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Correlates of Fruit and Vegetable Intakes in US Children

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ABSTRACT

The objective of this study was to assess the quality of the current intakes of fruits and vegetables compared to the *Dietary Guidelines for Americans* in US children and adolescents and identify factors related to low fruit and vegetable intake. This descriptive study examined differences in fruit and vegetable intakes by age, sex, ethnicity, poverty level, body mass index, and food security status utilizing data from the 1999-2002 National Health and Nutrition Examination Survey. Six thousand five hundred thirteen children and adolescents ages 2 to 18 years, who were respondents to the 1999-2002 National Health and Nutrition Examination Survey. Mean fruit and vegetable intakes were computed using 24-hour recalls for individuals and compared using analysis of variance. Leading contributors to fruit and vegetable intake were identified using frequency analysis. Children aged 2 to 5 years had significantly higher total fruit and juice intakes than 6- to 11- and 12- to 18-year-olds. Total vegetable and french fry intake was significantly higher among 12- to 18-year-old adolescents. Regarding sex differences, boys consumed significantly more fruit juice and french fries than girls. In addition, non-Hispanic African-American children and adolescents consumed significantly more dark-green vegetables and fewer mean deep-yellow vegetables than Mexican-American and non-Hispanic white children and adolescents. Total fruit consumption also differed significantly among race/ethnicities and household income. Children and adolescents most at risk for higher intakes of energy-dense fruits and vegetables (fruit juice and french fries) were generally boys, and adolescents, at risk for overweight or overweight and living in households below 350% of the poverty level.
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Fruit and vegetable intakes in children and adolescents in the United States are below recommended levels (1-6). Diets low in fruits and vegetables are likely low in essential nutrients and substances like phytochemicals, which may increase the risk for several diseases (7-9). Nutrient-dense fruits and vegetables, which are most strongly correlated with decreased risk for multiple chronic diseases, include green leafy, yellow/orange, and cruciferous vegetables, as well as citrus fruits (10-19); however, the most commonly consumed fruits and vegetables by Americans are tomatoes, potatoes (french-fried), bananas, oranges (juice), and iceberg lettuce (20,21).

The purpose of this study was to identify factors (eg, age, sex, race/ethnicity, body mass index, income, and food security status) significantly related to fruit and vegetable intakes in US children and adolescents (ages 2 to 18 years) using 1999-2002 National Health and Nutrition Examination Survey (NHANES) data, and to assess the sources of the current intakes of fruits and vegetables (22,23).

METHODS

Correlates of fruit and vegetable intake in US children and adolescents aged 2 to 18 years were assessed using 1999-2002 NHANES data. A final sample of 6,513 children and adolescents included those meeting the following criteria: aged between 2 and 18 years, food intake data available, and nonpregnant. The associations among fruit and vegetable intakes and sex, ethnicity, poverty level, weight status, and food security status were examined.

The dependent variables, fruit and vegetable intakes from 24-hour recalls, were measured using the US Department of Agriculture MyPyramid Equivalents Database (24). To identify the contribution of some groups of interest, vegetables consumed as french fries and fruit intakes from 100% fruit juice were generated for each analysis. Potato and fruit juice consumption have increased to contribute nearly one third of vegetable intakes and one quarter of fruit intakes, respectively, in the United States (6,25-27).

The factors examined for a relationship with fruit and vegetable intakes included age, sex, ethnicity, poverty level, weight status, and food security status. Age categories were created for preschool (age 2 to 5 years), young children (age 6 to 11 years), and adolescents (age 12 to 18 years). Race/ethnicity categories were Mexican American, non-Hispanic white, and non-Hispanic African American; those who were "other Hispanic" and "other race" were excluded from the analyses due to small sample sizes and difficulty in interpretation of the data. Household income was categorized into ≤130%, 130% to 350%, and >350%

of the federal poverty level. Weight status categories were created using body mass index percentile ranges for children: 5 to <85th percentile, 85th to <95th percentile, and >95th percentile (28), whereas food security classifications included fully food secure, marginally food secure, food insecure without hunger, and food insecure with hunger (29).

To identify factors related to fruit and vegetable intakes, we examined mean intakes in children and adolescents (ages 2 to 18 years) by sex, ethnicity, poverty level, weight status, and food security status. The leading contributors of total fruit and vegetable intakes were determined using the following formula (20):

$$\left(\sum \text{total fruit or vegetable cup-equivalents from each food group}\right) \div \left(\sum \text{total fruit or vegetable cup-equivalents from all foods}\right).$$

The mean proportion of total vegetables that were french fries and the mean proportion of total fruit that was juice were compared among various population subgroups. Finally, a logistic regression was conducted to identify correlates related to the likelihood of meeting recommendations on total fruit and vegetable intake on a given day. Those meeting recommended intakes of fruit and vegetables were classified using sedentary standards due to the lack of complete physical activity data for children and adolescents in the NHANES sample.

Pooled sample weights for the 4-year survey design were applied to yield a representative US population sample that adjusts for the complex sampling collection design of NHANES. SPSS Complex Samples (version 15.0, 2006, SPSS Inc, Chicago, IL) was used for statistical analyses. We used means±standard error, frequency analyses for fruit and vegetable intakes, and percent contribution and logistic regression to examine the correlates of fruit and vegetable intakes.

RESULTS AND DISCUSSION

The weighted sample of 6,513 children and adolescents contained 13.8% Mexican-American, 69.8% non-Hispanic white, and 16.4% non-Hispanic African-American individuals; 49% were girls. Seventy-five percent of the sample lived in households determined fully food secure, whereas 7.3% lived in marginally food secure households, 10.9% lived in households determined food insecure without hunger, and 6.2% lived in households determined food insecure with hunger. The mean intakes for both total vegetable and total fruit were 1.0 c per day.

As shown in Table 1, total vegetable consumption per day differed significantly across all age groups ($P<0.001$), although younger children consumed significantly more total fruit per day ($P=0.005$). Boys consumed significantly more total vegetables than girls (mean 1.10±0.03 and 0.98±0.03 c, respectively; $P=0.006$); however, total fruit intakes were not significantly different by sex. Total fruit intakes by Mexican Americans were significantly higher than those of non-Hispanic white children and adolescents ($P=0.035$). Total fruit intakes were significantly higher in children and adolescents living in households above 350% of the federal poverty level than households with incomes between 130% and 350% of the poverty-income ratio ($P<0.045$), although no differences existed across income levels for vegetable intakes. Similarly, children and adolescents living in households determined food insecure without hunger had the lowest mean intakes of total vegetables and fruit, but the differences across food security status were not significant. When assessing differences by weight status, no significant differences were seen among mean total vegetable intakes; however, mean total fruit intake was significantly higher in at-risk-for-overweight children ($P<0.001$).

To identify the primary sources of fruit and vegetable intakes in US children and adolescents, individual food intake data were used to determine which foods were the leading contributors to total fruit and vegetable intakes. The leading source of vegetables was french fries, which accounted for more than 28% of total vegetable intake. Adolescents consumed significantly more vegetables as french fries than children aged 2 to 5 years and 6 to 11 years ($P<0.001$, Table 1). Boys also consumed significantly more vegetables as french fries than girls ($P=0.028$). A nonsignificant trend for french-fry intake was noted, with the greatest intakes found in children living in food insecure with hunger households ($P=0.10$).

The leading source of total fruit was 100% fruit juice. Juice accounted for significantly more (>40%) of total fruit intake among 2- to 5-year-old children than 6- to 11-year-old and 12- to 18-year-old children ($P=0.006$). Boys consumed significantly more fruit juice than girls ($P=0.020$, Table1). Children living in households above 350% of the poverty level had the highest proportion of fruit as juice compared to children living in households between 130% to 350% of the poverty level ($P=0.015$). Similarly, children living in marginally food secure households had the highest intakes to total cups of fruit from juice compared to other food security categories, but the differences were not significant.

Table 2 presents the results of the logistic regression predicting those not meeting total fruit and total vegetable intake recommendations on a particular day. Six- to 11-year-old children were 2.7 and 1.5 times more likely than 2- to 5-year-olds to not meet MyPyramid fruit and vegetable intake recommendations, respectively. Adolescents were four times more likely to underconsume fruit and nearly 2.5 times more likely to underconsume vegetables. Mexican-American children were two thirds more likely to consume adequate amounts of fruit than non-Hispanic white children. Children from households >130% of the poverty-income ratio were 1.6 to 1.7 times more likely not to meet fruit intake recommendations.

These findings indicate that a large proportion of US children and adolescents were below the recommended fruit and vegetable intakes (23). Younger children consumed more fruit than older children and adolescents; however, vegetable intakes were lower. Johnston and colleagues (21) found that white potatoes contributed more than 30% of vegetable intake among US adults. Furthermore, only 8% of vegetables consumed by children and adolescents aged 2 to 19 years were dark green or orange, whereas fried potatoes constituted about 46% of total vegetable intakes, according to baseline data used by Healthy People 2010 (5). Higher intakes of french fries and lower intakes of fruits and vegetables have been

Table 1. Mean intakes of vegetables and fruits of US children by age, sex, body mass index (BMI), poverty status, food security, and race/ethnicity (1999-2002)

Demographic characteristic	Sample n	Sample %	Total fruit (cup equivalents)	% of MyPyramid fruit recommendations	Fruit juice (cups)	Total vegetable (cup equivalents)	% of MyPyramid vegetable recommendations	French fries (cups)
			← mean±standard error →					
Total sample	—	—	1.03±0.04	76.8±2.6	0.42±0.02	1.04±0.02	54.8±1.1	0.13±0.00
Age category								
2-5 y	1,202	21.2	1.29±0.06[x]	129.7±5.6[x]	0.52±0.03[x]	0.76±0.03[x]	62.8±2.6[x]	0.11±0.01[x]
6-11 y	1,838	36.9	0.99±0.05[y]	71.5±3.7[y]	0.38±0.03[y]	0.98±0.03[y]	58.3±1.7[y]	0.10±0.01[x]
12-18 y	3,473	41.9	0.93±0.05[y]	54.6±3.0[z]	0.40±0.03[y]	1.22±0.03[z]	47.6±1.2[z]	0.16±0.01[y]
Sex								
Male	3,289	51.0	1.07±0.05	75.3±3.1	0.46±0.03[x]	1.10±0.03[x]	54.2±1.5	0.14±0.01[x]
Female	3,224	49.0	0.98±0.04	78.3±3.3	0.38±0.02[y]	0.98±0.03[y]	55.4±1.7	0.11±0.01[y]
Race/ethnicity								
Mexican American	2,512	13.9	1.16±0.04[x]	88.8±2.8[x]	0.46±0.03	1.06±0.04	57.7±2.0	0.12±0.01
Non-Hispanic white	1,907	69.8	1.00±0.05[y]	74.3±3.5[y]	0.40±0.03	1.04±0.03	54.4±1.5	0.12±0.00
Non-Hispanic African American	2,094	16.4	1.05±0.04[xy]	77.1±2.9[y]	0.46±0.03	1.00±0.03	53.7±1.7	0.14±0.01
BMI category[a]								
Normal weight	4,263	69.8	1.02±0.05[x]	77.2±3.3[x]	0.42±0.03	1.03±0.03	54.9±1.4	0.12±0.00
At risk for overweight	1,045	15.1	1.16±0.06[y]	85.8±4.4[x]	0.42±0.04	1.03±0.04	56.3±2.1	0.12±0.02
Overweight	1,205	15.1	0.94±0.05[x]	65.6±3.7[y]	0.41±0.04	1.06±0.04	52.5±2.3	0.15±0.01
Household income[b]								
Lowest-130%	2,600	32.3	0.99±0.06[xy]	74.6±4.2[x]	0.41±0.04[xy]	1.05±0.03	56.9±1.4	0.13±0.01
130%-350%	2,120	37.8	0.93±0.06[x]	70.1±4.0[x]	0.36±0.03[x]	0.99±0.02	53.6±1.6	0.12±0.01
350%-highest	1,155	29.9	1.17±0.04[y]	85.3±3.0[y]	0.46±0.03[y]	1.08±0.04	53.9±2.2	0.13±0.01
Household food security								
Fully food secure	4,089	75.6	1.04±0.04	77.3±2.9	0.42±0.03	1.05±0.03	54.7±1.4	0.13±0.00
Marginally food secure	638	7.3	1.06±0.09	79.7±6.7	0.57±0.07	1.01±0.05	55.5±2.9	0.11±0.02
Food insecure without hunger	1,037	10.9	0.94±0.06	72.3±5.2	0.37±0.03	0.98±0.04	53.8±2.1	0.11±0.01
Food insecure with hunger	487	6.2	1.00±0.14	72.5±9.6	0.39±0.08	1.04±0.04	54.6±2.8	0.20±0.04

[a]Based on BMI percentiles from the 2000 Centers for Disease Control and Prevention BMI-for-age growth charts (28).
[b]Annual household income, expressed as a percent of the federal poverty level.
[xyz]Means with different superscripts (x, y, z) indicate significant differences ($P<0.05$).

associated with increased television viewing among children, especially during mealtimes (30,31).

Similarly, 100% fruit juice contributed more than 30% to total fruit intakes among 6- to 11-year-olds, while contributing more than 38% among 2- to 5-year-olds and 12- to 18-year-olds. The proportion of fruit juices contributing to total fruit intake among the different age categories partly explain this phenomenon because 2- to 5-year-old children consumed significantly higher fruit intakes than 6- to 11-year-olds and 12- to 18-year-olds. Furthermore, the percentage of children meeting fruit recommendations has been shown to decline with age (32). Recommendations from the *Dietary Guidelines for Americans 2005* specify that no more than half of fruit intakes should be obtained from fruit juice (22).

Among differing ethnicities, Mexican Americans consumed significantly more fruit than non-Hispanic white children and adolescents. A recent study showed among Mexican-American food secure families, mothers' attitudes about availability of healthful eating were positively associated with children's fruit intake (33). Efforts should be made to promote fruit intakes in all children, especially in non-Hispanic white and African-American children.

Recent literature in childhood obesity indicates a disparity in diet quality, with overweight children presenting with less desirable food intake habits (34,35). In our study, overweight children and adolescents consumed less total fruit and more french fries than those that were normal weight or at risk for overweight. Our data did not indicate a difference in fruit juice intakes by weight status in a nationally representative sample; however, fruit juice intakes and risk of overweight remain a controversial issue due to findings from nonrepresentative sam-

Table 2. Percent and likelihood of US children not meeting MyPyramid fruit and vegetable recommendations on 1 day by age, sex, race, weight status, household income, and food security status

	Not Meeting Fruit Intake Recommendations on 1 Day		Not Meeting Vegetable Intake Recommendations on 1 Day	
Child demographic characteristics	**%**	**OR[a] (95% CI[b])**	**%**	**OR (95% CI)**
Age category				
2-5 y	50.2	Referent	78.3	Referent
6-11 y	74.1	2.78 (2.25,3.44)	83.8	1.50 (1.25,1.80)
12-18 y	80.5	4.16 (3.34,5.17)	89.5	2.44 (1.83,3.25)
Sex				
Male	73.0	Referent	85.0	Referent
Female	70.4	0.89 (0.72,1.09)	85.1	1.02 (0.82,1.28)
Race/ethnicity				
Non-Hispanic white	72.7	Referent	85.2	Referent
Mexican American	66.4	0.66 (0.54,0.81)	82.9	0.83 (0.67,1.04)
Non-Hispanic African American	71.9	0.81 (0.60,1.08)	86.1	0.96 (0.75,1.24)
BMI category[c]				
Normal weight	71.3	Referent	85.0	Referent
At risk for overweight	70.5	0.90 (0.73,1.12)	81.5	0.75 (0.57,1.01)
Overweight	74.9	1.00 (0.79,1.26)	88.6	1.26 (0.89,1.77)
Household income[d]				
Lowest-130%	72.2	Referent	84.9	Referent
130%-350%	75.2	1.60 (1.23,2.08)	85.2	1.03 (0.77,1.36)
350%-highest	67.8	1.70 (1.40,2.07)	85.0	1.07 (0.85,1.34)
Household food security				
Fully food secure	71.8	Referent	85.2	Referent
Marginally food secure	71.4	0.95 (0.70,1.28)	85.3	1.08 (0.67,1.76)
Food insecure without hunger	71.5	0.91 (0.67,1.24)	85.5	1.04 (0.76,1.41)
Food insecure with hunger	73.9	0.93 (0.54,1.62)	85.3	1.07 (0.65,1.77)

[a]OR=odds ratio.
[b]CI=confidence interval.
[c]BMI=body mass index. Based on BMI percentiles from the 2000 Centers for Disease Control and Prevention BMI-for-age growth charts (28).
[d]Represents the percent of the annual household family income compared to the federal poverty rate.

ples. A recent study by Melgar-Quinonez and Kaiser (6) found risk of overweight (≥85th body mass index percentile) was positively related to juice intake in Mexican-American preschool-aged children. Juice intakes (≥12 fl oz) were also positively related to overweight in 2- and 5-year-old (97% white) children (36); no association between juice intake and overweight was seen in three other studies conducted with preschool-aged children (37-39).

Household income and limited financial resources have shown a compromising effect on diet quality in US households (40,41). There was a significant inverse association between household income and fruit juice intake, where those living in wealthier households had higher intakes from fruit juice than children and adolescents living in households below 350% the federal poverty level. Lower socioeconomic households with younger children may have been relying more on less-expensive vegetable sources, such as canned vegetables and french fries (42). Our findings are similar to those of Munoz and colleagues (41), who found fruit intakes were significantly higher in children from households above 130% of the federal poverty level.

Children living in food insecure households had higher proportions of french fries contributing to total vegetable intakes than children and adolescents living in fully food secure households. Drewnowski (42) has explored the economics of obesity and has described the role of low-cost, energy-dense foods in households with limited incomes. Similarly, fruit intakes are commonly higher in households with greater household incomes.

There are several limitations to this study. The 24-hour recall method may suffer recall bias, limiting the accuracy or completeness of the information; however, dietary interviewers went through training to properly execute 24-hour recalls and used computer-assisted dietary interview software. Finally, given the cross-sectional nature of our data, differences across levels of key demographic variables do not indicate a causal nature for differences in fruit and vegetable intakes.

CONCLUSIONS

Mean intakes by children and adolescents were below recommended levels of fruit and vegetable intakes. Children and adolescents most often not meeting MyPyramid recommendations were boys, older, and living in households between 130% and 350% of the federal poverty level. These children and adolescents should be targeted for nutrition interventions focusing on amounts and types of fruits and vegetables to consume. Nevertheless, there is a common need among American children and adolescents for nutritional interventions designed to increase daily fruit and vegetable consumption. When counseling children, adolescents, and their parents/caregivers, food and nutrition professionals need to address factors that may influence fruit and vegetable intake, such as sex, age, race/ethnicity, and income.

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