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Rice Consumption in the United States: Recent Evidence from Food Consumption Surveys

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ABSTRACT

Background Little is known about rice consumption, related food intake patterns, and the nutritional contribution that rice provides in the diets of Americans.

Objective To provide information about rice consumption in the United States and the diets of rice consumers.

Design Data come from the Continuing Survey of Food Intakes by Individuals (1994-1996) and the National Health and Nutrition Examination Survey (2001-2002). Respondents report 24-hour recall dietary intakes. The amount of rice available in foods is estimated using the Food Commodity Intake Database. Consumers are classified based on the amount of rice they consume in foods.

Subjects The analysis includes information from adult individuals: 9,318 from the Continuing Survey of Food Intakes by Individuals and 4,744 from National Health and Nutrition Examination Survey.

Statistics Weighted percentages and mean values show the food and nutrient intake amounts. Logistic regression analysis is used to examine relationships among economic, social, and demographic factors that affect rice consumption.

Results Rice is consumed by a significant portion of the US adult population. Compared with others who did not consume rice, rice consumers consumed a smaller share of energy per day from fat and saturated fat; more iron and potassium; and more dietary fiber, meat, vegetables, and grains. Race/ethnicity and education are determinants of the probability of consuming rice, and more so than low-income status.

Conclusions Rice consumers choose a diet that includes more vegetables, a smaller share of energy from fat and saturated fat, more dietary fiber and more iron than those who do not consume rice; the differences have remained relatively stable over the last decade. Accounting for race/ethnicity and income levels is important for better understanding of factors that affect food choices and for effective design of dietary interventions.

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Rice is a major staple among two-thirds of the world's population. By world standards, per capita rice consumption in the United States is not large, although it has increased during the past several decades, reaching a level of 21.0 lb per capita annually today (1). Rice is a grain product and available as a refined grain (white rice) or whole grain (brown rice) (2). Brown rice provides many nutrients, dietary fiber, and trace minerals. In contrast, white rice, as a refined grain, has a finer texture and improved shelf life but lacks dietary fiber, iron, and many B vitamins. Most of the white rice consumed in the United States is enriched with thiamin, riboflavin, niacin, vitamin B-6, and iron to make the nutritional level of the milled product similar to that of the whole grain (brown rice). All enriched rice is additionally fortified with folic acid (3).

Although per capita rice consumption in 2006 was nearly three times that of 1970 (1), little is known about rice consumption patterns and the nutritional contribution that rice provides in the diet of Americans. Some factors contributing to the increase include the growing Asian-American and Hispanic-American populations, new and expanded offerings of rice-based food products, and marketing efforts by the rice industry (4). Dietary guidance recommends substituting whole-grain products, including brown rice, for refined products such as white rice (2). This has implications in food assistance and meal programs. Brown rice was included as a whole-grain product and enriched white rice was excluded from recommended changes to the Supplemental Nutrition Program for Women, Infants, and Children program (5), although minority populations who prefer white rice are often participants of that program.

The Centers for Disease Control and Prevention recently reported significant declines in blood folate levels of women of childbearing age (6). According to recent data from the National Health and Nutrition Examination Survey (NHANES), women aged 15 to 49 years obtain an average of 151 μg/day food folate and an additional 128 μg/day folic acid through enriched or fortified foods, like white rice, for total intake of folic acid and dietary folate at a level below the 400 μg/day dietary folate equivalents recommendation of the Recommended Dietary Allowance for women of childbearing age (7,8). Enriched white rice is a good source of folic acid and, like other enriched

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grains, can help boost folic acid intake, especially important in this population that needs increased folic acid to help prevent serious birth defects (8). In addition, food patterns may be more important than a particular food consumed, and the inclusion of a food item, such as rice, may help develop a better food intake pattern compared to another grain choice.

Important socioeconomic and demographic factors that affect grain and rice consumption include income, education, sex, region, urbanization, family size and composition, and ethnicity (9-12). Data available from nationally representative surveys of food consumed by individuals in the United States allow comparison of consumption today (2001-2002) with consumption in the mid-1990s and analysis of factors associated with rice consumption. The analysis is based on data from the United States: the Continuing Survey of Food Intakes by Individuals (CSFII) (1994-1996) (13) and the NHANES (2001-2002) (14), both large, nationally representative surveys of individuals in the United States and the foods they consume.

This article provides information on current rice consumption patterns in the United States and the dietary intake of rice consumers in general, as well as rice consumers analyzed by income and race and ethnicity. The primary objective of the research was to gain a better understanding of rice consumption in the United States and whether consuming rice has a beneficial effect on total diet; that is, plays a role in fostering a diet that follows dietary guidance for health (15). This was accomplished by examining the contribution of economic, social, and demographic factors related to rice consumption, and changes in consumption between the two survey periods (1994-1996 and 2001-2002). Extension of the analysis of the general population to low-income individuals and individuals of different race and ethnic backgrounds provides insight into factors that affect the food choices among these groups. The results provide information useful to the design of food programs and nutrition education.

METHODS AND PROCEDURES

The data come from the 1994-1996 CSFII (13), conducted by the US Department of Agriculture (USDA), and the 2001-2002 NHANES (14), conducted by USDA and the US Department of Health and Human Services. The data are existing data from publicly available sources. This study was deemed exempt from Institutional Board Approval under federal regulation 45 CFR §46.101(b), exemption 4 (16). Both surveys are nationally representative and include data collected through in-person interviews with respondents who provide quantitative 24-hour recall information on their food intake. The CSFII survey collected food intakes on 2 nonconsecutive days. The NHANES has food intake data from one interview day. We report data from one day of intake: Day 1 from the CSFII and the only reported day from the NHANES data.

The analysis uses information from 9,318 adults in the CSFII and 4,744 adults in the NHANES, aged 20 years and older with complete intake data for the reported day (day 1 for CSFII and observed day for NHANES). Adults were classified by age groups defined for comparison to previous studies (17) and to identify any differences for the younger adults (aged 20 to 24 years) compared to those older. The food intake data were matched to the Food Commodity Intake Database (FCID) (18) through the common set of food codes to identify consumption of foods containing the commodity "rice." The FCID converts food intakes (reported as eaten) into food commodities (eg, as white rice, tomatoes, and beans rather than "chili with rice and beans") by linking foods identified by food codes and the amount eaten with commodity codes and the amount of commodity per 100 g food. The food commodities (over 500) are those listed by the US Environmental Protection Agency in their Food Commodity Master List of June 15, 2000. The FCID was used to identify whether a food item contained the commodity rice and, if so, the corresponding amount of rice (measured as a dry weight). One hundred grams of regular white rice, cooked, is 35.709 g rice dry weight. One serving of regular (refined) rice, according to the 1992 Food Guide Pyramid, is equal to ½ c rice or 79 g (food as eaten) (17). Thus, one serving (½ c) of regular, cooked rice is equivalent to 28.21 g rice dry weight. Following similar conversions, one serving (½ c) brown rice is equivalent to 26.24 g brown rice dry weight (19).

The Pyramid Servings Database for USDA Survey Food Codes, version 2.0 (20) provided data for the analysis of the Pyramid food groups consumed by individuals. This database includes data on servings for use with the national food consumption surveys and in amounts consistent with the 1992 USDA Food Guide Pyramid recommendations (The Pyramid Servings Database for USDA Survey Food Codes, version 2.0 was produced by USDA's Community Nutrition Research Group and updates the earlier version). These data characterize the consumption of foods for the two surveys used and allow comparison between consumers of rice vs other consumers in terms of food groups and food components consumed, including discretionary fat and added sugar intake. Discretionary fat includes amounts of fat above that consumed if the lowest-fat choices were made in all the food groups (eg, amount of fat in 2% milk above the amount of fat in skim milk) (20). Added sugars are sugars and syrups that are added to foods or beverages during processing or preparation. This does not include naturally occurring sugars such as those that occur in milk and fruits (2).

The Technical Support Database was the database used to code food data collected in the CSFII 1994-1996 and to calculate the nutrient value of those foods. The USDA Food and Nutrient Database for Dietary Studies, version 1.0 (21) was used to process NHANES 2001-2002. The percentages of energy from fat, saturated fat, and carbohydrates were calculated for each individual as the daily intake of energy from fat, saturated fat, and carbohydrates, respectively, divided by total energy intake.

Identification and Classification of Rice Consumers

Rice consumers were identified and classified based on the amount of consumption (intake) of rice consumed in foods. Information from the FCID was used to identify foods that contained the commodity (a commodity-based ingredient) rice. Only foods that contained white rice, brown rice, and rice flour were included. Rice from other sources (rice bran or baby foods) was not counted in the selection. The actual amount of rice consumed by report-

Table 1. Consumption of white or brown rice for different age groups by survey years and by rice amount, 1994-1996 and 2001-2002

Survey year or item	Total	Age 20-24 y	25-39 y	40-59 y	60 y and older
1994-1996[a]					
All individuals (n)	9,318	686	2,304	3,355	2,973
	←		%		→
White or brown rice					
No rice	78.8	78.7	77.2	78.2	82.1
Less than ¼ c[b]	3.8	2.9	2.9	4.3	5.0
¼ c or more	17.4	18.5	19.9	17.6	12.9
2001-2002[a]					
All individuals (n)	4,744	487	1,245	1,488	1,524
	←		%		→
White or brown rice					
No rice	77.3	80.4	72.6	78.7	79.8
Less than ¼ c[b]	4.5	1.8	5.4	4.5	4.9
¼ c or more	18.2	17.8	22.1	16.8	15.3

[a]Source: Continuing Survey of Food Intake by Individuals 1994-1996 (Day 1 data); National Health and Nutrition Examination Survey 2001-2002 (1-day data). Percentages are based on weighted data.
[b]A portion of ¼ c cooked rice is equivalent to 14.1 g white rice (dry weight).

ing individuals came from the individual's reported food intake (amount) matched to the commodity amounts in the foods.

The classification of "rice consumer" was assigned to individuals who reported eating ¼ c (half of a serving) or more of cooked rice during 1 day. This amount was selected based on the distribution of rice in food products. Other individuals were classified as nonconsumers, even though they may have consumed rice in a very small amount on the interview day, or consumed rice on other days.

The amounts of rice consumed were compared across rice consumers by using a "consumption index" to indicate the relative levels of intake compared with the average amounts consumed by rice consumers (22). The index equals 100.0 at the average consumption level for consumers of ¼ c rice or more. A value of 76.0 means that the respective group consumed 76% of the average reported consumption level, or 24% less than the average amount.

STATISTICAL ANALYSIS

Both data sets were weighted to be nationally representative. The CSFII data were analyzed using Linux SAS (version 9.1, 2002-2003, SAS Inc, Cary, NC) and the NHANES data were analyzed using SAS (version 9.1, 2002-2003, SAS Inc, Cary, NC). Statistical tests using analysis of variance test differences in means (both food group and nutrient intakes) were done using WESVAR 4.2 and accounted for the complex survey design used in each of the surveys.

Logistic regression analyses, carried out using SAS protocols (23), were used to examine relationships among economic, social, and demographic factors that affect rice consumption. The logistic model allows estimation of a binary (0,1) dependent variable, and uses a transformation (called logit) based on a prediction equation that restricts predicted values to be between zero and one (24). The logistic regression equation predicts the natural log of the odds for an individual being a rice consumer or nonconsumer. Moreover, the regression coefficients in a logistic regression equation can be used to estimate odds ratios for each of the independent variables.

For binary response models, the response Y of an individual can take one of two possible values, denoted for convenience 1 and 0 (Y=1 if rice consumer, Y=0 if otherwise). The linear logistic model estimated was:

$$\text{Logit}\,(p) \equiv \log\,(p/1-p) = \alpha + \beta' x + \varepsilon$$

where x is a vector of socio-demographic explanatory variables and $p=\Pr(Y=1\,|\,x)$ is the response probability that was modeled; α is the intercept parameter, β is the vector of slope parameters, and ε is the error term.

RESULTS

The analysis and results based on the CSFII 1994-1996 and the NHANES 2001-2002 data include basic information on consumption of rice, comparisons across demographic groups, intake of low-income adults, Pyramid food servings, and selected nutrient intake of rice consumers and nonconsumers and results from logistic regression analysis.

Consumption of Rice

The 1994-1996 (CSFII) data show that 17.4% of adults aged 20 years and older reported eating at least half a ¼ c white or brown rice on one day of observed data (Table 1) (28.3% consumed at least that amount on 2 survey days; data not shown). The 2001-2002 (NHANES) data show the share of consumers rose to over 18% (18.2%) of adults (Table 1). In both periods, the youngest (aged 20 to 24 years) and oldest (aged 60 years and older) age groups

Table 2. Share of population group who are consumers of white or brown rice and estimated mean intake, expressed as a percentage of consumers' mean intake by demographic characteristics, 1994-1996 and 2001-2002

Group	1994-1996[a]			2001-2002[a]		
	Total adults	Consumers of rice (≥¼ c)[b]	Consumption index[c]	Total adults	Consumers of rice (≥¼ c)[b]	Consumption index[c]
All individuals (n)	9,318	1,524		4,744	921	
Amount per day (g, dry weight)	11.8[d]	66.5[e]		11.4[d]	61.2[e]	
Individuals who are consumers (reference index value)			100.0			100.0
	← % →					
Racial/ethnic group						
White, non-Hispanic	76.3	12.4	76.5	72.0	14.2	80.2
Black, non-Hispanic	11.0	21.3	97.7	10.6	23.6	102.9
Mexican American	4.0	28.1	76.8	7.1	23.4	84.8
Other Hispanic	4.8	39.9	134.3	5.9	30.2	104.4
Other[f]	3.9	64.8	173.4	4.4	45.0	206.7
Total	100.0			100.0		
Annual household income (% poverty threshold)						
0%-185%	26.7	18.9	108.3	30.0	19.5	110.0
>185%	73.3	16.8	96.7	70.0	17.6	95.1
Total	100.0			100.0		
Education						
Less than high school[g]	15.5	16.6	111.6	19.2	21.0	110.5
High school or GED[h]	34.4	13.8	98.3	25.3	13.5	92.3
Some college	35.7	19.0	98.6	55.4	19.3	98.5
5+ years of college[i]	13.1	23.0	95.5	—	—	—
Other[j]	1.2	21.8	102.9	0.1	37.7	74.0
Total	100.0			100.0		

[a]Source: Continuing Survey of Food Intakes by Individuals 1994-96 (Day 1 data); National Health and Nutrition Examination Survey 2001-2002 (1-day data). Index and percentages are based on weighted data.
[b]A portion of ¼ c cooked rice is equivalent to 14.1 g white rice (dry weight).
[c]The consumption index value was calculated as 100 times the ratio of mean intake of rice consumers in the demographic subpopulation group divided by the overall mean intake of rice consumers. An index value <100 indicates mean intake less than the mean of rice consumers; a value >100 indicates mean intake more than the mean of rice consumers.
[d]Day 1 average for total adult population (including those who do not consume).
[e]Day 1 average for adults consuming white or brown rice.
[f]Continuing Survey of Food Intakes by Individuals 1994-1996: Asian, Pacific Islander, American Indian, Alaskan Native, other. National Health and Nutrition Examination Survey 2001-2002: Other race, including Asian and multiracial.
[g]Continuing Survey of Food Intakes by Individuals 1994-1996: Includes never attended.
[h]GED=General Educational Development Testing Service crediting for high school equivalency.
[i]Some college and more combined for National Health and Nutrition Examination Survey 2001-2002.
[j]Continuing Survey of Food Intakes by Individuals 1994-1996: Question not asked/other/refused/don't know/not ascertained. National Health and Nutrition Examination Survey 2001-2002: Refused/don't know.

had the largest shares of individuals that did not consume rice; the 25- to 39-year-old group had the largest share of rice consumers. Even though brown rice is recommended as a whole grain (2), it is consumed by a relatively small share of adults (1.3% in each survey consumed at least ¼ c brown rice on 1 day) (data not shown).

Although the percentage of the population that consumed rice increased between the two periods (Table 1), the average amount of rice (white or brown) consumed by all adults and by rice consumers declined during the later survey period (Table 2). For the rice consumers (ie, consuming ¼ c or more of rice), the average amount of rice consumed decreased 8% (66.5 g, dry weight in 1994-1996 compared to 61.2 g, dry weight in 2001-2002). The total amount consumed is equivalent to just over 1 c cooked rice per day.

Comparison across Demographic Groups

Table 2 provides information on the distribution of the population by socioeconomic characteristics and their relative consumption patterns. The first and fourth columns of data show the population distributions for all adults; the second and fifth columns indicate the respective shares of rice consumers. Although in both periods, rice is more likely to be consumed by those other than white non-Hispanics, the shifts in the percentages who are consumers of rice show that rice is more widely—and evenly—consumed in the later period.

As expected, the "other" ethnic group, which includes Asians, has the highest share of rice consumers (64.8% in 1994-1996). However, by 2001-2002, this percentage had fallen (45%).

Ethnicity and Race. During both survey periods white, non-Hispanic adults were least likely to be consumers (12.4% and 14.2% in the two periods) and, as consumers, ate the smallest amount of rice on average compared to all other ethnic and racial groups. Although Mexican-Americans had a higher share of consumers of rice than represented by their share of population, they consumed amounts below the average and an amount similar to that consumed by white, non-Hispanic consumers (Table 2). Both black non-Hispanics and other Hispanics (not Mexican American) had higher shares of rice consumers and consumed near average amounts. As expected, the "other" ethnic group (including Asian, Pacific Islander, American Indian, Alaska Native, and other) consumed the largest amount of rice, 126.5 g/day on average (data not shown).

Income and Education. Low-income adults had a higher share of consumers of rice, and those consuming rice ate larger amounts of rice than did other individuals—more than 8% more than the average amount. Those with less education (less than high school) also consumed relatively more rice than average (Table 2).

Low-Income Adults

Because low-income individuals were more likely to consume rice, the demographic characteristics and consumption of those with low incomes (income less than or equal to 185% of the poverty threshold) were analyzed separately.

Among the low-income consumers, white, non-Hispanic consumers were least likely to consume rice. There were relative large shifts between the periods for some consumer groups, including a decline in the percentage of Hispanics (including Mexican Americans) who consumed rice. Black (non-Hispanic), low-income consumers of rice consumed amounts near the average level during both periods (Table 3).

Pyramid Food Servings

Estimated mean intakes of Pyramid food groups consumed by rice consumers and by nonconsumers allow comparison of dietary intakes between the two groups. Differences were evaluated for statistical significance. Results from the 2001-2002 data (Table 4) show that when compared with those not consuming at least ¼ c rice per day, rice consumers reported dietary intakes that included more grains, including rice, more vegetables (measured to include legumes and not potatoes), fewer potatoes, and more deep-yellow vegetables. The rice consumers also consumed more meat, poultry, and fish. In addition to being statistically significant, most of the differences between the rice consumers and nonconsumers represented more than half a serving of the food group. However, for some food groups (such as deep-yellow vegetable consumption by higher-income consumers), the differences between the consumer groups, although statistically significant, are small and less meaningful in practical application. The diets did not differ in terms of discretionary fat or added sugar intake. When consumers are separated by sex (data not shown), the evidence is similar.

There were several differences between the 2001-2002 results and those of the earlier period (1994-1996). In general, the 1994-1996 period showed rice consumers to have diets that were markedly different from those who did not consume rice, especially for white, non-Hispanic individuals—the dominant racial/ethnic group (data not shown). Rice consumers had intakes with more grains; whole grains; vegetables (defined to include legumes but not potatoes); dark-green vegetables; deep-yellow vegetables; fruit; and meat, poultry and fish, and less added sugar, although some differences were relatively small in a practical sense. In the 2001-2002 period, rice consumers consumed more grains; vegetables; deep-yellow vegetables; and meat, poultry, and fish (Table 4). It is useful to note that for all consumers, average daily intakes of both discretionary fat and added sugar increased over time (between 1994-1996 and 2001-2002).

Among low-income consumers, rice consumers consumed more grains (but not whole grains); more vegetables (measured with legumes and without potatoes); less potatoes; and more meat, poultry, and fish than other low-income individuals. These results apply to both analysis periods. In addition, low-income rice consumers consumed more fruits in 1994-1996. Intakes of other Pyramid food groups were not statistically different.

A few differences emerge among the population groups based on race and ethnicity (data not shown). In 1994-1996, black, non-Hispanic rice consumers consumed more grains and fewer potatoes than others in that population group; Mexican-American rice consumers consumed more vegetables; and other Hispanic (but not Mexican American) rice consumers consumed more grains, fewer potatoes, and more meat, poultry, and fish than Other Hispanic non–rice consumers. In comparison, the 2001-2002 data show rice consumers to be more similar to other individuals in their food choices when compared by racial and ethnic groups. Black, non-Hispanic rice consumers consumed more grains and vegetables, and fewer potatoes; Mexican-American rice consumers continued to consume more vegetables and also consumed more grains; other Hispanic (but not Mexican-American) rice consumers now differed from non–rice consumers only by consuming more grains. Among all of the groups, most differences in food intake between rice consumers and others in the group occurred for the white non-Hispanics.

Nutrient Intakes

Rice consumers had a lower share of energy from fat and saturated fat, more fiber, and higher intake of iron and potassium, as shown in Table 5. The differences were statistically significant ($P \leq 0.001$). These results apply also to adult low-income rice consumers (data not shown) and are valid for the two periods analyzed (1994-1996 and 2001-2002).

Table 3. Share of low-income population group who are consumers of white or brown rice and estimated mean intake, expressed as a percentage of consumers' mean intake by demographic characteristics, 1994-1996 and 2001-2002

Group	1994-1996[a]			2001-2002[a]		
	Total adults	Consumers of rice (≥¼ c)[b]	Consumption index[c]	Total adults	Consumers of rice (≥¼ c)[b]	Consumption index[c]
All individuals (n)	3,242	561		1,767	359	
Amount per day (g, dry weight)	13.8[d]	72.0[e]		13.3[d]	67.3[e]	
Individuals who are consumers (reference index value)			100.0			100.0
	← % →					
Racial/ethnic group						
White, non-Hispanic	59.2	10.0	79.3	56.1	13.4	70.6
Black, non-Hispanic	19.1	21.7	96.8	16.5	24.0	100.1
Mexican American	8.5	27.9	77.9	12.6	21.8	83.7
Other Hispanic	8.8	46.6	115.4	10.4	30.5	86.3
Other[f]	4.4	54.5	151.9	4.4	48.3	247.4
Total	100.0			100.0		
Education						
Less than high school[g]	34.5	19.0	109.6	38.1	21.7	104.3
High school or GED[h]	37.3	16.1	90.1	29.0	12.9	100.1
Some college	22.0	21.7	100.3	32.6	22.4	96.0
5+ y college[i]	4.4	30.4	95.4	—	—	—
Other[j]	1.8	16.6	103.2	0.3	57.6	67.3
Total	100.0			100.0		

[a]Source: Continuing Survey of Food Intakes by Individuals 1994-1996 (Day 1 data); National Health and Nutrition Examination Survey 2001-2002 (1-day data). Index and percentages are based on weighted data. Low-income population defined as individuals living in a household with income ≤185% of the poverty threshold.
[b]A portion of ¼ c cooked rice is equivalent to 14.1 g white rice (dry weight).
[c]The consumption index value was calculated as 100 times the ratio of mean intake of rice consumers in the demographic subpopulation group divided by the overall mean intake of rice consumers. An index value <100 indicates mean intake less than the mean of rice consumers; a value >100 indicates mean intake more than the mean of rice consumers.
[d]Day 1 average for total adult population (including those who do not consume).
[e]Day 1 average for adults consuming white or brown rice.
[f]Continuing Survey of Food Intakes by Individuals 1994-1996: Asian, Pacific Islander, American Indian, Alaskan Native, other. NHANES 2001-2002: Other race-including Asian and multiracial.
[g]Continuing Survey of Food Intakes by Individuals 1994-1996: Includes never attended.
[h]GED=General Educational Development Testing Service crediting for high school equivalency.
[i]Some college and more combined for National Health and Nutrition Examination Survey 2001-2002.
[j]Continuing Survey of Food Intakes by Individuals 1994-1996: Question not asked/other/refused/don't know/not ascertained. National Health and Nutrition Examination Survey 2001-2002: Refused/don't know.

Predicting Consumption of Rice

Multivariate analysis was conducted to better understand the factors that predict rice consumption. Table 6 shows the logistic regression results. Being of a race/ethnic group other than white non-Hispanic is positively associated with the consumption of rice, particularly those in the "Other" group, which includes the Asian-American population. Other factors that positively influence rice consumption are having an education other than high school. The 2001-2002 data also indicate that being a younger adult (aged 24 to 39 years) is positively associated with the consumption of rice. Although not statistically significant, the predicted odds ratios indicate that being a low-income consumer is negatively associated with rice consumption compared to higher-income consumers.

DISCUSSION

This research focused on identifying rice consumers, understanding any changes in rice consumption between the periods of 1994-1996 and 2001-2002, and analyzing whether the diets of rice consumers differed from other consumers. More recently, USDA developed a food-group intake database (MyPyramid) consistent with the 2005 Dietary Guidelines for Americans (15). The accompanying database can be used to determine how well individuals are eating compared to the recommended amounts of food specified in the Pyramid. In contrast, our purpose in the research reported here was to better understand underlying differences in the consumption of grain products (rice) and other foods by rice consumers. The results provide information for such comparisons.

Although rice is not consumed frequently by all consumers in the United States, it is an important food source, especially for some ethnic groups. Furthermore, rice consumers differ from other consumers in their nutrient intake and in the food choices they make. Rice consumers (in general), when compared with other individuals, have food choices that include more grains (but not whole grains); more vegetables (including legumes but not potatoes); fewer potatoes, more meat, poultry, and

Table 4. Average daily servings of Food Guide Pyramid food groups, grams of discretionary fat and teaspoons of added sugar consumed by individuals classified by consumption of rice and income, 2001-2002[a]

	Adults ≥20 y		Annual Household Income, % of Poverty (0%-185%)		Annual Household Income, % of Poverty (>185%)	
Group	**(0-<¼ c)[b]**	**(≥¼ c rice)**	**(0-<¼ c)[b]**	**(≥¼ c rice)**	**(0-<¼ c)[b]**	**(≥¼ c rice)**
All individuals (n)	3,823	921	1,408	359	2,415	562
	← *Servings* →					
Grains	6.5**	8.0	6.4**	8.0	6.6**	7.9
Whole Grains	0.8	0.9	0.6	0.6	0.9	1.0
Vegetables[c]	2.4**	3.2	2.1**	2.9	2.5**	3.4
Potatoes	1.1**	0.6	1.1*	0.6	1.1**	0.6
Dark-green vegetables	0.2	0.3	0.1	0.2	0.2	0.3
Deep-yellow vegetables	0.2	0.3	0.1	0.2	0.1*	0.3
Fruit	1.6	1.8	1.3	1.6	1.7	1.9
Dairy	1.6	1.5	1.4	1.4	1.7	1.6
Meat, poultry, and fish[d]	4.7**	5.7	4.4*	5.6	4.8*	5.7
Discretionary fat	64.0	59.9	59.6	55.6	65.8	62.0
Added sugar	21.8	20.4	23.1	23.1	21.3	19.1

[a]Sources: National Health and Nutrition Examination Survey 2001-2002 (1-day data) (14), and Pyramid Servings Database, Version 2 (20). Averages are based on weighted data. Rice refers to white or brown rice.
[b]A portion of ¼ c cooked rice is equivalent to 14.1 g white rice (dry weight).
[c]Includes legumes but not potatoes.
[d]Ounces of lean meat from meat, poultry, or fish.
*$P \leq 0.01$.
**$P \leq 0.001$; analysis of variance tests were performed to determine differences in mean consumption between rice consumers (consuming ≥¼ c rice) and others. Wesvar version 4.2 was used to perform the tests.

Table 5. Average daily nutrient intake by individuals classified by consumption of rice, 2001-2002[a]

Consumption level	**No. of individuals (n)**	**% Energy from fat**	**% Energy from saturated fat**	**% Energy from carbohydrates**	**Dietary fiber (g)**	**Iron (mg)**	**Potassium (g)**
Recommended amount 2001-2002		20-35[b]	<10[b]	45-65[b]	21-38[c]	5-8.1[d]	4.7[e]
Adults (≥20 y)	4,744	33.4	10.6	50.3	16.0	15.6	2.7
(0-<¼ c)[f]	3,823	34.1*	10.9*	49.8*	15.5*	15.0*	2.7*
(≥¼ c rice)	921	30.2	9.3	52.9	17.9	17.9	3.0

[a]Source: National Health and Nutrition Examination Survey 2001-2002 (1-day data) (14). Averages are based on weighted data. Rice refers to white or brown rice.
[b]Recommended amounts of % energy from fat, % energy from saturated fat, and % energy from carbohydrates based on the 2005 Dietary Guidelines for Americans (15).
[c]Dietary fiber: Adequate Intake (AI) is 25 g/d for women age 19-50 y and 21 g/d for women aged 51 y and older; 38 g/d for men aged 19-50 y and 30 g/d for men age 51 y and older (26).
[d]Iron: Estimated Average Requirement is 8.1 mg/d for women aged 19-50 y and 5 mg/d for age 51 y and older; Estimated Average Requirement is 6 mg/d for men aged 19 y and older (27).
[e]Potassium: AI is 4.7 g/d for women and men aged 19 y and older (28).
[f]A portion of ¼ c cooked rice is equivalent to 14.1 g white rice (dry weight).
*$P \leq 0.001$. Analysis of variance tests were performed to determine differences in mean consumption between rice consumers (consuming ≥¼ c rice) and others. Wesvar version 4.2 (2002, Rockville, MD) was used to perform the tests.

fish; and, in the earlier period, less discretionary fat and less added sugar. Although causality is not established, including rice in the day's menu was associated with the selections of these other foods and food components. And, selections of a more healthful diet may be influenced by learned behaviors as well as other environmental influences, such as what food combinations others are eating (25). Rice consumers' diets are also lower in the share of energy from fat and higher in dietary fiber, iron, and potassium.

Closer evaluation of the evidence suggests that not all rice consumers are the same. The analysis identified individuals with above-average rice consumption as those from the other ethnicity group (which includes Asian and multiracial) and other Hispanics (but not Mexican American) and those with lower income (below the 185% poverty threshold). The importance of ethnicity and income is consistent with findings in earlier studies (9,10,12). Multivariate analysis shows that some demographic attributes, such as race and ethnicity, are important factors that influence the probability of rice consumption. Shifts in consumption of rice among the race and ethnic groups across time suggest differences in both underlying preferences among the groups, as well as some changes in population.

The proportion of rice consumers, as well as differences

Table 6. Estimated coefficients from analysis predicting consumption of rice, 1994-1996 and 2001-2002

	1994-1996[a]			2001-2002[a]		
Explanatory variable	**Odd ratios**	**Confidence limits**	***P* value**	**Odd ratios**	**Confidence limits**	***P* value**
Sex						
Male	1.00	(0.88-1.11)	NS[b]	1.03	(0.89-1.19)	NS
Annual household income						
0%-185% of poverty threshold	0.90	(0.77-1.04)	NS	0.95	(0.81-1.13)	NS
Race/ethnicity						
Black non-Hispanic	2.39	(2.01-2.83)	<0.0001	1.97	(1.61-2.40)	<0.0001
Mexican American	3.32	(2.58-4.28)	<0.0001	1.91	(1.56-2.33)	<0.0001
Other Hispanic	5.97	(4.82-7.40)	<0.0001	3.38	(2.46-4.64)	<0.0001
Other race[c]	11.30	(8.89-14.35)	<0.0001	4.55	(3.25-6.37)	<0.0001
Education level						
Less than high school[d]	1.07	(0.90-1.28)	NS	1.35	(1.08-1.68)	0.0078
More than high school	1.53	(1.34-1.76)	<0.0001	1.42	(1.16-1.74)	0.0006
Other[e]	1.60	(0.99-2.57)	0.05	2.54	(0.44-14.82)	NS
Age (20 y≤age≤24)						
24 y≤age≤39 y	1.12	(0.88-1.41)	NS	1.30	(0.99-1.70)	0.06
39 y≤age≤59 y	1.14	(0.90-1.43)	NS	1.05	(0.80-1.37)	NS
Age >59y	0.93	(0.73-0.18)	NS	1.03	(0.79-1.35)	NS

[a]Source: Continuing Survey of Food Intakes by Individuals 1994-1996 (Day 1 data) (13); National Health and Nutrition Examination Survey 2001-2002 (1-day data) (14). Hosmer and Lemeshow Goodness-of-Fit applied. CSFII: χ^2=10.554, DF=8, Pr>χ^2=0.23. NHANES: χ^2=3.949, DF=8, Pr≥χ^2=0.86.
[b]NS=not significant.
[c]Continuing Survey of Food Intakes by Individuals 1994-1996: Asian, Pacific Islander, American Indian, Alaskan Native, other. National Health and Nutrition Examination Survey 2001-2002: Other race, including Asian and multiracial.
[d]Continuing Survey of Food Intakes by Individuals 1994-1996: Includes never attended.
[e]Continuing Survey of Food Intakes by Individuals 1994-1996: Not asked question, other, refused, do not know, not ascertain. National Health and Nutrition Examination Survey 2001-2002: Refused/don't know.

between rice consumers and nonconsumers, has remained relatively stable between 1994-1996 and 2001-2002 periods, although the diets of low-income rice consumers have become more similar to the diets of non–rice consumers in the more recent period. Underlying changes in the ethnic and racial composition of the population may mask some differences that persist and may not be identified well in the racial/ethnic classifications used. The sharp drop in the share of rice consumers from 64.8% in 1994-1996 to 45% in 2001-2002 in the "Other" racial/ethnic group, a group that includes Asian consumers, may indicate that the change in consumption patterns includes a possible shift in the population mix. Goodwin and colleagues (12) find differences among Asian-American groups. Among the low-income consumers, the drop in share of rice consumers in the "other Hispanic" (but not Mexican American) group is sharp (46.6% in 1994-1996 to 30.5% in 2001-2002) and also suggests underlying shifts in the composition of this low-income group.

One limitation of the data source is the lack of detailed demographic information to further disaggregate and compare across time the racial and ethnic groups. Another limitation of the comparisons used is that between the two periods, the food supply changed to include more prepackaged and convenience foods. New foods, with rice ingredients, have been added. However, other dishes prepared as convenience foods, or consumed in fast-food establishments, may be less likely to include main rice dishes. Our analysis did not distinguish between foods prepared and eaten at home and those consumed away from home.

CONCLUSIONS

This research provides information about rice consumption in the United States and shows similarities and differences in the diets of those who consume rice compared with those who do not. The findings suggest that the design of food assistance and meal programs and nutrition education should consider ethnicity and income as important factors in the food choices made by individuals. The use of rice as a component of the diet is associated with differences in the selection of foods. Rice consumers choose more grains; vegetables; and meat, poultry, and fish. However, diets have become more similar over time and fewer differences exist today between rice consumers and nonconsumers of rice than occurred in the past. Knowing that diets that include more rice also include more vegetables and meats may benefit clinicians who are planning interventions or counseling diverse clients about the use of rice and foods associated with the use of rice in improving diets. Identifying healthful modifications to traditional meals as well as dietary patterns that might improve diets are among strategies likely to be effective at the individual or micro level and ultimately to reduce health disparities (25). Clients and other consumers may benefit from new recipes in which rice, in particular brown rice, is used in combination with vegetables and low-fat meats.

Additional research that links other sociodemographic factors such as acculturation with income and the role these factors play in determining food choices is important. This is true particularly for individuals of Hispanic

background, an ethnic group that has become the largest minority group in the United States. The inclusion of rice in planning menus for food assistance programs or in the school lunch program may not only be widely accepted, but may also further encourage consumption of a varied diet that includes more vegetables. Rice is a grain that food and nutrition professionals should be able to recommend to their clients as an affordable, culturally appropriate, and nutritionally sound option to meet recommended intake of bread, cereals, and grains.

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