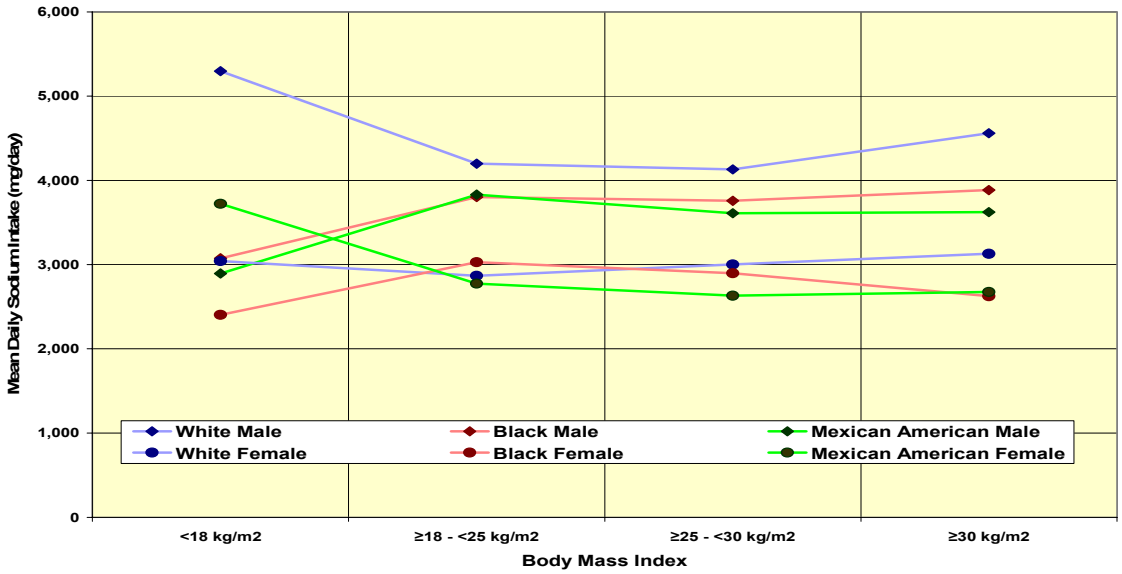

Figure 4. Mean Daily Sodium Intake of Adult Americans by Body Mass Index, Gender and Race/Ethnicity.

There were no significant differences in the mean daily sodium intake per 1000 kilocalories between the males and females overall (p = 0.1779). There were also no significant differences in the mean daily sodium intake per 1000 kilocalories across the male race/ethnicity groups (p = 0.2180); however, there was a significant (p = 0.0483) difference among the female race/ethnicity groups in which the White females consumed a significantly higher amount of sodium per 1000 kilocalories than the Mexican American females.

Table 6. Mean ± SEM Daily Sodium Intake per 1000 Kilocalories (g/1000 kcal) of Adult Americans by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male					
	1.56 ± 0.01	1.58 ± 0.02[a]	1.52 ± 0.02[a]	1.46 ± 0.03[a]	0.2180
n	(3099)	(1505)	(680)	(914)	
Female					
	1.59 ± 0.02	1.62 ± 0.02[a]	1.52 ±0.03[ab]	1.51 ± 0.02[b]	0.0483
n	(3036)	(1486)	(663)	(887)	
p-value	0.1779	0.1956	0.9854	0.1563	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when α = 0.05.
3. Adjusted by age, BMI, household income, and physical activity.

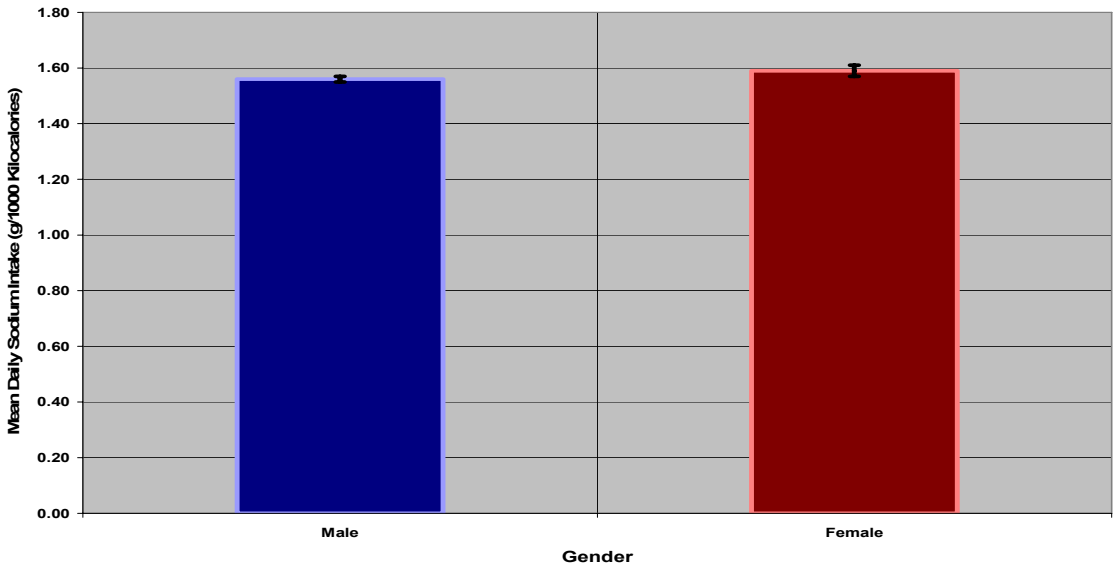

Figure 5. Mean Daily Sodium Intake per 1000 Kilocalories of Adult Americans by Gender.

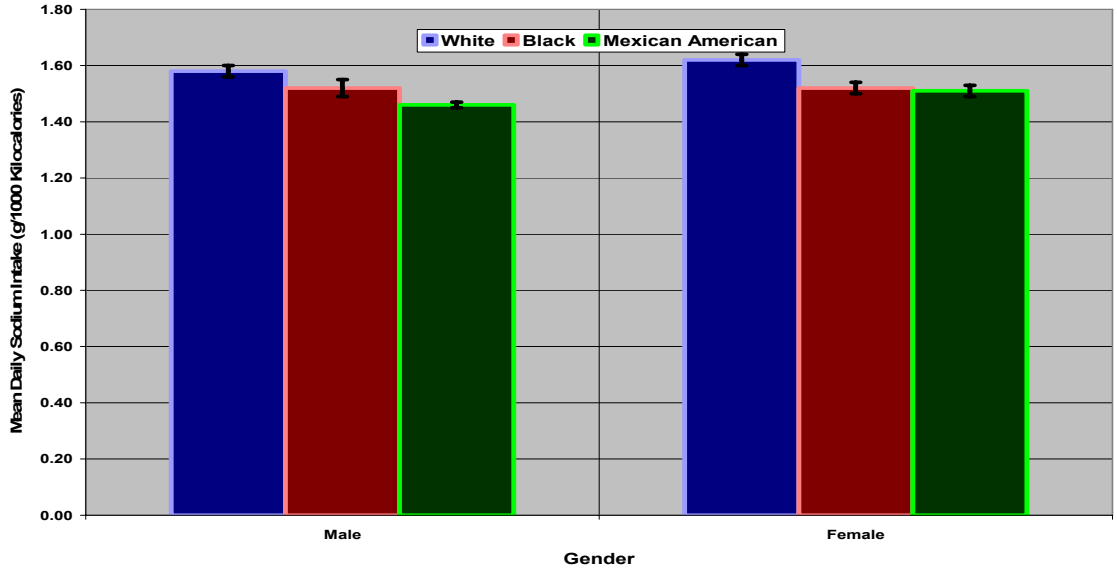

Figure 6. Mean Daily Sodium Intake per 1000 Kilocalories of Adult Americans by Gender and Race/Ethnicity.

Age

Table 7 and Figure 7 show the differences in the mean daily sodium intake per 1000 kilocalories among the gender and race/ethnicity groups with regard to age. The analysis of covariance found significant differences in the mean daily sodium intake per 1000 kilocalories in the males overall (p = 0.0168), the White males (p = 0.0397), and the Black males (p = 0.0362).

Table 7. Mean ± SEM Daily Sodium Intake (grams) per 1000 Kilocalories of Adult Americans by Age (years), Gender and Race/Ethnicity.[2,3]

Gender	Age	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	18-29	1.49 ± 0.03[a]	1.50 ± 0.03[a]	1.50 ± 0.04[a]	1.39 ± 0.04[a]
	30-39	1.57 ± 0.03[ab]	1.59 ± 0.03[a]	1.57 ± 0.05[a]	1.48 ± 0.06[a]
	40-49	1.53 ± 0.03[ab]	1.55 ± 0.04[a]	1.47 ± 0.04[a]	1.51 ± 0.06[a]
	50-59	1.59 ± 0.03[ab]	1.62 ± 0.03[a]	1.39 ± 0.06[a]	1.53 ± 0.08[a]
	60-69	1.66 ± 0.05[ab]	1.68 ± 0.06[a]	1.67 ± 0.07[a]	1.56 ± 0.07[a]
	70+	1.69 ± 0.04[b]	1.71 ± 0.05[a]	1.62 ± 0.15[a]	1.56 ± 0.06[a]
p-value		0.0168	0.0397	0.0362	0.1282
Female					
n		(3036)	(1486)	(663)	(887)
	18-29	1.58 ± 0.03[a]	1.59 ± 0.04[a]	1.53 ± 0.05[a]	1.53 ± 0.03[a]
	30-39	1.60 ± 0.03[a]	1.62 ± 0.04[a]	1.56 ± 0.05[a]	1.46 ± 0.04[a]
	40-49	1.58 ± 0.04[a]	1.61 ± 0.05[a]	1.46 ± 0.06[a]	1.48 ± 0.04[a]
	50-59	1.59 ± 0.0 [a]	1.61 ± 0.04[a]	1.49 ± 0.07[a]	1.52 ± 0.07[a]
	60-69	1.66 ± 0.03[a]	1.67 ± 0.03[a]	1.57 ± 0.07[a]	1.66 ± 0.07[a]
	70+	1.65 ± 0.05[a]	1.66 ± 0.06[a]	1.62 ± 0.07[a]	1.58 ± 0.08[a]
p-value		0.7771	0.8184	0.5964	0.1582

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by BMI, household income, and physical activity.

However, when Tukey's multiple comparison procedure was run to find the significant differences in the above groups, no significant differences were found, except that in the males overall, the 18-29 year age group consumed a significantly lower amount of sodium per 1000 kilocalories than those in the 70+ year age group. This could have been due to the small sample sizes and some large variances. Nevertheless, the trend was that the sodium intake per 1000 kilocalories increased with age. There were no significant differences among age groups within the Mexican American

male group (p = 0.1282). There were also no significant differences in mean sodium intake per 1000 kilocalories among the female age groups.

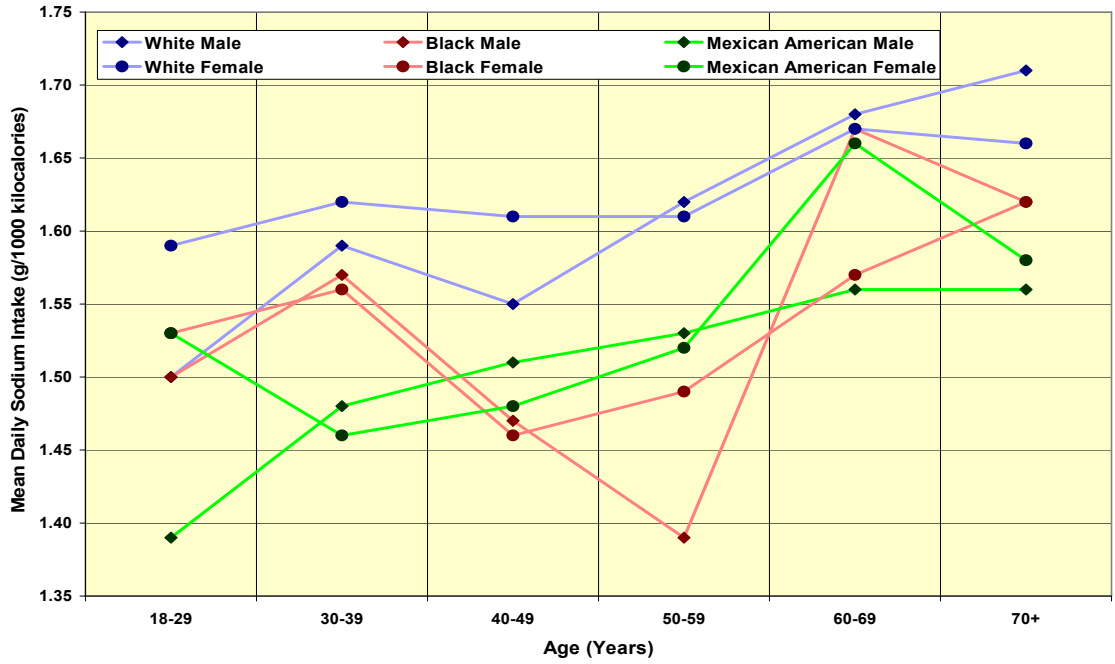

Figure 7. Mean Daily Sodium Intake per 1000 Kilocalories of Adult Americans by Age, Gender and Race/Ethnicity.

Body Mass Index

The analysis of covariance indicated that there were significant differences in the mean sodium intake per 1000 kilocalories among the four BMI groups for the males (p = 0.0038) and females (p = 0.0241) overall, and the White males (p = 0.0068) and White females (p = 0.0131). When Tukey's multiple comparison procedure was run to find the significant differences in the above groups, no significant differences were found in any of the four BMI groups. This was due to the very large standard error of the mean and small sample size for the <18 kg/m^2 BMI group. Figure 8 and Table 8 show the daily sodium intake per 1000 kilocalories in the gender and race/ethnicity groups with regard to BMI.

Table 8. Mean Daily ± SEM Sodium Intake (grams) per 1000 Kilocalories of Adult Americans by Body Mass Index, Gender and Race/Ethnicity.[2,3]

Gender	BMI	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	<18	1.69 ± 0.07[a]	1.76 ± 0.09[a]	1.47 ± 0.12[a]	1.55 ±0.15[a]
	≥18 - <25	1.52 ± 0.02[a]	1.53 ± 0.03[a]	1.49 ± 0.03[a]	1.43 ± 0.03[a]
	≥25 - <30	1.53 ± 0.03[a]	1.55 ± 0.03[a]	1.47 ± 0.04[a]	1.45 ± 0.04[a]
	≥30	1.64 ± 0.02[a]	1.67 ± 0.03[a]	1.60 ± 0.04[a]	1.50 ± 0.05[a]
p-value		0.0038	0.0068	0.1502	0.5826
Female					
n		(3036)	(1486)	(663)	(887)
	<18	1.47 ± 0.07[a]	1.47 ± 0.07[a]	1.71 ± 0.11[a]	1.48 ± 0.24[a]
	≥18 - <25	1.54 ± 0.02[a]	1.54 ± 0.02[a]	1.54 ± 0.06[a]	1.52 ± 0.04[a]
	≥25 - <30	1.64 ± 0.03[a]	1.66 ± 0.03[a]	1.57 ± 0.05[a]	1.52 ±0.03[a]
	≥30	1.64 ± 0.03[a]	1.69 ± 0.04[a]	1.49 ± 0.03[a]	1.51 ± 0.04[a]
p-value		0.0241	0.0131	0.1972	0.9921

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, household income, and physical activity.

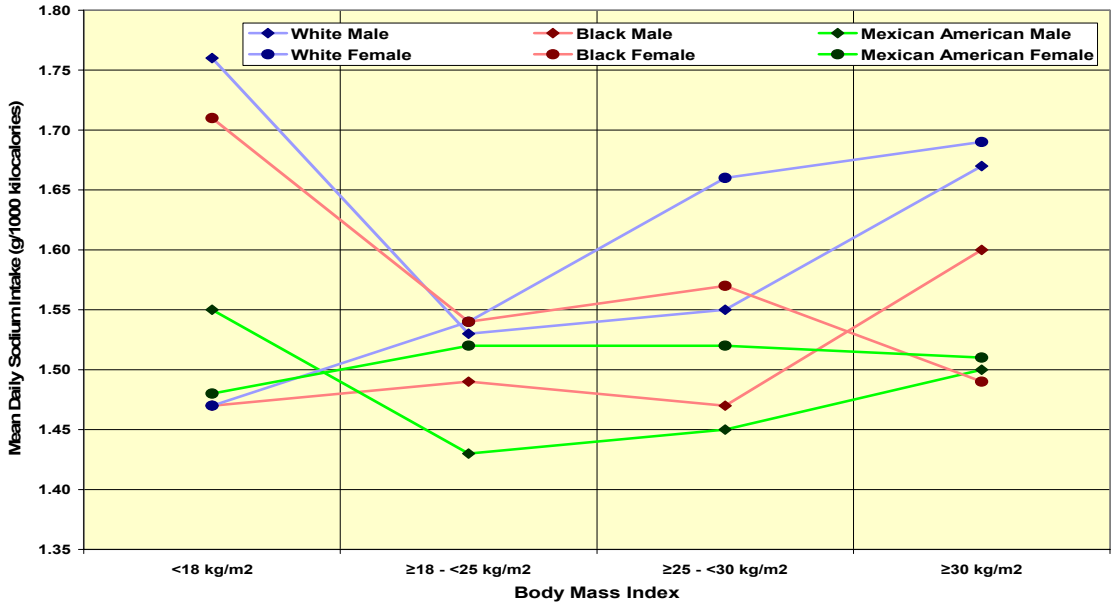

Figure 8. Mean Daily Sodium Intake per 1000 Kilocalories of Adult Americans by Body Mass Index, Gender and Race/Ethnicity.

Percent of Adult Americans Consuming ≤1.5 g/day of Sodium

A Chi-square test for independence was used to find the differences in the percentages of Americans who consumed the recommended ≤1.5 grams of daily dietary sodium. If there were significant differences found, multiple comparison was used to determine the significance of the differences. Overall, there were higher percentages of the females who consumed the recommended daily sodium intake compared to the males across the race/ethnicity groups combined (p = 0.0000) and within each race/ethnicity group (p = 0.0000, p = 0.0002, and p = 0.0005). There were also significant differences seen across the race/ethnicity groups for the males (p = 0.0000) and the females (p = 0.0064). A significantly smaller percentage of the White males consumed the recommended ≤1.5 g/day of sodium compared to the Black and Mexican American males. A smaller percentage of the White females consumed the recommended ≤1.5 g/day of sodium compared to the Black females. Table 9 and Figures 9 and 10 show the comparisons of the percentages of adult Americans who consumed ≤1.5 g/day of sodium among the gender and race/ethnicity groups.

Table 9. Percentage of Adult Americans Consuming ≤1.5 mg/day of Sodium by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male Percent *n*	6.07 ± 0.44 (3099)	4.91 ± 0.46 (1505)	11.29 ± 1.27[a] (680)	9.59 ± 1.17[a] (914)	0.0000
Female Percent *n*	13.77 ± 1.09 (3036)	12.38 ± 1.33[a] (1486)	20.38 ± 1.97[b] (663)	17.78 ± 1.76[ab] (887)	0.0064
p-value	0.0000	0.0000	0.0002	0.0005	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when α = 0.05.
3. Adjusted by age, BMI, household income, and physical activity.

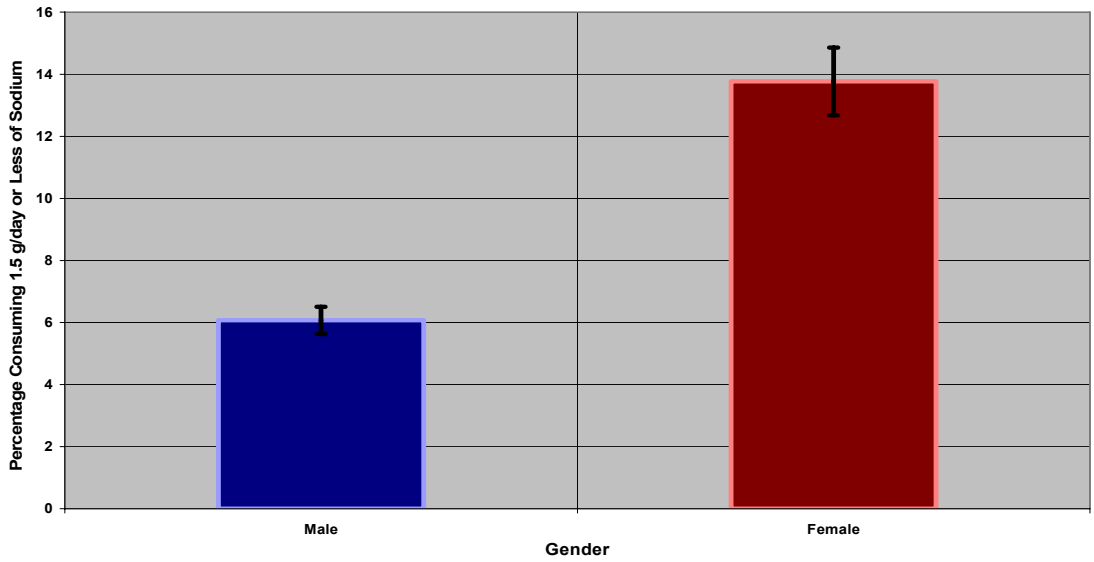

Figure 9. Percentage of Adult Americans Consuming ≤1.5 g/day of Sodium by Gender.

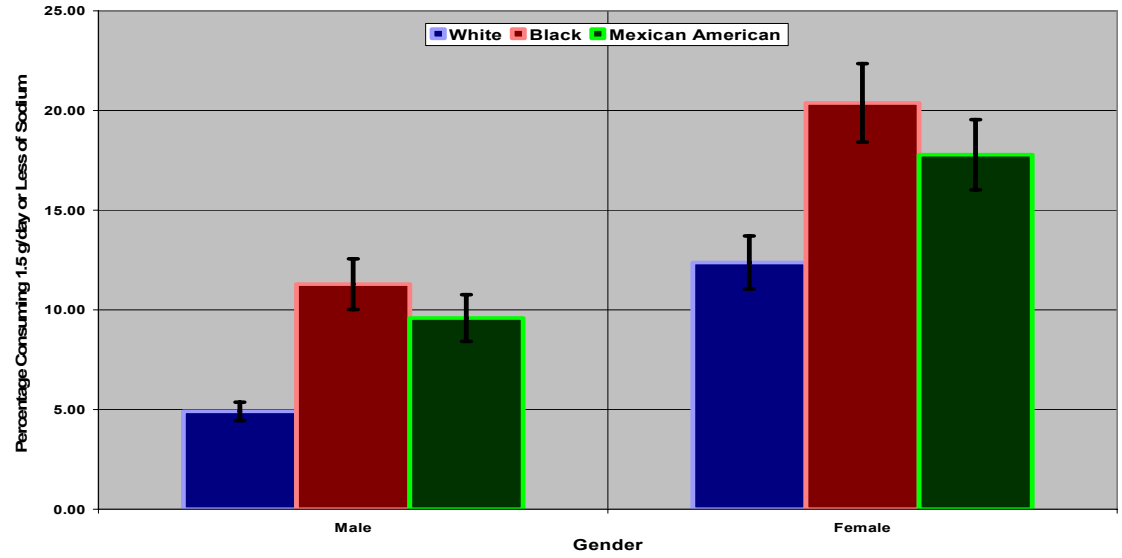

Figure 10. Percentage of Adult Americans Consuming ≤1.5 g/day of Sodium by Gender and Race/Ethnicity.

Mean Daily Potassium Intake of Adult Americans

Gender and Race/Ethnicity

Table 10 and Figures 11 and 12 show the comparisons of the mean daily potassium intakes between the gender groups among the race/ethnicity groups. The analysis of covariance determined that overall, there were significant differences in the mean potassium consumption in

the male race/ethnicity groups (p = 0.0000) and the female race/ethnicity groups (p = 0.0000). When Tukey's multiple comparison procedure was run to find the differences in the above groups, there were significant differences among all of the male race/ethnicity groups, but it was determined that the Black females consumed a significantly lower amount of potassium compared to the White and Mexican American females. In addition, within each race/ethnicity group, the males consumed more potassium than the females.

Table 10. Mean ± SEM Daily Potassium Intake (mg/day) of Adult Americans by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male					
	3233 ± 40	3338 ± 51	2673 ± 56	3018 ± 67	0.0000
n	(3099)	(1505)	(680)	(914)	
Female					
	2416 ± 42	2478 ± 50[a]	2064 ± 55	2336 ± 45[a]	0.0000
n	(3036)	(1486)	(663)	(887)	
p-value	0.0000	0.0000	0.0000	0.0000	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when α = 0.05.
3. Adjusted by age, BMI, household income, and physical activity.

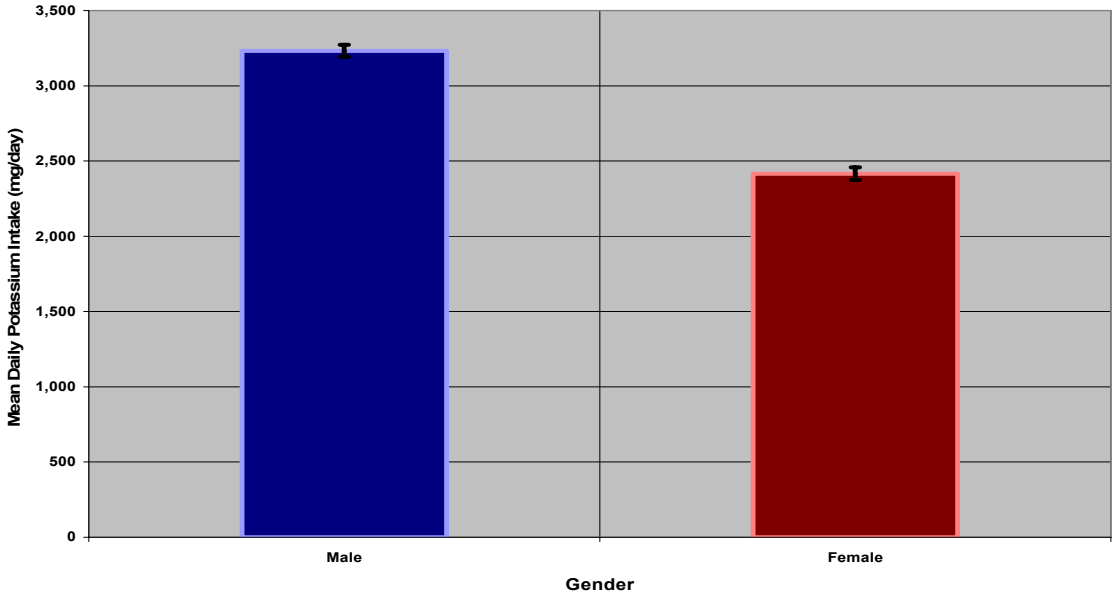

Figure 11. Mean Daily Potassium Intake of Adult Americans by Gender.

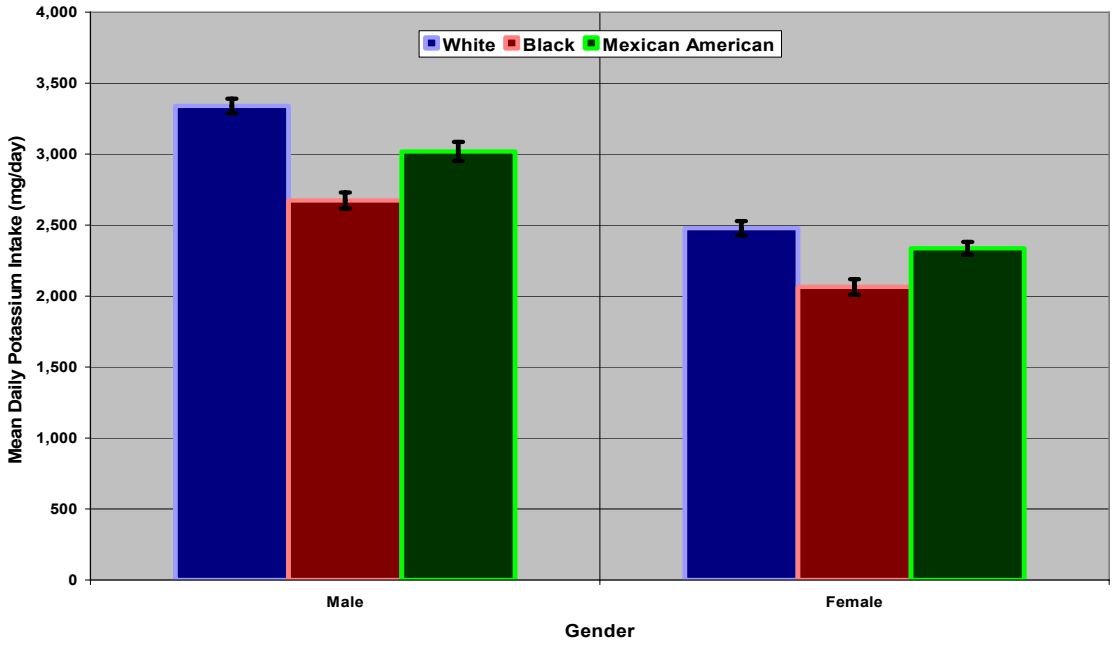

Figure 12. Mean Daily Potassium Intake of Adult Americans by Gender and Race/Ethnicity.

Age

The differences in the mean daily potassium intakes of the gender and race/ethnicity groups with regard to age are shown in Table 11 and Figure 13. The analysis of covariance indicated that there were significant differences in the mean potassium intakes among the six male age groups overall (p = 0.0304), the Black male age groups (p = 0.0427) and the Mexican American male age groups (p = 0.0012). When Tukey's multiple comparison procedure was run to find the significant differences in the above groups, no significant differences were found in any of the six groups. There were no significant differences in the mean daily potassium intakes of the White male group with regard to age.

Among the females, the analysis of covariance indicated there were significant differences in the mean daily potassium intakes among the six female age groups overall (p = 0.0001) and the White female age groups (p = 0.0000). Tukey's multiple comparison procedure determined that, overall, the 18-29 year age group consumed a significantly lower amount of potassium than the 40-

49, 50-59, and 60-69 year age groups. The same results were also true of the White female age groups. There were no significant differences in the mean daily potassium intakes of the Black and Mexican American female groups with regard to age.

Table 11. Mean ± SEM Daily Potassium Intake (mg/day) of Adult Americans by Age (years), Gender and Race/Ethnicity.[2,3]

Gender	Age	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	18-29	3108 ± 80[a]	3219 ± 104[a]	2655 ± 118[a]	2757 ± 102[a]
	30-39	3300 ± 67[a]	3355 ± 74[a]	2971 ± 188[a]	3216 ± 142[a]
	40-49	3345 ± 69[a]	3432 ± 85[a]	2817 ± 145[a]	3272 ± 109[a]
	50-59	3297 ± 91[a]	3429 ± 111[a]	2475 ± 158[a]	3221 ± 131[a]
	60-69	3228 ± 104[a]	3346 ± 126[a]	2414 ± 131[a]	2960 ± 164[a]
	70+	2989 ± 78[a]	3111 ± 92[a]	2290 ± 207[a]	2563 ± 142[a]
p-value		0.0304	0.1477	0.0427	0.0012
Female					
n		(3036)	(1486)	(663)	(887)
	18-29	2121 ± 56[a]	2091 ± 70[a]	2002 ± 102[a]	2314 ± 59[a]
	30-39	2381 ± 67[ab]	2395 ± 80[ab]	2189 ± 108[a]	2392 ± 108[a]
	40-49	2506 ± 64[b]	2610 ± 80[b]	1910 ± 80[a]	2377 ± 99[a]
	50-59	2551 ± 68[b]	2667 ± 72[b]	1898 ± 101[a]	2203 ± 134[a]
	60-69	2637 ± 75[b]	2733 ±87[b]	2095 ± 97[a]	2406 ± 136[a]
	70+	2422 ± 67[ab]	2504 ± 75[ab]	1980 ± 131[a]	2090 ± 180[a]
p-value		0.0001	0.0000	0.3783	0.5486

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by BMI, household income, and physical activity.

Body Mass Index

The analysis of covariance indicated there were significant differences in the mean potassium intake per 1000 kilocalories for the females, overall ($p = 0.0370$). When Tukey's multiple

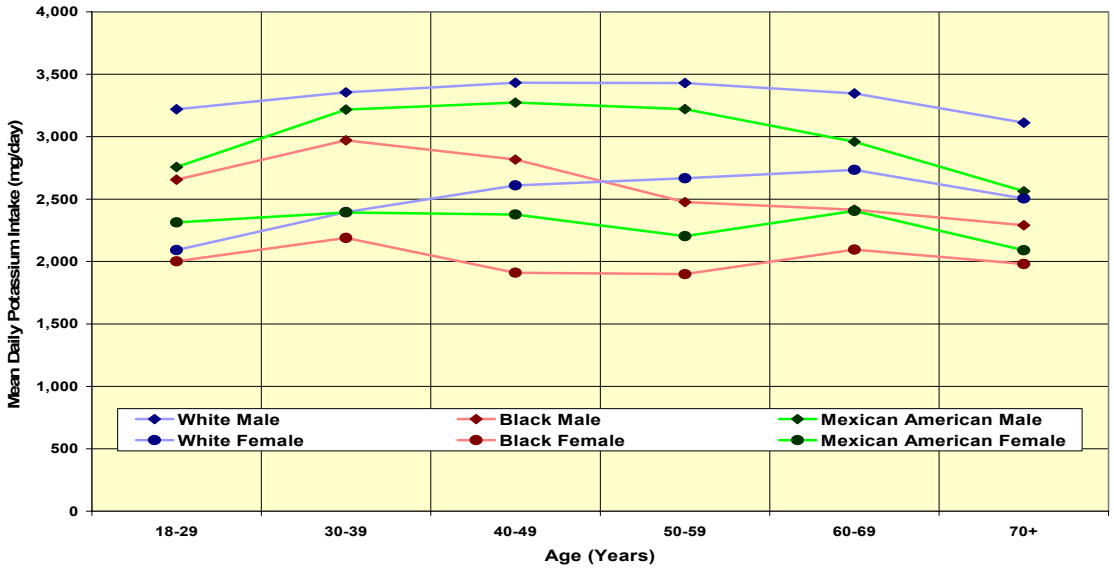

Figure 13. Mean Daily Potassium Intake of Adult Americans by Age, Gender and Race/Ethnicity.

comparison procedure was run to find the significant differences, there were no significant differences found among the female BMI groups overall. This could be due to the very large standard error of the mean and small sample size for the BMI group <18 kg/m^2. Figure 14 and Table 12 show the comparisons of the mean daily potassium intakes of the gender and race/ethnicity groups with regard to BMI.

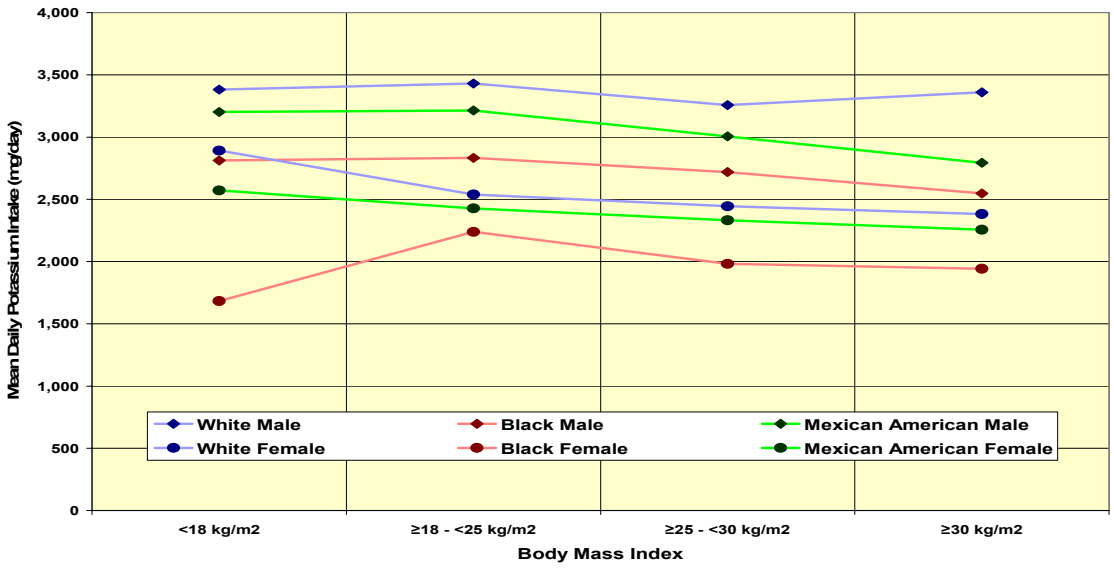

Figure 14. Mean Daily Potassium Intake of Adult Americans by Body Mass Index, Gender and Race/Ethnicity.

Table 12. Mean ± SEM Daily Potassium Intake (mg/day) of Adult Americans by Body Mass Index (kg/m^2), Gender and Race/Ethnicity.[2,3]

Gender	BMI	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	<18	3326 ± 345[a]	3381 ± 418[a]	2812 ± 481[a]	3201 ± 398[a]
	≥18 - <25	3336 ± 73[a]	3430 ± 92[a]	2832 ± 101[a]	3213 ± 126[a]
	≥25 - <30	3173 ± 54[a]	3257 ± 65[a]	2719 ± 115[a]	3004 ± 90[a]
	≥30	3223 ± 78[a]	3359 ± 99[a]	2547 ± 131[a]	2794 ± 82[a]
p-value		0.2962	0.4337	0.4988	0.1322
Female					
n		(3036)	(1486)	(663)	(887)
	<18	2733 ± 186[a]	2892 ± 199[a]	1682 ± 389[a]	2573 ± 385[a]
	≥18 - <25	2495 ± 44[a]	2539 ± 50[a]	2239 ± 119[a]	2428 ± 67[a]
	≥25 - <30	2374 ± 59[a]	2445 ± 72[a]	1981 ± 120[a]	2332 ± 68[a]
	≥30	2317 ± 54[a]	2382 ± 63[a]	1942 ± 55[a]	2256 ± 83[a]
p-value		0.0370	0.1009	0.2390	0.4358

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, household income, and physical activity.

Mean Daily Potassium Intake per 1000 Kilocalories of Adult Americans

Gender and Race/Ethnicity

Overall, the males consumed a lower amount of potassium per 1000 kilocalories than the females across all the gender and race/ethnicity groups except the Black males and females. Table 13 and Figures 15 and 16 show the comparisons of the potassium intakes per 1000 kilocalories between the males and females and between all three race/ethnicity groups. The analysis of covariance for potassium intake per 1000 kilocalories indicated significant differences among the race/ethnicity groups for the males ($p = 0.0000$) and the females ($p = 0.0000$). Using Tukey's multiple comparison procedure, it was found that the Black males consumed a significantly lower amount of

potassium per 1000 kilocalories than the White and Mexican American males. The same results were also true among the female race/ethnicity groups.

Table 13. Mean ± SEM Daily Potassium Intake per 1000 Kilocalories (g/1000 kcal)of Adult Americans by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male					
	1.25 ± 0.01	1.27 ± 0.02[a]	1.12 ± 0.03	1.22 ± 0.01[a]	0.0000
n	(3099)	(1505)	(680)	(914)	
Female					
	1.33 ± 0.01	1.36 ± 0.02[a]	1.14 ± 0.02	1.34 ± 0.02[a]	0.0000
n	(3036)	(1486)	(663)	(887)	
p-value	0.0000	0.0003	0.5433	0.0003	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, BMI, household income, and physical activity.

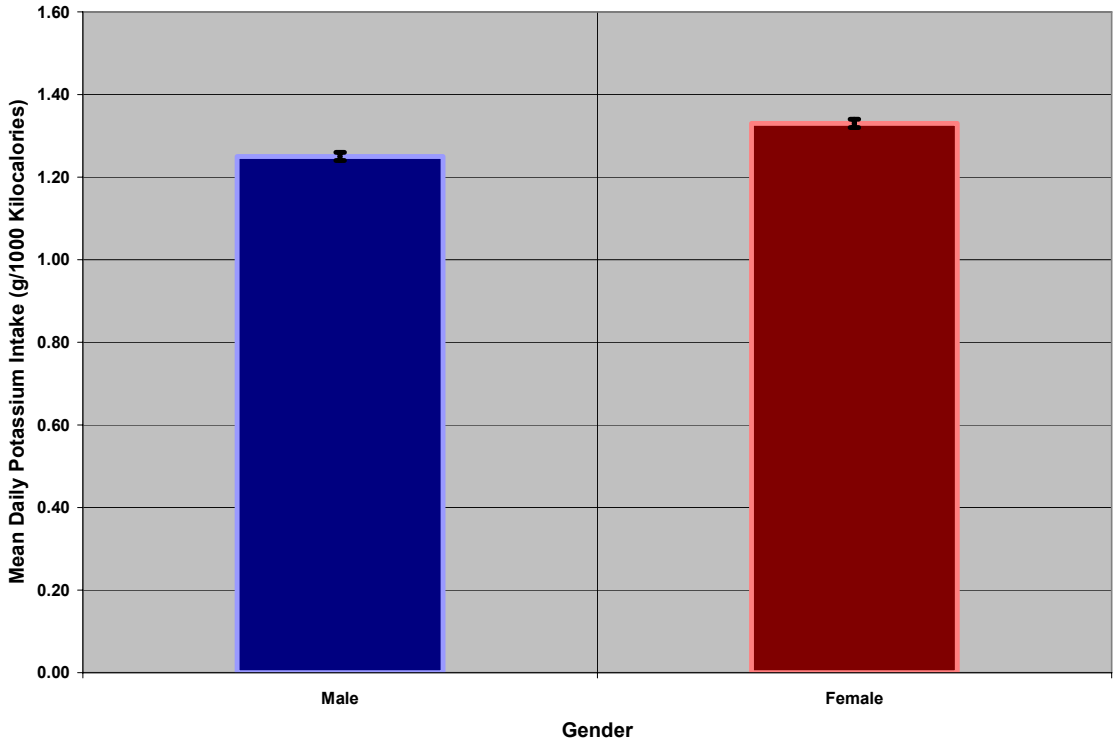

Figure 15. Mean Daily Potassium Intake per 1000 Kilocalories of Adult Americans by Gender.

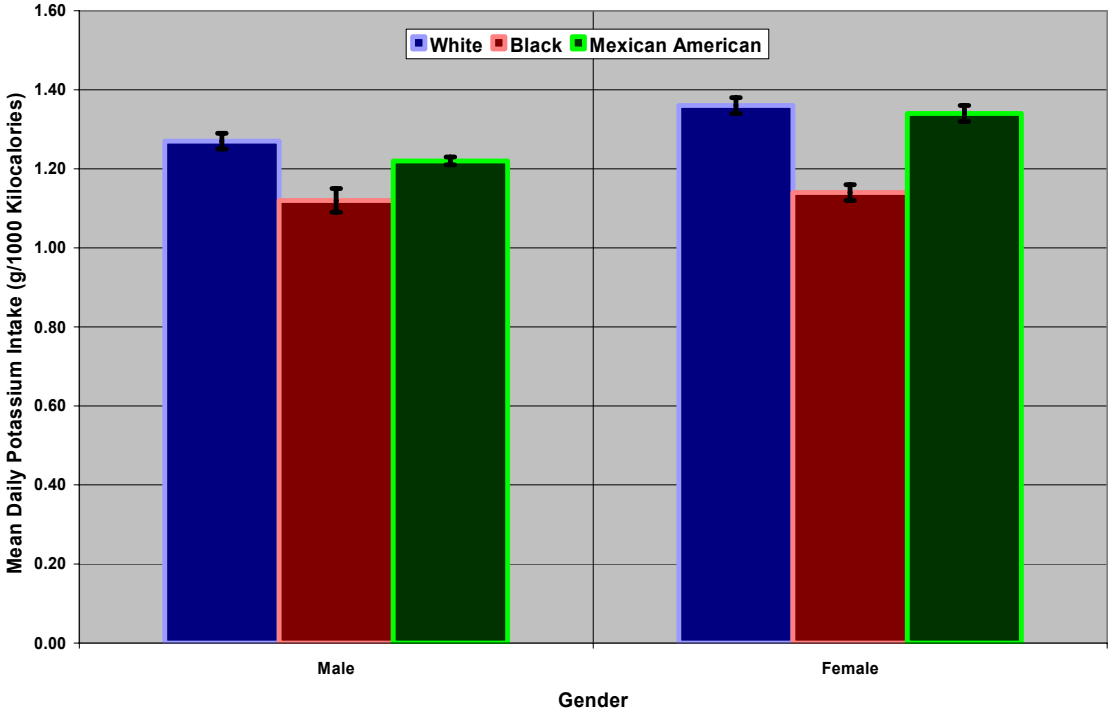

Figure 16. Mean Daily Potassium Intake per 1000 Kilocalories of Adult Americans by Gender and Race/Ethnicity.

Age

Overall, the mean daily intake of potassium per 1000 kilocalories increased as age increased in all the gender and race/ethnicity groups. Table 14 and Figure 17 show the differences in potassium intake per 1000 kilocalories among the gender and race/ethnicity groups with regard to age.

Among all males, there were significant differences found in the potassium intake per 1000 kilocalories (p = 0.0000) as the 18-29 year age group consumed significantly less potassium per 1000 kilocalories than the other age groups. The 50-59 year age group consumed significantly more potassium per 1000 kilocalories than the 18-29 and 30-39 year age groups but less than the 60-69 and 70+ age groups. In addition, the 60-69 and 70+ year age groups consumed significantly higher amounts of potassium per 1000 kilocalories compared to the other age groups. There were significant differences found among the White male age groups (p = 0.0000), as the 18-29 year

age group consumed significantly less potassium per 1000 kilocalories than all the age groups except the 30-39 year age group, and the 60-69 and 70+ year age groups consumed significantly more potassium per 1000 kilocalories than the 18-29, 30-39, and 40-49 year age groups. There were also significant differences indicated among the Black male age groups ($p = 0.0002$) as the 18-29 and 40-49 year age groups consumed significantly less potassium per 1000 kilocalories than those in the 60-69 and 70+ year age groups. There were significant differences found among the Mexican American male age groups ($p = 0.0000$) and the Tukey's multiple comparison procedure confirmed the only significant differences were that the 18-29 year age group consumed significantly more potassium per 1000 kilocalories than all the age groups except the 30-39 year age group.

There were significant differences found among the all female age groups ($p = 0.0000$) as the 18-29 year age group consumed significantly lower amounts of potassium per 1000 kilocalories than the other age groups. The 50-59 year age group consumed a significantly greater amount of potassium per 1000 kilocalories than the 18-29 and 30-39 year age groups. In addition, the 60-69 and 70+ year age groups consumed significantly greater amounts of potassium per 1000 kilocalories than the 18-29, 30-39, and 40-49 year age groups. The very same results were also true for the White female age groups ($p = 0.0000$). There were significant differences indicated among the Black female age groups ($p = 0.0000$) as the 18-29 year age group consumed significantly lower amounts of potassium per 1000 kilocalories than the 50-59, 60-69, and 70+ year age groups. In addition, the 60-69 and 70+ year age groups consumed significantly greater amounts of potassium per 1000 kilocalories than those in the 18-29, 30-39, and 40-49 year age groups. Among the Mexican American female age groups, there were significant differences indicated ($p = 0.0001$) as the 18-29 and 30-39 year age groups consumed significantly lower amounts of potassium per 1000 kilocalories than those in the 60-69 year age group.

Table 14. Mean ± SEM Daily Potassium Intake (grams) per 1000 Kilocalories of Adult Americans by Age (years), Gender and Race/Ethnicity.[2,3]

Gender	Age	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	18-29	1.05 ± 0.02	1.05 ± 0.03[a]	0.98 ± 0.04[a]	1.12 ± 0.03[a]
	30-39	1.18 ± 0.02[a]	1.19 ± 0.02[ab]	1.09 ± 0.06[ab]	1.21 ± 0.05[ab]
	40-49	1.28 ± 0.02[ab]	1.30 ± 0.02[b]	1.08 ± 0.05[a]	1.31 ± 0.03[b]
	50-59	1.33 ± 0.03[b]	1.35 ± 0.04[bc]	1.18 ± 0.04[ab]	1.32 ± 0.05[b]
	60-69	1.53 ± 0.03[c]	1.55 ± 0.04[c]	1.44 ± 0.07[b]	1.41 ± 0.04[b]
	70+	1.61 ± 0.06[c]	1.58 ± 0.04[c]	2.01 ± 0.48[b]	1.54 ± 0.09[b]
p-value		0.0000	0.0000	0.0002	0.0000
Female					
n		(3036)	(1486)	(663)	(887)
	18-29	1.07 ± 0.02	1.05 ± 0.03	0.99 ± 0.03[a]	1.24 ± 0.03[a]
	30-39	1.25 ± 0.03[a]	1.26 ± 0.03[a]	1.08 ± 0.04[ab]	1.35 ± 0.04[a]
	40-49	1.37 ± 0.03[ab]	1.40 ± 0.03[ab]	1.11 ± 0.05[ab]	1.41 ± 0.05[ab]
	50-59	1.46 ± 0.03[bc]	1.50 ± 0.03[bc]	1.23 ± 0.04[bc]	1.41 ± 0.[06ab]
	60-69	1.63 ± 0.03[c]	1.64 ± 0.04[c]	1.53 ± 0.07[c]	1.66 ± 0.05[b]
	70+	1.65 ± 0.04[c]	1.68 ± 0.04[c]	1.49 ± 0.06[c]	1.50 ± 0.08[ab]
p-value		0.0000	0.0000	0.0000	0.0001

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by BMI, household income, and physical activity.

Body Mass Index

The analysis of covariance indicated that there were significant differences in the mean potassium intake per 1000 kilocalories among the four BMI groups for the females overall (p = 0.0374) and the Mexican American females (p = 0.0209). The results are shown in Figure 18 and Table 15. When Tukey's multiple comparison procedure was run to find the significant differences in the above groups, no significant differences were found in the female BMI groups overall.

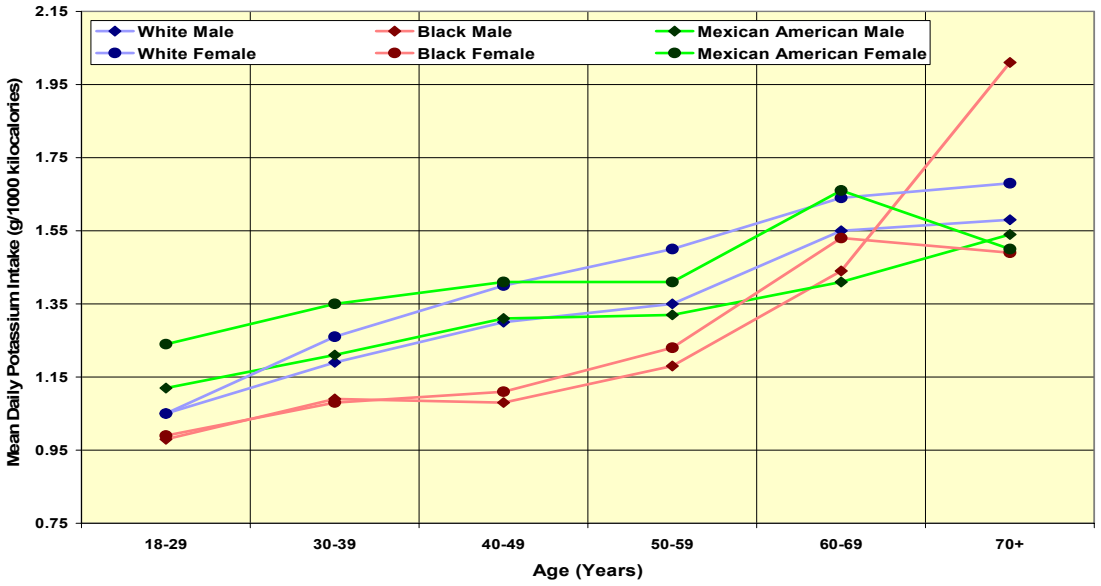

Figure 17. Mean Daily Potassium Intake per 1000 Kilocalories of Adult Americans by Age, Gender and Race/Ethnicity.

However, the Mexican American females in the <18 kg/m^2 BMI group did consume a significantly lower amount of potassium per 1000 kilocalories than those in the ≥18 - < 25 kg/m^2 BMI group. These results were due to the very large standard error of the mean and the small sample size for the BMI group, <18 kg/m^2.

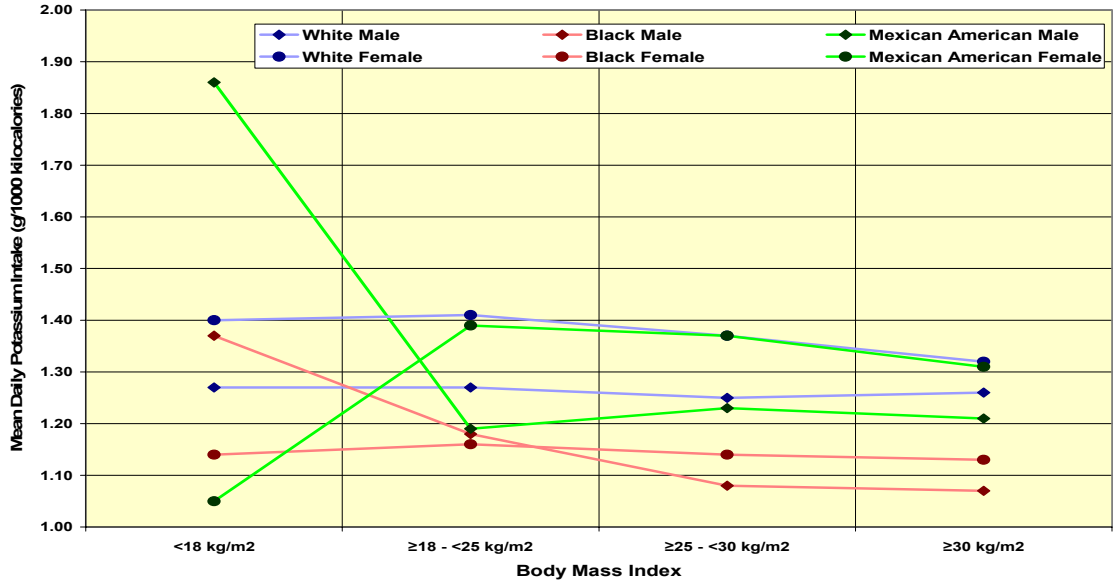

Figure 18. Mean Daily Potassium Intake per 1000 Kilocalories of Adult Americans by Body Mass Index, Gender and Race/Ethnicity.

Table 15. Mean ± SEM Daily Potassium Intake (grams) per 1000 Kilocalories of Adult Americans by Body Mass Index (kg/m^2), Gender and Race/Ethnicity.[2,3]

Gender	BMI	Total	White[1]	Black[1]	Mexican American
Male					
n		(3099)	(1505)	(680)	(914)
	<18	1.31 ± 0.14[a]	1.27 ± 0.15[a]	1.37 ± 0.30[a]	1.86 ± 0.32[a]
	≥18 - <25	1.26 ± 0.01[a]	1.27 ± 0.01[a]	1.18 ± 0.06[a]	1.19 ± 0.03[a]
	≥25 - <30	1.23 ± 0.02[a]	1.25 ± 0.03[a]	1.08 ± 0.04[a]	1.23 ± 0.03[a]
	≥30	1.23 ± 0.02[a]	1.26 ± 0.03[a]	1.07 ± 0.04[a]	1.21 ± 0.03[a]
p-value		0.7011	0.8995	0.2757	0.2261
Female					
n		(3036)	(1486)	(663)	(887)
	<18	1.34 ± 0.07[a]	1.40 ± 0.08[a]	1.14 ± 0.19[a]	1.05 ± 0.09[a]
	≥18 - <25	1.38 ± 0.02[a]	1.41 ± 0.02[a]	1.16 ± 0.04[a]	1.39 ± 0.04[b]
	≥25 - <30	1.34 ± 0.02[a]	1.37 ± 0.02[a]	1.14 ± 0.04[a]	1.37 ± 0.04[ab]
	≥30	1.30 ± 0.02[a]	1.32 ± 0.03[a]	1.13 ± 0.02[a]	1.31 ±0.04[ab]
p-value		0.0374	0.0849	0.9570	0.0209

1. Non-Hispanic
2. Same letter superscripts within a column indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, household income, and physical activity.

Percentage of Adult Americans Consuming ≥4.7 g/day of Potassium

The contingency table analysis indicated there were no significant differences in the percentages of Americans who consumed the recommended ≥4.7 grams of daily dietary potassium across the race/ethnicity groups for the males ($p = 0.0549$) and females ($p = .3581$). Overall, a greater percentage of the males consumed ≥4.7 g/day of potassium than the females in all the race/ethnicity groups combined ($p = 0.0000$) and within each race/ethnicity group ($p = 0.0000$, $p = 0.0000$, and $p = 0.0001$). Table 16 and Figures 19 and 20 show the comparisons of the percentages of adult Americans who consumed ≥4.7 g/day of potassium among the gender and race/ethnicity groups.

Table 16. Percentage of Adult Americans Consuming ≥4.7 g/day of Potassium by Gender and Race/Ethnicity.[2,3]

Gender	Total	White[1]	Black[1]	Mexican American	*p*-value
Male Percent *n*	14.76 ± 1.02 (3099)	15.68 ± 1.35[a] (1505)	10.11 ± 1.38[a] (680)	12.54 ± 1.34[a] (914)	0.0549
Female Percent *n*	3.44 ± 0.53 (3036)	3.64 ± 0.65[a] (1486)	2.28 ± 0.76[a] (663)	3.24 ± 0.68[a] (887)	0.3581
p-value	0.0000	0.0000	0.0000	0.0001	

1. Non-Hispanic
2. Same letter superscripts within a row indicate no significant differences when $\alpha = 0.05$.
3. Adjusted by age, BMI, household income, and physical activity.

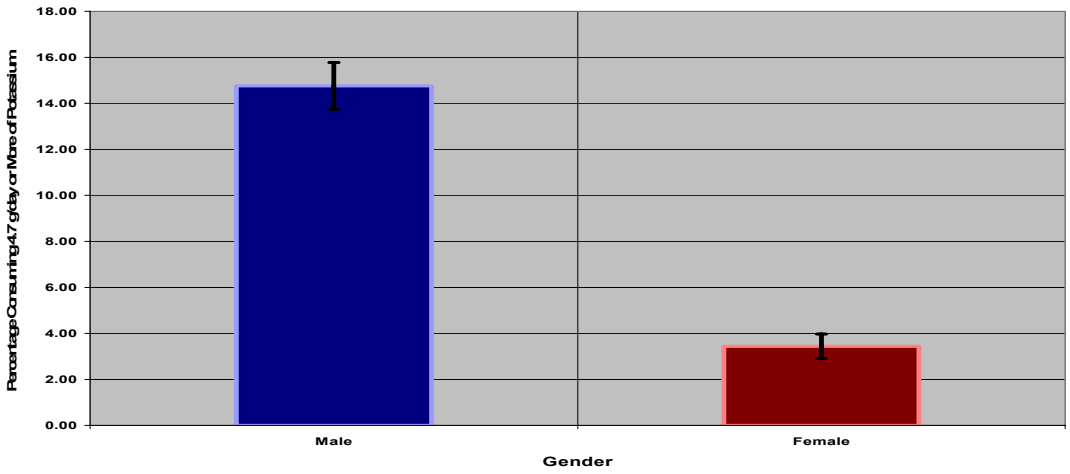

Figure 19. Percentage of Adult Americans Consuming ≥4.7 g/day of Potassium by Gender.

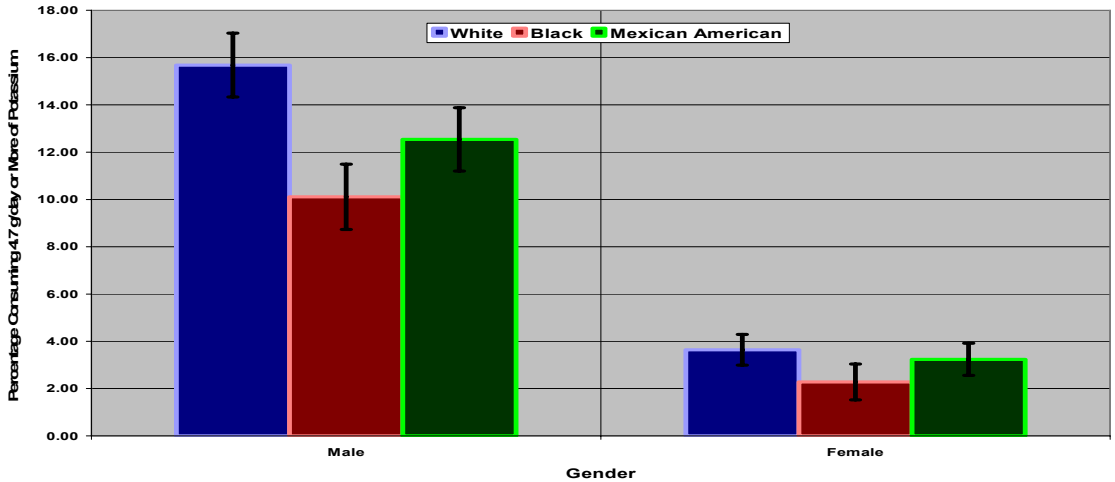

Figure 20. Percentage of Adult Americans Consuming ≥4.7 g/day of Potassium by Gender and Race/Ethnicity.

CHAPTER V: DISCUSSION

This study investigated the mean daily sodium and potassium intake of adult Americans with regard to gender, race/ethnicity, age, and body mass index using data from the National Health and Nutrition Examination Survey (NHANES) 1999-2000 and 2001-2002. For this study, the NHANES 1999-2000 and 2001-2002 data were combined in order to provide a larger sample size.

Mean Daily Sodium Intake of Adult Americans

Gender

It was found in this study that males consumed more sodium than females, 4,150 mg/day and 2,958 mg/day, respectively. This finding is supported by the previous results from the NHANES III study where the average sodium consumption for men ranged from 3,100 to 4,700 mg/day and for women from 2,300 to 3,100 mg/day.[2] A study conducted by Bauer et al., using the data from NHANES II, also found that males consumed more sodium than females,[49] and a study by Abraham and Carroll, using the data from NHANES I, found that males had a reported sodium intake of 2,701 mg/day, which was more than the reported female consumption of 1,850 mg/day.[50]

As reported by the U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, and National Center for Health Statistics, nutrient intake is related to the overall caloric intake. The caloric and sodium intake were higher in males than in females.[38] This study also found American women consumed slightly more sodium per 1000 kilocalories of daily energy intake than men at 1.59 g/1000 kcal for women and 1.56 g/1000 kcal for men.

This study found a greater percentage of females consumed the recommended ≤1.5 g/day of sodium than males. Similarly, Millen et al. conducted a study of 2,520 adult participants from the Framingham Offspring-Spouse Study to look at population nutrient intake in comparison to the dietary recommendations during 1991-1995. The recommended dietary intake for sodium in that time period was <3 g/day. The results showed that men consumed 3.4 g/day, and women

consumed 2.5 g/day. It was concluded that the women in the study were 70 percent more likely to follow the dietary guidelines for sodium intake compared to the 35 percent likelihood of men.[51]

Race/Ethnicity

Among the ethnic groups in this study, Black individuals were found to consume less total daily dietary sodium and less sodium per 1000 kilocalories than White and Mexican American individuals. These findings contradict known characteristics found in past race/ethnicity studies. Black males consumed 3,760 mg/day of total daily dietary sodium and Black females consumed 2,828 mg/day. White males and females consumed 4,253 mg/day and 3,009 mg/day, respectively, and Mexican American males and females consumed 4,253 mg/day and 2,704 mg/day, respectively. Per 1000 kilocalories, both Black males and females consumed 1.52 grams. White males and females consumed 1.58 and 1.62 grams, respectively, and Mexican American males and females consumed 1.46 and 1.51 grams, respectively. Supporting these findings was a study conducted by Bauer et al. which found Black individuals to have the lowest average daily intake of sodium among data from the NHANES II survey.[49] In a study conducted by Diaz et al., using data from 1,567 NHANES 1999-2000 participants, White and Mexican American participants also had higher overall calorie and sodium intakes than Black participants; 2,398.9 kilocalories, 2,117.57 kilocalories, 2,112.8 kilocalories respectively; and 3,815.99 mg/day, 3,334.99 mg/day, 3,191.65 mg/day of sodium, respectively.[52] Overall, Mexican American participants consumed the least amount of sodium in the current study.

According to the results of this study, 11.29 percent of Black males and 20.38 percent of the Black females met the recommended ≤1.5 g/day of sodium while 4.91 percent of the White males, 12.38 percent of the White females, 9.59 percent of the Mexican American males, and 17.78 percent of the Mexcian American females met the recommended ≤1.5 g/day of sodium. Contrary to the results of this study, Gebers et al. conducted a study of Black men and women

ages 25 to 50 residing in Pitt County, North Carolina.[41] They found that mean sodium intakes and enhanced sodium intakes for both Black men and women were near or above the upper limit of 1,100-3,300 mg/day that was recommended as safe and adequate sodium intake levels at that time.[41]

Age

A negative relationship was found in this study between mean sodium intake and age. Similar results were found in data obtained from the NHANES III survery.[2] It is known that as adults age, their energy consumption decreases, thus overall sodium intake decreases as well.[2,53] According to the Baltimore Longitudinal Study of Aging, the energy intake of a sample of males decreased from 2,700 kilocalories per day at the age of 30 to 2,100 kilocalories per day at approximately the age of 80.[53]

American adults may be consuming less calories as they age, but the calories which they consume, can be sodium-dense calories from items that are convenient, inexpensive, and/or easy to prepare.[53] This study found a positive relationship between sodium density and age in that more sodium is being consumed per 1000 kilocalories as adults increase in age. There are several factors that can interfere with appetite or affect the ability to purchase, prepare, and consume an adequate diet, such as whether or not a person lives alone, how many daily meals one is eating, who does the cooking and grocery shopping, physical impediments, adequate income to purchase appropriate foods, and medications.[53]

Body Mass Index

A slight increase in sodium intake was discovered in this study between the overweight (≥25 - <30 kg/m^2) and obese (≥30 kg/m^2) BMI groups. There was a 361 mg/day increase in males and a 48 mg/day increase in females. The differences, however, were not enough to show a significant relationship. Contradictory to these findings, He et al. conducted a study on 5,233 non-

overweight and 5,129 overweight males and females regarding the examination of the relationship between sodium intake and congestive heart failure risk.[54] He et al. reported that dietary intake of sodium was lower in overweight individuals compared to non-overweight individuals, but later found dietary sodium intake to be significantly associated with congestive heart failure risk in overweight individuals as opposed to non-overweight individuals.[54]

The normal and overweight BMI groups consumed the least sodium-dense foods. It is likely that the overweight and obese BMI groups were consuming more energy that was more sodium-dense than the normal and underweight BMI groups. For example, French et al. found that an increase in the consumption of sodium-dense foods, such as French fries, dairy products, and meat, in women were positively correlated to weight gain over a 2 year period.[55]

Mean Daily Potassium Intake of Adult Americans

Gender

This study found that males consumed much more potassium than females. The males consumed 3,233 mg/day, whereas females consumed 2,416 mg/day. In a study conducted by Fang et al., 9,866 males and females were followed, and the men had a significantly higher potassium intake than the women, 2,444.3 mg/day versus 1,862 mg/day, with a significance of $p < 0.0001$.[36]

The women consumed more potassium per 1000 kilocalories than men in this study, which could be attributed to more fruit and vegetable consumption. Females consumed 1.33 g/1000 kcal and males consumed 1.25 g/1000 kcal. In a study conducted by Tucker et al., of participants aged 69-97 years from the Framingham Heart Study, the average reported fruit and vegetable intake was 4.7 servings per day for the 345 men and 5.3 servings per day for the 562 women.[40] Steptoe et al., on the other hand, found that the number of fruit and vegetable servings consumed per day were greater for men (3.74 servings) than women (3.58 servings).[37]

Overall, in this study, 14.76 percent of men consumed the recommended while only 3.44 percent of females consumed the recommended ≥4.7 g/day of potassium. Tucker et al. reported that there was no significant difference in potassium intake between males and females, 2,988 mg and 2,930 mg respectively.[40] A further contradiction was indicated in the study conducted by Stables et al. in that women were more likely to consume the recommended ≥4.7 g/day of potassium because they consumed five or more daily servings of fruits and vegetables.[39] In a study of the Behavioral Risk Factor Surveillance System telephone survey, results also showed women were more likely to consume more fruits and vegetables, at least 5 servings per day, than men.[56] In the study conducted by Tucker et al., fruit and vegetables contributed to more than half of the overall total dietary potassium consumption.[40]

Race/Ethnicity

The results demonstrated in the current study found White subjects to have the highest intake in daily dietary potassium over Black and Mexican American subjects. White males consumed an average of 3,338 mg/day and females consumed an average of 2,478 mg/day compared to Black males and females and Mexican American males and females who consumed 2,673 mg/day, 2,064 mg/day, 3,018 mg/day, and 2,336 mg/day respectively. Large nutrition and dietary behavior surveys in the United States have shown lower potassium intakes among Black Americans than White Americans.[41] Fang et al. supports these findings as their study found White participants had significantly higher daily dietary intakes of potassium than Black participants, 2,178.3 mg/day versus 1,606.6 mg/day with a significance of $p < 0.001$.[36] However, Bauer et al., using data from the NHANES II survey, found Mexican Americans along with White Americans to have the highest potassium intake.[49] Many factors play into the variability of potassium consumption; ethnicity and food availability being two of the most influential.

This study also determined that Black American subjects consumed a lower amount of daily dietary potassium per 1000 kilocalories than White and Mexican American participants. The study conducted by Fang et al., using data from the NHANES I survey, made similar determinations as Black participants had significantly lower dietary potassium intake per 1000 kilocalories than White participants.[36]

Although not statistically different, 15.68 percent of the White males and 3.65 percent of the White females consumed the recommended dietary intake of ≥4.7 g/day of potassium compared to 10.11 percent of the Black males and 2.28 percent of the Black females or 12.54 percent of the Mexican American males and 3.24 percent of the Mexican American female participants in this study. Lack of fresh fruits and vegetables in the diet can be speculated as the reason for such low percentages of individuals meeting the DRI for potassium. Access to potassium-rich foods, such as fruits and vegetables, can be heavily influenced by socioeconomic status. Lindstrom et al. found that for both genders, unskilled manual workers had a higher risk of low vegetable and fruit juice intake than non-manual employees. Many of the unskilled manual workers in the U.S. population are Black and Mexican American, and as the results of the study show, both Black and Mexican American males and females consumed the least amounts of potassium.[57]

Age

The results of this study showed that male and female adults consumed more potassium at a younger age and than those adults in the middle and older age groups. Gebers et al. determined that Black men 25 to 54 years of age residing in Pitt County, North Carolina, who are predominantly low socio economic status, had lower mean daily dietary potassium intakes than the 25 to 54-year-old Black men and White men in the NHANES II study.[41]

As determined in this study, there is a positive correlation between age and potassium intake per 1000 kilocalories. As age increased, mean daily potassium intake per 1000 kilocalories also increased. This, again, brings to light the point that as adults age, energy intake decreases, but nutrient density increases.[2]

Body Mass Index

Although not significant, the current study showed an overall decrease in mean daily potassium consumption as BMI increased. He et al. supports these findings as their study of dietary potassium intake, among other nutrients, was lower in overweight subjects.[54]

Also, though not significant, this study showed a slight decrease in the consumption of daily dietary potassium per 1000 kilocalories as BMI increased. It could be speculated with these findings that adult Americans in the higher BMI groups are consuming less potassium-rich foods, such as fruits and vegetables, and more calorie-dense foods. It can also be speculated that increasing fruit and vegetable consumption will displace more calorie-dense foods from the diet which may ultimately result in weight loss. Drapeau et al. found that in some studies, increasing fruit and vegetable consumption was associated with a decrease in body weight; however, other studies did not support this theory.[58]

Conclusion

Generally, men consumed more mean sodium and potassium than women; however, women consumed more sodium and potassium per 1000 kilocalories. Black and Mexican American participants consumed less sodium than the White participants, and the same was true for potassium consumption except the Black participants consumed the least amount of potassium. Sodium and potassium consumption generally decreased as age increased due to decreased energy intake. There was a positive relationship between sodium intake and BMI, but a negative

relationship between potassium intake and BMI. In general, Americans are consuming too much sodium and not enough potassium in relation to the DRI for these nutrients.

As the results of this study demonstrate, the present super-sized Western diet contains sodium levels that are much higher and potassium levels that are much lower than what is recommended for a healthy diet. Excessive sodium consumption and obesity harbor a favorable environment for the development hypertension.[52] The disparities do not necessarily lie only within the minority race/ethnicity groups. This is an issue that spans all genders, race/ethnicity groups, and ages. It is imperative for nutrition professionals to educate all individuals about the importance of variety in the diet that includes 3-5 servings of fruits and vegetables daily and cooking and consuming more natural foods at home as opposed to consuming pre-prepared and pre-packaged foods.

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