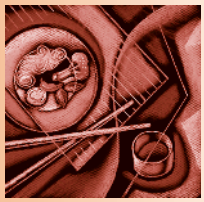

Diet Quality and Markers for Human Health in Rice Eaters Versus Non–Rice Eaters

An Analysis of the US National Health and Nutrition Examination Survey, 1999–2004

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Evidence from the most recent (1999–2004) National Health and Nutrition Examination Survey provides new information on the relationship between rice consumption and food group/nutrient intake and certain health parameters in children and adults. Of 25 374 eligible participants, 5213 were identified as rice consumers using guidelines established in previous research. Health parameters of interest included body weight, body mass index, waist circumference, blood pressure (systolic and diastolic), blood lipids (total, low-density lipoprotein, and high-density lipoprotein cholesterol and triglycerides), C-reactive protein, and others. Analyses were conducted to determine if rice consumers had lower odds ratio (ie, risk) of being overweight; being obese; having metabolic syndrome, elevated blood lipids, and elevated blood pressure; and other related parameters. Main results ($P < .05$) show an association between eating at least 1 daily serving of rice (white or brown) and better health and diet parameters including less total fat, saturated fat, and added sugars; higher amounts of more than 12 essential vitamins and minerals, including iron, folate, and other B vitamins; more fruit and legumes; nearly 4 tsp (16 g) less added sugar; and 7 g less solid fats. For the 19- to 50-year-old subgroup, main results ($P < .05$) also showed rice consumption associated with reduced likelihood of being overweight or obese, 34% reduced risk of high blood pressure, 27% reduced likelihood of having an increased waist circumference, and 21% reduced risk of metabolic syndrome. Compared with non–rice eaters, rice eaters are less likely to have risk factors associated with cardiovascular disease, type 2 diabetes, and metabolic syndrome; they are more likely to have an overall better diet quality. Nutr Today. 2010;45(6):262–272

Background

Rice is a major staple food for more than half of the world's population. In the United States, yearly rice consumption per person is approximately 26 to 27 lb (USDA-ERS 2007).[1,2] Rice intake has grown over the past 25 years, perhaps due in part to growing Asian American and Hispanic American populations, new rice-based food products, and marketing efforts by the rice industry (USDA-ERS 2004), although a slower rate of growth has been noted in recent years, compared with the 1980s and 1990s, perhaps because of the popularity of protein-based diets in the early 21st century or a shift to a more Western diet by second- and third-generation Asian immigrants (USDA-ERS 2007).[2] Overall, rice continues to grow as a substantial part of the US diet, whereas dietary and health parameters associated with its intake are still largely unknown.

Previous research[3] on US rice consumption patterns and diet quality of rice consumers comparing rice consumers with nonconsumers found that, based on data from the United States: the Continuing Survey of Food Intakes by Individuals (CSFII, 1994–1996) and the National Health and Nutrition Examination Survey (NHANES, 2001–2002), rice consumers were more likely to choose foods in line with the 2005 Dietary Guidelines compared with non–rice eaters.

Table 1. Distribution of Rice Consumers—NHANES 1999–2002[a]

Total Observations (25 374)	
Users	Nonusers
5213	20 161

Children 2–13 y 7049		Children 14–18 y 4132	
Users	Nonusers	Users	Nonusers
1424	5625	805	3327

Adults 19–50 y 7950		Adults 51+ y 6243	
Users	Nonusers	Users	Nonusers
1840	6110	1144	5099

[a]Only nonpregnant, nonlactating subjects with reliable records.

The objective of this research was to use the most recent (1999–2004) data from the NHANES to determine the diet quality and markers for human health in children and adults who eat rice compared with those who do not.

Rice consumers were defined using the same approach used in previous research, namely, reporting in the 24-hour recall the consumption of at least 14 g of uncooked white or brown rice (approximately ¼ cup cooked rice). Health parameters of interest included anthropometric data (body weight, body mass index [BMI], waist circumference), blood pressure (systolic and diastolic), blood lipids (total, low-density lipoprotein [LDL], and high-density lipoprotein [HDL] cholesterol and triglycerides), C-reactive protein, and others. We also conducted analyses to determine if rice consumers had lower odds ratios (ie, risk) of being overweight; being obese; having metabolic syndrome, elevated blood lipids, and elevated blood pressure; and other related parameters.

Methods

Data were combined from NHANES 1999–2000, 2001–2002, and 2003–2004 to provide information for 25 374 nonpregnant, nonlactating individuals with dietary records meeting minimum acceptable criteria. Data were separated into 4 age groups: (1) children 2 to 13 years; (2) children 14 to 18 years; (3) adults 19 to 50 years; and (4) adults 51+ years. Using the food codes from a previous intake analysis of the Continuing Survey of Food Intake by Individuals,[3] we defined rice consumers as individuals with reported consumption of at least 14 g of uncooked white or brown rice (approximately ¼ cup cooked rice) in a 24-hour period. Only the first day's 24-hour recall was used for the 2003–2004 data.

SAS (Cary, NC) and SUDAAN (Research Triangle Park, NC) were used to analyze the data, and all analyses were adjusted for the complex sampling design of NHANES using appropriate sample weights. We compared nutrient and food group intake of rice

Table 2A. Adjusted Nutrient Intake for Rice Products Consumers for Children—NHANES 1999–2004[a]

	2–13 y		
	Observations = 7049		
	Users = 1424	Nonusers = 5625	
Nutrients	Mean ± SE	Mean ± SE	P
Energy, kcal[b]	2044.1 ± 51.7	1918.9 ± 14.6	.0185
Protein, g	67.7 ± 0.94	65.2 ± 0.49	.0159
Carbohydrate, g	277.9 ± 1.6	263.7 ± 1.1	<.0001
Dietary fiber, g	12.5 ± 0.31	12.0 ± 0.12	.1392
Total fat, g	64.5 ± 0.79	72.3 ± 0.41	<.0001
Saturated fat, g	22.8 ± 0.32	26.1 ± 0.20	<.0001
Monounsaturated fat, g	24.0 ± 0.40	27.2 ± 0.18	<.0001
Polyunsaturated fat, g	12.6 ± 0.25	13.4 ± 0.14	.0061
Cholesterol, mg	205.3 ± 7.4	213.3 ± 2.6	.3496
Vitamin E, mg ATOC	5.2 ± 0.15	5.3 ± 0.08	.3877
Vitamin A (RE)	632.6 ± 22.8	552.0 ± 11.8	.0016
Thiamin, mg	1.7 ± 0.03	1.5 ± 0.01	<.0001
Riboflavin, mg	2.2 ± 0.05	2.1 ± 0.02	.0168
Niacin, mg	21.0 ± 0.32	18.6 ± 0.22	<.0001
Vitamin B_6, mg	1.8 ± 0.05	1.5 ± 0.02	<.0001
Total folate, DFE	649.5 ± 15.6	513.2 ± 9.8	<.0001
Vitamin B_{12}, μg	5.0 ± 0.18	4.6 ± 0.08	.0294
Vitamin C, mg	92.9 ± 4.4	85.3 ± 1.6	.1209
Calcium, mg	933.9 ± 21.6	965.8 ± 12.1	.1301
Phosphorus, mg	1191.1 ± 22.7	1200.2 ± 10.1	.6810
Magnesium, mg	229.9 ± 4.3	216.7 ± 1.7	.0029
Iron, mg	15.3 ± 0.24	13.9 ± 0.15	<.0001
Zinc, mg	10.8 ± 0.21	10.4 ± 0.11	.1204
Copper, mg	1.0 ± 0.02	0.98 ± 0.01	.0241
Sodium, mg	3066. ± 744.0	2938.4 ± 13.9	.0056
Potassium, mg	2284.4 ± 46.5	2188.8 ± 21.9	.0407

Abbreviations: ATOC, alpha-tocopherol; DFE, dietary folate equivalent; RE, retinol equivalent.
[a]Adjusted for sex, ethnicity, and energy.
[b]Adjusted for sex and ethnicity.

Table 2B. Adjusted Nutrient Intake for Rice Products Consumers for Children—NHANES 1999–2004[a]

	14–18 y		
	Observations = 4132		
	Users = 805	Nonusers = 3327	
Nutrients	Mean ± SE	Mean ± SE	P
Energy, kcal[b]	2495.3 ± 60.5	2354.1 ± 34.8	.0661
Protein, g	86.7 ± 1.5	79.9 ± 0.72	.0001
Carbohydrate, g	324.2 ± 3.7	319.8 ± 1.9	.2793
Dietary fiber, g	14.9 ± 0.36	13.4 ± 0.18	.0004
Total fat, g	82.7 ± 1.1	87.9 ± 0.68	.0001
Saturated fat, g	27.7 ± 0.51	30.4 ± 0.28	.0001
Monounsaturated fat, g	31.2 ± 0.57	33.5 ± 0.28	.0005
Polyunsaturated fat, g	17.2 ± 0.42	17.1 ± 0.25	.9360
Cholesterol, mg	270.6 ± 10.3	257.3 ± 4.8	.1783
Vitamin E, mg ATOC	6.9 ± 0.20	6.6 ± 0.13	.3692
Vitamin A (RE)	664.8 ± 33.0	554.8 ± 11.6	.0036
Thiamin, mg	1.9 ± 0.03	1.7 ± 0.02	<.0001
Riboflavin, mg	2.3 ± 0.05	2.2 ± 0.03	.2169
Niacin, mg	26.7 ± 0.53	22.9 ± 0.30	<.0001
Vitamin B_6, mg	2.2 ± 0.06	1.8 ± 0.04	<.0001
Total folate, DFE	747.9 ± 25.1	567.8 ± 13.1	<.0001
Vitamin B_{12}, μg	5.8 ± 0.23	5.2 ± 0.09	.0121
Vitamin C, mg	97.0 ± 4.8	94.7 ± 3.4	.6906
Calcium, mg	953.2 ± 24.5	1009.2 ± 14.8	.0700
Phosphorus, mg	1388.4 ± 16.0	1357.0 ± 10.6	.1182
Magnesium, mg	274.8 ± 4.9	246.5 ± 2.4	<.0001
Iron, mg	18.9 ± 0.41	16.1 ± 0.21	<.0001
Zinc, mg	13.7 ± 0.31	12.3 ± 0.20	.0011
Copper, mg	1.3 ± 0.04	1.1 ± 0.01	<.0001
Sodium, mg	3777.3 ± 63.5	3536.8 ± 34.6	.0006
Potassium, mg	2566.7 ± 43.2	2458.7 ± 29.5	.0207

[a]Adjusted for sex, ethnicity, and energy.
[b]Adjusted for sex and ethnicity.

consumers and nonconsumers after adjusting for sex, ethnicity, age, and calories (calorie consumption was adjusted only for sex, ethnicity, and age). Health parameters were also adjusted for sex, ethnicity, age, and other relevant covariates (see footnote in tables for specifics). Logistic regression was utilized to determine if adult rice consumers had a lower odds ratio of being overweight (BMI, ≥≥25 kg/m^2), being obese (BMI, ≥30 kg/m^2), having elevated blood lipids (LDL cholesterol, ≥100 mg/dL; HDL cholesterol, <40 mg/dL in men and <50 mg/dL in women), elevated fasting triglycerides (≥150 mg/dL), elevated fasting blood glucose (≥110 mg/dL), increased waist size (>102 cm/40.1″ in men and >88 cm/34.6″ in women), and elevated blood pressure (systolic blood pressure, ≥130 mm Hg; diastolic blood pressure, ≥85 mm Hg). Risk of metabolic syndrome was defined as having 3 of 5 risk factors (elevated waist size, elevated blood pressure, elevated triglycerides, elevated fasting blood glucose, and risk of low HDL). Logistic regression was also used to determine if rice consumption in children was associated with being overweight (BMI, ≥95th percentile) or with a risk for being overweight (BMI, ≥85th percentile). Data are presented as means ± SEs, and $P < .05$ was deemed statistically significant.

Table 2C. Adjusted Nutrient Intake for Rice Products Consumers for Adults—NHANES 1999–2004[a]

	19–50 y		
	Observations = 7950		
	Users = 1840	Nonusers = 6110	
Nutrients	Mean ± SE	Mean ± SE	P
Energy, kcal[b]	2473.9 ± 23.5	2378.1 ± 15.7	.0010
Protein, g	91.2 ± 0.81	86.3 ± 0.55	<.0001
Carbohydrate, g	311.7 ± 1.9	293.9 ± 1.6	<.0001
Dietary fiber, g	17.5 ± 0.28	15.3 ± 0.21	<.0001
Total fat, g	81.6 ± 0.87	90.4 ± 0.51	<.0001
Saturated fat, g	26.4 ± 0.38	30.3 ± 0.20	<.0001
Monounsaturated fat, g	30.4 ± 0.38	34.1 ± 0.20	<.0001
Polyunsaturated fat, g	17.6 ± 0.26	18.2 ± 0.19	.0827
Cholesterol, mg	295.2 ± 5.5	299.8 ± 3.2	.4134
Vitamin E, mg ATOC	7.6 ± 0.16	7.2 ± 0.11	.1081
Vitamin A (RE)	670.6 ± 25.5	584.2 ± 11.8	.0009
Thiamin, mg	1.9 ± 0.03	1.7 ± 0.02	<.0001
Riboflavin, mg	2.2 ± 0.04	2.2 ± 0.02	.4395
Niacin, mg	27.0 ± 0.30	24.3 ± 0.19	<.0001
Vitamin B_6, mg	2.1 ± 0.03	1.9 ± 0.02	<.0001
Total folate, DFE	692.4 ± 14.5	541.3 ± 8.2	<.0001
Vitamin B_{12}, μg	5.3 ± 0.19	5.3 ± 0.14	.7128
Vitamin C, mg	104.6 ± 4.2	91.0 ± 2.4	.0008
Calcium, mg	867.7 ± 18.7	930.9 ± 11.5	.0051
Phosphorus, mg	1428.1 ± 3.6	1402.6 ± 8.8	.0979
Magnesium, mg	316.6 ± 3.6	284.7 ± 2.6	<.0001
Iron, mg	17.7 ± 0.22	15.7 ± 0.13	<.0001
Zinc, mg	13.0 ± 0.19	12.5 ± 0.12	.0407
Copper, mg	1.5 ± 0.02	1.3 ± 0.02	.0005
Sodium, mg	3931.6 ± 32.3	3622.7 ± 28.3	<.0001
Potassium, mg	2910.5 ± 33.0	2746.6 ± 19.6	<.0001

[a]Adjusted for sex, ethnicity, and energy.
[b]Adjusted for sex and ethnicity.

Results

We identified 5213 rice consumers of the 25 374 eligible subjects for these analyses (Table 1). There were 2984 adult rice consumers and 2229 rice-consuming children.

Nutrient and Food Group Intake

Adjusted nutrient intakes are presented in Tables 2A–2D. In children, rice consumption was associated with a greater ($P < .05$) intake of protein, vitamin A, thiamin, niacin, vitamin B_6, total folate, vitamin B_{12}, iron, magnesium, copper, and potassium with lower intake of total and saturated fat compared with those with no rice consumption (Tables 2A, 2B). In adults, rice consumption was associated with a greater ($P < .05$) intake of carbohydrates, dietary fiber, thiamin, niacin, vitamin B_6, total folate, vitamin C, iron, and magnesium with lower consumption of total fat, saturated fat, and calcium. Adjusted daily MyPyramid equivalents are presented in Tables 3A–3D. In all age groups, rice consumption was associated with an increase in sodium intake in the diet (Tables 2A–2D); however, blood pressure was not adversely affected.

Table 2D. Adjusted Nutrient Intake for Rice Products Consumers for Adults—NHANES 1999–2004[a]

	51 y or Older		
	Observations = 6243		
	Users = 1144	Nonusers = 5099	
Nutrients	Mean ± SE	Mean ± SE	P
Energy, kcal[b]	2007.0 ± 39.8	1865.3 ± 17.5	.0026
Protein, g	74.8 ± 1.0	72.9 ± 0.43	.0836
Carbohydrate, g	244.6 ± 2.1	228.1 ± 1.2	<.0001
Dietary fiber, g	16.4 ± 0.36	15.5 ± 0.21	.0210
Total fat, g	67.1 ± 0.80	73.9 ± 0.58	<.0001
Saturated fat, g	21.0 ± 0.33	23.8 ± 0.23	<.0001
Monounsaturated fat, g	24.9 ± 0.35	27.4 ± 0.25	<.0001
Polyunsaturated fat, g	14.9 ± 0.31	15.8 ± 0.20	.0184
Cholesterol, mg	247.8 ± 7.7	269.2 ± 4.5	.0139
Vitamin E, mg ATOC	6.8 ± 0.20	6.7 ± 0.10	.5695
Vitamin A (RE)	627.1 ± 18.2	637.1 ± 12.3	.6673
Thiamin, mg	1.6 ± 0.03	1.5 ± 0.02	.0002
Riboflavin, mg	2.0 ± 0.04	2.1 ± 0.02	.3292
Niacin, mg	22.8 ± 0.42	21.0 ± 0.19	.0002
Vitamin B_6, mg	2.0 ± 0.04	1.7 ± 0.02	<.0001
Total folate, DFE	650.2 ± 16.9	477.7 ± 6.8	<.0001
Vitamin B_{12}, µg	4.7 ± 0.32	5.0 ± 0.12	.4283
Vitamin C, mg	103.5 ± 3.3	89.8 ± 2.1	.0004
Calcium, mg	735.4 ± 12.8	777.4 ± 10.2	.0235
Phosphorus, mg	1184.8 ± 13.7	1192.0 ± 7.8	.6552
Magnesium, mg	279.8 ± 4.1	266.3 ± 2.3	.0019
Iron, mg	15.9 ± 0.27	14.5 ± 0.16	.0001
Zinc, mg	11.0 ± 0.27	10.9 ± 0.14	.8598
Copper, mg	1.2 ± 0.02	1.2 ± 0.02	.5307
Sodium, mg	3303.9 ± 52.0	3006.4 ± 17.8	<.0001
Potassium, mg	2690.0 ± 33.8	2685.0 ± 19.1	.8900

[a]Adjusted for sex, ethnicity, and energy.
[b]Adjusted for sex and ethnicity.

Table 3A. Adjusted Daily MyPyramid Equivalents for Rice Products for Children—NHANES 1999–2004[a]

	2–13 y		
	Observations = 7049		
	Users	Nonusers	
Food Groups	Mean ± SE	Mean ± SE	P
Total grains	7.0 ± 0.13	6.6 ± 0.07	.0027
Non–whole grains	6.5 ± 0.13	6.1 ± 0.07	.0045
Whole grains	0.50 ± 0.04	0.51 ± 0.02	.7689
Total fruits	1.2 ± 0.07	1.1 ± 0.03	.0440
Total vegetables	1.0 ± 0.04	0.94 ± 0.02	.8042
Total meat, poultry, and fish	3.2 ± 0.10	3.0 ± 0.07	.0982
Eggs	0.26 ± 0.03	0.27 ± 0.01	.6816
Legumes	0.10 ± 0.01	0.06 ± 0.01	.0007
Nuts	0.40 ± 0.08	0.35 ± 0.02	.5724
Total dairy	2.1 ± 0.07	2.2 ± 0.04	.0996
Milk	1.6 ± 0.07	1.5 ± 0.03	.1751
Cheese	0.40 ± 0.04	0.64 ± 0.02	<.0001
Yogurt	0.06 ± 0.01	0.04 ± 0.01	.1790
Added sugar	20.5 ± 0.51	22.5 ± 0.32	<.0001
Discretionary fat-solid	40.7 ± 0.75	47.0 ± 0.50	<.0001
Discretionary fat-oils	12.1 ± 0.47	14.2 ± 0.34	.0005

[a]Adjusted for sex, ethnicity, and energy.

In all age groups, rice consumption was associated with greater ($P < .05$) intake of total grains and non–whole grains with no difference in whole grains (Tables 3A–3D). Rice consumers of all age groups had about twice ($P < .05$) the number of legume servings as compared with subjects with no rice consumption. Rice consumers also had less cheese consumption in all age groups. Added sugars and solid discretionary fat were significantly lower ($P < .05$) in all age groups of rice consumers as compared with nonconsumers.

Health Parameters

There were no differences in health parameters in young children (Table 4A). In older children, body weight, waist circumference, triglycerides, and diastolic blood pressure were lower ($P < .05$) in rice consumers

Table 3B. Adjusted Daily MyPyramid Equivalents for Rice Products for Children—NHANES 1999–2004[a]

	14–18 y		
	Observations = 4132		
	Users	Nonusers	
Food Groups	Mean ± SE	Mean ± SE	P
Total grains	8.3 ± 0.21	7.8 ± 0.09	.0203
Non–whole grains	7.8 ± 0.22	7.3 ± 0.09	.0679
Whole grains	0.55 ± 0.05	0.45 ± 0.03	.1233
Total fruits	1.0 ± 0.06	0.97 ± 0.04	.3370
Total vegetables	1.3 ± 0.07	1.3 ± 0.03	.9699
Total meat, poultry, and fish	5.0 ± 0.21	4.2 ± 0.10	.0004
Eggs	0.33 ± 0.04	0.31 ± 0.02	.5633
Legumes	0.15 ± 0.02	0.06 ± 0.01	<.0001
Nuts	0.46 ± 0.14	0.35 ± 0.03	.4261
Total dairy	1.9 ± 0.08	2.2 ± 0.05	.0059
Milk	1.3 ± 0.08	1.3 ± 0.04	.2933
Cheese	0.54 ± 0.05	0.89 ± 0.03	<.0001
Yogurt	0.01 ± 0.01	0.02 ± 0.01	.0108
Added sugar	26.5 ± 1.1	31.8 ± 0.57	<.0001
Discretionary fat-solid	47.2 ± 0.94	53.8 ± 0.55	<.0001
Discretionary fat-oils	19.2 ± 1.0	19.5 ± 0.50	.7764

[a]Adjusted for sex, Ethnicity, and Energy.

Table 3C. Adjusted Daily MyPyramid Equivalents for Rice Products for Adults—NHANES 1999–2004[a]

	19–50 y		
	Observations = 7950		
	Users	Nonusers	
Food Groups	Mean ± SE	Mean ± SE	P
Total grains	8.0 ± 0.13	7.1 ± 0.08	<.0001
Non–whole grains	7.4 ± 0.12	6.6 ± 0.08	<.0001
Whole grains	0.62 ± 0.04	0.53 ± 0.02	.0360
Total fruits	1.1 ± 0.06	0.90 ± 0.04	.0026
Total vegetables	1.7 ± 0.04	1.6 ± 0.03	.0648
Total meat, poultry, and fish	5.5 ± 0.10	5.1 ± 0.08	.0007
Eggs	0.39 ± 0.02	0.45 ± 0.01	.0103
Legumes	0.21 ± 0.01	0.10 ± 0.01	<.0001
Nuts	0.54 ± 0.04	0.56 ± 0.03	.6763
Total dairy	1.5 ± 0.06	1.8 ± 0.03	.0014
Milk	1.0 ± 0.05	0.90 ± 0.03	.3100
Cheese	0.53 ± 0.03	0.82 ± 0.02	<.0001
Yogurt	0.04 ± 0.01	0.03 ± 0.01	.4633
Added sugar	22.9 ± 0.54	27.0 ± 0.54	<.0001
Discretionary fat-solid	45.9 ± 0.70	53.4 ± 0.45	<.0001
Discretionary fat-oils	17.2 ± 0.61	19.4 ± 0.40	.0074

[a]Adjusted for sex, ethnicity, and energy.

than nonconsumers (Table 4B). Hematocrit and hemoglobin were also lower in rice consumers than nonconsumers, but the magnitude of the difference was quite small and still within the reference range.

In adults 19 to 50 years of age, rice consumption was associated with lower ($P < .05$) body weight, BMI, waist circumference, systolic blood pressure, diastolic blood pressure, and C-reactive protein compared with nonconsumers (Table 4C). Again, hematocrit and hemoglobin were also lower in rice consumers than nonconsumers, but similar to what was seen in children, the magnitude of the difference was quite small and still within the reference range. In older adults, only ferritin was lower for rice consumers as compared with nonconsumers (Table 4D).

In children (2–18 years), percentile BMI for age and z scores for BMI for age were not significantly different ($P > .05$) in rice consumers and nonconsumers (Table 5A); however, percentile weight for age and z scores for weight for age were lower ($P < .05$) in rice consumers as compared with nonconsumers. Risk of overweight (BMI, ≥95th percentile) and risk of being overweight (BMI, ≥85th percentile) were not different ($P > .05$) among rice-consuming and non–rice-consuming children (Table 5B). In adults 19 to 50 years old, rice consumers had a lower

Table 3D. Adjusted Daily MyPyramid Equivalents for Rice Products for Adults—NHANES 1999–2004[a]

	51+ y		
	Observations = 6243		
	Users	Nonusers	
Food Groups	Mean ± SE	Mean ± SE	P
Total grains	6.6 ± 0.11	5.8 ± 0.07	<.0001
Non–whole grains	5.8 ± 0.10	5.0 ± 0.06	<.0001
Whole grains	0.80 ± 0.05	0.80 ± 0.02	.9808
Total fruits	1.3 ± 0.06	1.2 ± 0.03	.0722
Total vegetables	1.6 ± 0.05	1.6 ± 0.02	.7247
Total meat, poultry, and fish	4.3 ± 0.13	4.2 ± 0.07	.2995
Eggs	0.40 ± 0.04	0.50 ± 0.02	.0225
Legumes	0.15 ± 0.02	0.08 ± 0.01	.0002
Nuts	0.42 ± 0.04	0.63 ± 0.04	.0017
Total dairy	1.3 ± 0.04	1.4 ± 0.03	.0236
Milk	0.87 ± 0.03	0.89 ± 0.02	.5521
Cheese	0.33 ± 0.02	0.44 ± 0.02	<.0001
Yogurt	0.05 ± 0.01	0.03 ± 0.01	.0364
Added sugar	13.9 ± 0.46	15.9 ± 0.30	.0009
Discretionary fat-solid	37.3 ± 0.68	41.3 ± 0.46	<.0001
Discretionary fat-oils	14.5 ± 0.52	16.8 ± 0.35	.0009

[a]Adjusted for sex, ethnicity, and energy.

Table 4A. Adjusted Physiological Measures for Rice Products Consumers for Children—NHANES 1999–2004

Physiological Measure	2–13 y, Observations = 7049		
	Users = 1424	Nonusers = 5625	
	Mean ± SE	Mean ± SE	P
Weight,[a] kg	32.5 ± 0.30	32.9 ± 0.28	.3335
Body mass index,[a] kg/m^2	18.4 ± 0.12	18.4 ± 0.11	.8291
Waist circumference,[a] cm	62.9 ± 0.33	63.0 ± 0.32	.8120
Triceps skinfold,[a] mm	12.8 ± 0.26	12.9 ± 0.17	.6103
Systolic blood pressure[b]	103.3 ± 0.57	103.3 ± 0.35	.9227
Diastolic blood pressure[b]	56.5 ± 0.68	56.9 ± 0.42	.5990
Total cholesterol,[c] mg/dL	165.6 ± 1.1	164.2 ± 0.86	.2105
HDL cholesterol,[c] mg/dL	53.7 ± 1.2	54.5 ± 0.64	.4108
LDL cholesterol,[c] mg/dL	93.2 ± 1.4	93.5 ± 0.93	.8457
Triglycerides,[d] mg/dL	89.3 ± 3.5	87.6 ± 1.7	.6472
Plasma glucose,[d] mg/dL	92.1 ± 0.92	91.6 ± 0.46	.6268
Insulin,[d] μU/mL	14.4 ± 1.2	12.2 ± 0.33	.0779
TIBC,[e] μg/dL	378.7 ± 5.4	376.9 ± 3.4	.7094
Transferrin sat.,[f] %	20.8 ± 1.1	21.5 ± 0.41	.5360
Ferritin,[e] ng/mL	33.8 ± 2.3	32.7 ± 1.0	.6296
Hematocrit,[e] %	38.9 ± 0.16	39.0 ± 0.12	.5245
Hemoglobin,[e] g/dL	13.3 ± 0.05	13.4 ± 0.04	.2351
Serum folate,[f] ng/mL	17.6 ± 0.50	18.0 ± 0.23	.3869
Folate, RBC,[f] ng/mL	282.3 ± 4.1	278.2 ± 2.7	.3384
Homocysteine,[f] μmol/L	4.7 ± 0.07	4.6 ± 0.04	.3372
C-reactive protein,[g] mg/dL	0.12 ± 0.01	0.14 ± 0.01	.2201
Bone alkaline phosphatase,[g] μg/L	97.3 ± 2.5	98.0 ± 1.5	.7517
N-telopeptides,[g] nmol BCE	4488.5 ± 70.7	4690.0 ± 162.7	.5803

[a]Adjusted for sex, ethnicity, age, and energy.
[b]Adjusted for sex, ethnicity, age, body mass index, and energy.
[c]Adjusted for sex, ethnicity, age, body mass index, energy, saturated fat, and cholesterol.
[d]Adjusted for sex, ethnicity, age, body mass index, and energy.
[e]Adjusted for sex, ethnicity, age, body mass index, energy, iron, and vitamin C.
[f]Adjusted for sex, ethnicity, age, body mass index, energy, folate, vitamin B_6, and vitamin B_{12}.
[g]Adjusted for sex, ethnicity, age and energy.

Table 4B. Adjusted Physiological Measures for Rice Products Consumers for Children—NHANES 1999–2004

Physiological Measure	14–18 y, Observations = 4132		
	Users = 805	Nonusers = 3327	
	Mean ± SE	Mean ± SE	P
Weight,[a] kg	64.7 ± 0.74	67.6 ± 0.49	**.0029**
Body mass index,[a] kg/m^2	23.0 ± 0.27	23.6 ± 0.15	**.0315**
Waist circumference,[a] cm	79.7 ± 0.63	81.8 ± 0.43	**.0068**
Triceps skinfold,[a] mm	15.9 ± 0.42	16.1 ± 0.23	.5529
Systolic blood pressure[b]	109.5 ± 0.43	109.6 ± 0.35	.9332
Diastolic blood pressure[b]	61.5 ± 0.53	62.8 ± 0.43	**.0377**
Total cholesterol,[c] mg/dL	161.5 ± 1.3	160.4 ± 0.88	.4302
HDL cholesterol,[c] mg/dL	54.2 ± 1.6	51.8 ± 0.59	.1867
LDL cholesterol,[c] mg/dL	93.0 ± 2.2	91.9 ± 1.0	.6689
Triglycerides,[d] mg/dL	84.5 ± 2.9	95.4 ± 3.8	**.0420**
Plasma glucose,[d] mg/dL	89.7 ± 1.0	94.0 ± 1.9	.1239
Insulin,[d] μU/mL	12.3 ± 0.60	12.2 ± 0.31	.7770
TIBC,[e] μg/dL	384.7 ± 6.2	382.8 ± 4.4	.7759
Transferrin sat.,[f] %	24.9 ± 0.75	25.7 ± 0.65	.3934
Ferritin,[e] ng/mL	44.1 ± 2.1	46.5 ± 1.9	.4000
Hematocrit,[e] %	42.2 ± 0.13	42.6 ± 0.12	**.0130**
Hemoglobin,[e] g/dL	14.3 ± 0.05	14.5 ± 0.04	**.0054**
Serum folate,[f] ng/mL	12.2 ± 0.32	12.7 ± 0.19	.1566
Folate, RBC,[f] ng/mL	245.4 ± 5.8	246.7 ± 3.2	.8162
Homocysteine,[f] μmol/L	6.2 ± 0.13	6.6 ± 0.08	**.0122**
C-reactive protein,[g] mg/dL	0.16 ± 0.02	0.17 ± 0.01	.7536
Bone alkaline phosphatase,[g] μg/L	42.3 ± 1.7	42.9 ± 1.6	.7826
N-telopeptides,[g] nmol BCE	2662.2 ± 224.3	2576.9 ± 196.5	.7325

[a]Adjusted for sex, ethnicity, age, and energy.
[b]Adjusted for sex, ethnicity, age, body mass index, and energy.
[c]Adjusted for sex, ethnicity, age, body mass index, energy, saturated fat, and cholesterol.
[d]Adjusted for sex, ethnicity, age, body mass index, and energy.
[e]Adjusted for sex, ethnicity, age, body mass index, energy, iron, and vitamin C.
[f]Adjusted for sex, ethnicity, age, body mass index, energy, folate, vitamin B_6, and vitamin B_{12}.
[g]Adjusted for sex, ethnicity, age and energy.

Table 4C. Adjusted Physiological Measures for Rice Products Consumers for Adults-NHANES 1999–2004

Physiological Measure	19–50 y Observations = 7950 Users = 1840 Mean ± SE	Nonusers = 6110 Mean ± SE	P
Weight,[a] kg	78.8 ± 0.70	81.1 ± 0.38	**.0065**
Body mass index,[a] kg/m^2	27.3 ± 0.21	27.9 ± 0.14	**.0181**
Waist circumference,[a] cm	92.6 ± 0.57	94.4 ± 0.34	**.0082**
Triceps skinfold,[a] mm	18.3 ± 0.30	18.7 ± 0.15	.2028
Systolic blood pressure[b]	115.4 ± 0.36	117.3 ± 0.34	<.0001
Diastolic blood pressure[b]	71.7 ± 0.29	72.7 ± 0.24	**.0013**
Total cholesterol,[c] mg/dL	195.4 ± 1.1	195.9 ± 0.86	.7272
HDL cholesterol,[c] mg/dL	53.4 ± 0.78	52.3 ± 0.65	.1768
LDL cholesterol,[c] mg/dL	118.7 ± 1.5	117.3 ± 0.98	.4190
Triglycerides,[d] mg/dL	135.6 ± 6.2	138.1 ± 3.8	.7216
Plasma glucose,[d] mg/dL	96.5 ± 1.1	96.4 ± 0.45	.9452
Insulin,[d] μU/mL	11.9 ± 0.48	11.3 ± 0.26	.2709
TIBC,[e] μg/dL	365.5 ± 3.6	368.0 ± 2.4	.4768
Transferrin sat.,[f] %	26.1 ± 0.46	26.0 ± 0.52	.9409
Ferritin,[e] ng/mL	120.1 ± 5.2	114.4 ± 2.9	.2733
Hematocrit,[e] %	42.9 ± 0.11	43.2 ± 0.10	**.0051**
Hemoglobin,[e] g/dL	14.5 ± 0.04	14.7 ± 0.04	**.0009**
Serum folate,[f] ng/mL	12.3 ± 0.22	12.7 ± 0.25	.1191
Folate, RBC,[f] ng/mL	272.0 ± 4.1	269.2 ± 3.1	.4997
Homocysteine,[f] μmol/L	7.8 ± 0.11	8.0 ± 0.09	.2417
C-reactive protein,[g] mg/dL	0.32 ± 0.02	0.37 ± 0.01	**.0255**
Bone alkaline phosphatase,[g] μg/L	15.3 ± 0.28	15.5 ± 0.32	.6857
N-telopeptides,[g] nmol BCE	488.5 ± 21.4	532.5 ± 34.5	.1500

[a]Adjusted for sex, ethnicity, age, and energy.
[b]Adjusted for sex, ethnicity, age, body mass index, and energy.
[c]Adjusted for sex, ethnicity, age, body mass index, energy, saturated fat, and cholesterol.
[d]Adjusted for sex, ethnicity, age, body mass index, and energy.
[e]Adjusted for sex, ethnicity, age, body mass index, energy, iron, and vitamin C.
[f]Adjusted for sex, ethnicity, age, body mass index, energy, folate, vitamin B_6, and vitamin B_{12}.
[g]Adjusted for sex, ethnicity, age and energy.

Table 4D. Adjusted Physiological Measures for Rice Products Consumers for Adults-NHANES 1999–2004

Physiological Measure	51 y or Older Observations = 6243 Users = 1144 Mean ± SE	Nonusers = 5099 Mean ± SE	P
Weight,[a] kg	79.0 ± 0.76	80.2 ± 0.38	.1729
Body mass index,[a] kg/m^2	28.4 ± 0.27	28.6 ± 0.14	.4750
Waist circumference,[a] cm	98.7 ± 0.67	100.2 ± 0.33	.0521
Triceps skinfold,[a] mm	20.1 ± 0.37	19.8 ± 0.14	.3272
Systolic blood pressure[b]	133.4 ± 0.81	133.2 ± 0.43	.8596
Diastolic blood pressure[b]	71.5 ± 0.47	71.1 ± 0.32	.4030
Total cholesterol,[c] mg/dL	213.0 ± 1.8	212.7 ± 0.96	.8844
HDL cholesterol,[c] mg/dL	56.0 ± 1.4	55.2 ± 0.36	.6343
LDL cholesterol,[c] mg/dL	124.2 ± 2.8	126.6 ± 1.1	.4267
Triglycerides,[d] mg/dL	173.9 ± 18.0	161.9 ± 3.7	.5252
Plasma glucose,[d] mg/dL	106.8 ± 1.8	109.0 ± 1.0	.2050
Insulin,[d] μU/mL	11.7 ± 0.76	12.1 ± 0.30	.6280
TIBC,[e] μg/dL	360.6 ± 3.7	364.2 ± 2.2	.2938
Transferrin sat.,[f] %	25.0 ± 0.62	25.3 ± 0.42	.6757
Ferritin,[e] ng/mL	135.8 ± 7.2	157.9 ± 5.8	**.0476**
Hematocrit,[e] %	42.3 ± 0.17	42.5 ± 0.14	.2185
Hemoglobin,[e] g/dL	14.3 ± 0.06	14.4 ± 0.05	.0722
Serum folate,[f] ng/mL	18.0 ± 0.61	17.8 ± 0.29	.7847
Folate, RBC,[f] ng/mL	354.9 ± 5.8	342.9 ± 3.8	.0677
Homocysteine,[f] μmol/L	9.8 ± 0.20	10.1 ± 0.14	.1333
C-reactive protein,[g] mg/dL	0.47 ± 0.04	0.52 ± 0.02	.2643
Bone alkaline phosphatase,[g] μg/L	17.0 ± 0.65	17.5 ± 0.34	.3479
N-telopeptides,[g] nmol BCE	348.6 ± 31.3	353.8 ± 19.3	.8788

[a]Adjusted for sex, ethnicity, age, and energy.
[b]Adjusted for sex, ethnicity, age, body mass index, and energy.
[c]Adjusted for sex, ethnicity, age, body mass index, energy, saturated fat, and cholesterol.
[d]Adjusted for sex, ethnicity, age, body mass index, and energy.
[e]Adjusted for sex, ethnicity, age, body mass index, energy, iron, and vitamin C.
[f]Adjusted for sex, ethnicity, age, body mass index, energy, folate, vitamin B_6, and vitamin B_{12}.
[g]Adjusted for sex, ethnicity, age and energy.

Table 5A. Weight for Age for Rice Consumers for Children Aged 2–18 y—NHANES 1999–2004

Measures	Users Mean ± SE	Nonusers Mean ± SE	P
Percentile for weight for age	61.0 ± 0.84	63.3 ± 0.73	.0267
z Score for weight for age	0.42 ± 0.03	0.51 ± 0.03	.0249
Percentile for body mass index for age	60.5 ± 1.0	62.3 ± 0.80	.1114
z Score for body mass index for age	0.39 ± 0.04	0.45 ± 0.03	.1774

likelihood of being overweight (relative risk [RR], 0.77; 95% confidence interval [CI], 0.65–0.91; $P < .05$) or obese (RR, 0.83; 95% CI, 0.69–0.1.0; $P < .05$) as compared with nonconsumers (Tables 5C, 5D).

Adults aged 19 to 50 years who consumed rice were less likely to have metabolic syndrome (RR, 0.79; 95% CI, 0.64–0.97; $P < .05$) than those who did not consume rice (Table 6A). Rice consumers of this age group had a lower risk of elevated systolic blood pressure (RR, 0.73; 95% CI, 0.60–0.89; $P < .05$), diastolic blood pressure (RR, 0.70; 95% CI, 0.57–0.87; $P < .05$), and elevated waist size (RR, 0.73; 95% CI, 0.63–0.86; $P < .05$). Risks of low HDL cholesterol, elevated LDL cholesterol, elevated triglycerides, and elevated fasting blood glucose were similar among rice consumers and nonconsumers of this age group. In older adults, only the risk of elevated LDL cholesterol (RR, 0.75; 95% CI, 0.56–0.1.0; $P < .05$) was significantly different among rice consumers and nonconsumers (Table 6B).

Discussion

These data indicate that rice consumption is associated with better nutrient intake in children and adults. The consistency of the association of rice consumption with higher thiamin, niacin, vitamin B_6, total folate, magnesium, and iron with lower discretionary fats (in particular saturated fat) and less added sugars is very positive. There was also fairly consistent (in 3 of 4 age groups) association of rice consumption with higher protein, carbohydrate, dietary fiber, vitamin A, and potassium.

Sodium intake was higher in all age groups of rice consumers, although the differences were in the range of 125 to 300 mg/d. Despite rice being sodium-free, this suggests that some processed rice products may deliver more sodium or that consumers season rice dishes with salt. However, at the same time, potassium was also higher in rice consumers, and recent studies have suggested that potassium may play a role in managing hypertension.[4,5] This may explain why rice consumers were not negatively impacted with higher blood pressure. These data suggest that although individuals may use added salt to flavor foods when consuming rice, the additional fruit and/or vegetable servings may be helping to negate the sodium intake with additional potassium. All of the results above were adjusted for caloric intake, which means that rice consumption was associated with a more nutrient-dense diet.

One interesting consistent finding regarding the MyPyramid equivalents data was that rice consumers of all age groups had greater intake of legumes. The doubling

Table 5B. Likelihood of Rice Consumers Aged 2–18 y Being Overweight or at Risk for Being Overweight—NHANES 1999–2004

Rice	Overweight[a] Odds Ratio (95% CI)	P	At Risk for Being Overweight[b] Odds Ratio (95% CI)	P
User	0.96 (0.78–1.18)	.6823	0.96 (0.82–1.13)	.6246
Nonuser	1.00 (1.00–1.00)		1.00 (1.00–1.00)	

Abbreviations: BMI, body mass index; CI, confidence interval.
[a]BMI, ≥95th percentile.
[b]BMI, ≥85th percentile.

Table 5C. Likelihood of Rice Consumers Aged 19–50 y Being Overweight or Obese—NHANES 1999–2004

Rice	Overweight (BMI, ≥25 kg/m^2) Odds Ratio (95% CI)	P	Obese (BMI, ≥30 kg/m^2) Odds Ratio (95% CI)	P
Users	0.77 (0.65–0.91)	.0027	0.83 (0.69–1.00)	.0487
Nonusers	1.00 (1.00–1.00)		1.00 (1.00–1.00)	

Abbreviations: BMI, body mass index; CI, confidence interval.

Table 5D. Likelihood of Rice Consumers 51 y or Older Being Overweight or Obese—NHANES 1999–2004

Rice	Overweight (BMI, ≥25 kg/m^2) Odds Ratio (95% CI)	P	Obese (BMI, ≥30 kg/m^2) Odds Ratio (95% CI)	P
Users	1.07 (0.88–1.30)	.4939	0.88 (0.71–1.10)	.2669
Nonusers	1.00 (1.00–1.00)		1.00 (1.00–1.00)	

Abbreviations: BMI, body mass index; CI, confidence interval.

Table 6A. Association of Rice Intake on the Risks for Metabolic Syndrome for Adults Aged 19–50 y—NHANES 1999–2004[a]

	Elevated Systolic BP Risk[b]		Elevated Diastolic BP Risk[c]		Elevated BP Risk[d]	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	0.73 (0.60–0.89)	.0023	0.70 (0.57–0.87)	.0020	0.66 (0.57–0.76)	<.0001
Nonuser	1.00 (1.00–1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	
	Lower HDL Risk[e]		**Elevated LDL Risk[f]**		**Elevated Triglycerides Risk[g]**	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	1.03 (0.79–1.36)	.8032	0.98 (0.81–1.19)	.8421	1.10 (0.80–1.50)	.5561
Nonuser	1.00 (1.00–1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	
	Elevated Fasting Glucose Risk[h]		**Increased Waist Size Risk[i]**		**Metabolic Syndrome Risk[j]**	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	0.91 (0.57–1.44)	.6704	0.73 (0.63–0.86)	.0003	0.79 (0.64–0.97)	.0286
Nonuser	1.00 (1.00–1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	

Abbreviations: BP, blood pressure; CI, confidence interval; HDL, high-density lipoprotein; LDL, low-density lipoprotein.
[a]Adjusted for sex, ethnicity, and age.
[b]Elevated systolic BP is defined as ≥130 mm Hg.
[c]Elevated diastolic BP is defined as ≥85 mm Hg.
[d]Elevated BP is defined as ≥130/85 mm Hg.
[e]Lower HDL is defined as <40 mg/dL for men and <50 mg/dL for women.
[f]Elevated LDL is defined as ≥100 mg/dL.
[g]Elevated triglycerides is defined as ≥150 mg/dL.
[h]Elevated fasting glucose is defined as ≥110 mg/dL.
[i]Increased waist size is defined as >102 cm for men and >88 cm for women.
[j]Meets 3 or more of metabolic syndrome risk components.

of legume intake associated with rice consumption may be in part due to rice being consumed as a rice-and-beans pairing. Given that the US Department of Agriculture had to recommend a tripling of bean consumption to help meet the current recommendations for dietary fiber, potassium, and magnesium, recommending more rice consumption may be a viable strategy to help Americans get more legumes/beans in their diet.[6]

Although there were no changes in health parameters comparing young (2–13 years old) rice consumers and nonconsumers, adolescent rice consumers had lower body weight, BMI, and waist circumference than nonconsumers. The association of rice consumption with lower body weight in adolescents was probably responsible for the lower percentile and *z* scores for weight for age in children aged 2 to 18 years. Overall rice consumption was not associated with any changes in risk for being overweight in children 2 to 18 years of age. Thus, consumption of this carbohydrate-rich food can be confidently recommended to children.

In older adults (50+ years), we do not see many changes in physiological parameters comparing rice consumers and nonconsumers. However, in younger adults (19–50 years), we see a significant association of rice consumption with lower weight status and better blood pressure status. The differences in these weight and blood pressure results in a significant reduction in risk of being overweight or obese (about a 20% reduction in risk) and a significant reduction in risk for having elevated blood pressure (about a 30% reduction in risk) for this age group (even in the presence of slightly higher sodium intakes). These effects lead to the finding that rice consumption was associated with about a 20% reduced risk of having metabolic syndrome in young adult rice consumers as compared with nonconsumers. The lack of these findings in older adults may indicate that any benefit of rice consumption may be overwhelmed by age-associated changes in physiological function (ie, increased blood pressure associated with age).

In adolescents and adults, we see lower hematocrit and hemoglobin levels in rice consumers as compared with nonconsumers. These differences, although statistically significant, are not biologically significant as the mean values are well within the reference range. These results

Table 6B. The Association of Rice Intake on the Risks for Metabolic Syndrome for Adults 51 y or Older—NHANES 1999–2004[a]

	Elevated Systolic BP Risk[b]		Elevated Diastolic BP Risk[c]		Elevated BP Risk[d]	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	1.11 (0.94–1.30)	.2030	1.05 (0.86–1.28)	.6375	1.11 (0.94–1.30)	.2110
Nonuser	1.00 (1.00–1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	
	Lower HDL Risk[e]		**Elevated LDL Risk[f]**		**Elevated Triglycerides Risk[g]**	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	1.27 (0.99-1.63)	.0586	0.75 (0.56–1.00)	.0488	0.83 (0.65–1.07)	.1543
Nonuser	1.00 (1.00-1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	
	Elevated Fasting Glucose Risk[h]		**Increased Waist Size Risk[i]**		**Metabolic Syndrome Risk[j]**	
Rice	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
User	0.78 (0.59-1.04)	.0924	0.91 (0.75–1.11)	.3527	1.12 (0.91–1.36)	.2717
Nonuser	1.00 (1.00-1.00)		1.00 (1.00–1.00)		1.00 (1.00–1.00)	

Abbreviations: BP, blood pressure; CI, confidence interval; HDL, high-density lipoprotein; LDL, low-density lipoprotein.
[a]Adjusted for sex, ethnicity, and age.
[b]Elevated systolic BP is defined as ≥130 mm Hg.
[c]Elevated diastolic BP is defined as ≥85 mm Hg.
[d]Elevated BP is defined as ≥130/85 mm Hg.
[e]Lower HDL is defined as <40 mg/dL for men and <50 mg/dL for women.
[f]Elevated LDL is defined as ≥100 mg/dL.
[g]Elevated triglycerides is defined as ≥150 mg/dL.
[h]Elevated fasting glucose is defined as ≥110 mg/dL.
[i]Increased waist size is defined as >102 cm for men and ≥88 cm for women.
[j]Meets 3 or more of metabolic syndrome risk components.

might suggest data from vegetarians, which usually have lower iron status based on elimination of heme iron in their diets, among rice consumers compared with nonconsumers.

The association of rice consumption with lower C-reactive protein in young adult rice consumers is an interesting finding given recent news on the role of chronic inflammation and health. These findings should be examined in other studies.

Overall, these data indicate that rice consumption is associated with positive improvements in the diet of children and most adults with concomitant improvement in some health parameters.

That said, it is important to remember that these results are from a cross-sectional epidemiological study, and as such, we cannot draw conclusions about cause and effect. Rice consumption was associated with better nutrient intake and, in some cases, better health status; however, we cannot conclude that these changes were exclusively due to rice consumption. It is possible that rice consumers have an overall healthier diet or that they exercise more, which may also explain these results. Even with that caveat, we can clearly convey that rice consumption is at least a marker for these positive results.

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