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RESEARCH ARTICLE

Associations of Deciles of Orange Juice Consumption with Nutrient Intake, Diet Quality, and Weight in Children Using National Health and Nutrition Examination Survey 2003-2016 Data

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Abstract

Objective: The purpose of this study was to examine the relationship among deciles of orange juice (OJ) consumption with nutrient intake, diet quality, fruit consumption, and weight parameters in children 2-8 and 9-18 years participating in the National Health and Nutrition Examination Survey 2003-2016.

Methods: Intake was determined using 24-hour dietary recalls. Primary analyses were based on linear regression of deciles of OJ on energy; nutrients; diet quality, determined by the Healthy Eating Index-2015 (HEI); fruit consumption; and weight parameters: weight, body mass index z-score, and percent overweight and obese. Subjects were separated into two age groups: 2-8 and 9-18 years; consumption of OJ was categorized by 10 deciles. All analyses were adjusted for complex sampling design of NHANES and incorporated appropriate sample weights as recommended by the NHANES analytical guidelines; and were performed using SAS release 9.4. Significance was $p < 0.01$ for all analyses.

Results: Energy and nutrient intake varied among age groups; except those 2-8 years, energy showed a positive linear association with decile of OJ consumption. Most nutrients, including dietary fiber, folate DFE, vitamin C, calcium, magnesium, and potassium showed a positive linear association for all age groups. There was no positive linear association with added sugars in any of the age groups. Total HEI scores and the total fruit subcomponent also showed a positive linear association in all age groups. In separate analyses, there were no linear associations with whole fruit in any age group, although there was for total fruit and fruit juice. There was no association for any of the weight parameters in any age group.

Conclusion: Consumption of OJ should be encouraged by children as part of an overall healthy diet, since it improves nutrient intake and diet quality and is not associated with weight parameters.

Key words: Orange juice, fruit juice, nutrient intake, healthy eating index, fruit consumption, weight, children, NHANES

Abbreviations

AAP: American Academy of Pediatrics; BMI: Body Mass Index; Cup eq: Cup equivalent; DFE : Dietary folate equivalents; DGA: Dietary Guidelines for Americans; DV: Daily Value; FJ: 100% Fruit Juice; FPED: Food Pattern Equivalents Database; HEI: Healthy Eating Index-2015; Kcals: Kilocalories; NFS: Not Further Specified; NHANES National Health and Nutrition Examination Survey; OJ: 100% Orange Juice; PIR: Poverty Index Ratio; RAE : Retinol Activity Equivalents; SFA: Saturated Fatty Acids; WWEIA What We Eat In America; Years: Years of Age

Introduction

One hundred percent orange juice (OJ) is the most commonly consumed 100% fruit juice (FJ) in the United States with a per capita availability of 2.45 gallons [1]. According to the Economic Research Service of the United States Department of Agriculture, per capita availability of all FJ, including OJ, has fallen significantly over the past 20 years [1]. To compare with the above number, for OJ, maximum per capita availability was 6.14 gallons in 1998 [1]. One cup (8 oz) of 100% OJ constitutes 1 cup equivalent (cup eq) from the fruit group. Fruit recommendations for children vary by age and gender, but range from 1 cup eq for children 2-3 years of age

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(years) to 2 cup eq for males 14-18 years [2]. The US Dietary Guidelines for Americans (DGA) [3] reports that 100% FJ "can be part of healthy eating patterns;" however, they recommend that at least half the fruit recommendation come from whole fruit since whole fruit is a better source of fiber. The American Academy of Pediatrics [4], however, has recommended that FJ not be given to infants 12 months of age or younger, unless clinically indicated, and that FJ intake should be limited to 4 ounces/day, 4-6 ounces/day, and 8 ounces/day for children 1-3 years, 4-6 years, and 7-18 years, respectively [4].

Citrus juices, including 100% OJ, are among the most nutrient dense of the FJs [5]. The nutrient content of OJ varies slightly depending upon the type, e.g. baby OJ vs canned vs fresh; processing; fortification; ripeness of the fruit at juicing; and growing conditions. However, an 8 ounce serving of OJ Not Further Specified (NFS) (Food Code 61210000, What We Eat in America (WWEIA) [6] provides the following nutrient content [7]: 119 kilocalories (kcals); 0.74 g dietary fiber; total sugars 20.6 g; calcium 139 mg; magnesium 27.3 mg; phosphorus 69.4 mg; potassium 441 mg; vitamin C 83.3 mg; folate DFE (dietary folate equivalents) 47.1 µg; and vitamin A RAE (Retinol Activity Equivalents) 4.69% µg. Citrus juices are also major contributors of total flavonoids and antioxidants in the diet [8,9].

Orange juice provides nearly 100% of the new Food and Drug Administration for labeling of daily values (DV) of vitamin C, approximately 10% of the DV of folate DFE and 10% potassium for children 4 years of age and older [10]. Vitamin C and potassium are among the underconsumed nutrients identified by the 2015-2020 DGA [3].

Over the past decade, using various national data sets including the National Health and Nutrition Examination Survey (NHANES), the UK (United Kingdom) National Diet and Nutrition Survey, and Brazil's Pesquisa de Orçamentos Familiares, a number of studies have shown positive associations between FJ and nutrient intake or adequacy [11-15], consumption of total or whole fruit [12; 14], and diet quality [9; 15-17] in children. However, studies on OJ alone are very limited; but those that have studied specifically OJ consumption have demonstrated an association with higher nutrient intake [9; 16], nutrient adequacy [18]; and diet quality [9;16] in children. Some of the limitations of most of these studies was that they used older data, had relatively small populations with a limited number of NHANES cycles, and only compared consumers vs non-consumers without accounting for the amount of FJ/OJ consumed.

It is clear that consumption of either FJ or OJ can contribute significantly to the diets of children. Despite this, recommendations to limit FJ consumption [3; 4; 19] and even against consuming any type of FJ have been made [20]. Although there are limited data to support limitation of FJ consumption, there are a number of arguments that have been made on why to limit FJ recommendations.

The lack of dietary fiber in FJ is one reason cited why consumption of FJ should be limited [3] and intake of whole fruit should be encouraged. Several studies that have looked at nutrient intake of those consuming FJ have shown that while dietary fiber intake is low in children, it is higher in FJ/OJ consumers [9; 18; 21]. Recently, however, Maillot, et al., using NHANES 2013-2016 data, reported there was no difference in fiber consumption between children who consumed OJ and those that did not [8]. Clearly additional studies are needed.

The most compelling reasons given for limiting FJ intake is the sugar content; although, by definition, none of the sugars found in 100% FJ/OJ are added sugars [22]. There is concern that consumption of excess sugar, especially fructose, the main sugar in FJ, can contribute to variety of metabolic diseases including obesity, dyslipidemia, and diabetes [23]; however many of the study results are controversial. With the exception of obesity, most of these studies have been conducted in adults. Further, concern about fructose may be misplaced, since an eight oz serving of OJ contributes only 10% of fructose to the diet [22].

The main reason that FJ has been of concern as a beverage for children is that it has been associated with overweight and obesity in children, with the first publication appearing more than 20 years ago [24]. Thus, the issue of weight and FJ consumption has been a key health issue for children and adolescents over the past several decades. Multiple studies, including one systematic review [25] and two meta-analyses [21; 26], have shown no or very little association with weight and fruit juice consumption in children. Other studies have shown a positive association with FJ consumption and weight in select populations of children [25; 27-28]. Studies that have looked at children who consume OJ have also provided conflicting results. Some have shown no association or an inverse relationship [16; 29]; whereas, Sakaki et al., [30] showed no association with OJ consumption and weight in females, but showed a positive association with males. The objective of this study was to examine the relationship among deciles of OJ consumption for nutrient intake, diet quality, fruit consumption, and weight parameters in children 2-8years and 9-18 years participating in NHANES 2003-2016.

Materials and Methods

Study overview, study population, and analytic sample

Methods similar to those used in this manuscript, including a description of the purpose and overview of NHANES have been published previously [16, 31] and are available on line [32; 33]. Data from children 2 to 18 years of age (years) (N=25,295) participating in NHANES 2003-2016; were used after the exclusion of unreliable data (n=3,218) and pregnant or lactating females (n=85) for a final analytical sample of N=21,998. The children were placed into three age subgroups for analyses: 2-8 years (N=9,288), 9-18 years (N=12,710), and 2-18 years (N=21,998) (the data for children 2-18 are presented as Supplemental Tables.

The National Center for Health Statistics Research Ethics Review Board has approved the use of human subjects for

NHANES studies [34]. Given that this study was a secondary data analysis which lacked personal identifiers, it did not require additional Institutional Review Board approval.

Demographic Data

Demographic data, including age; gender; ethnicity: Mexican-American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, and other; poverty index ratio (PIR): PIR<1.35, 1.35≤PIR<1.85; and physical activity: sedentary, moderate, and vigorous were determined by questionnaire [35].

Dietary Intake Data

Dietary data were collected using two 24-hour dietary recalls using an automated multiple-pass method [36]; the first recall was conducted in person by a trained interviewer, and the second recall was conducted 3 to 10 days later via telephone. Proxies, usually parents or guardians, of children 2-5 years provided the 24-hour dietary recalls; children 6-11 years were assisted by an adult, and all others provided their own recall. Detailed descriptions of the dietary recalls and data collection are available in the NHANES Dietary Interviewer's Training Manual [37].

Determination of energy, nutrients and orange juice intake

Energy and nutrient intake from foods were determined using respective Food and Nutrient Database for Dietary Studies for each NHANES cycle [38; 39] available from total nutrient intake files. Added sugars were defined by the USDA Food Patterns Equivalent Databases [40]. Use of supplements was not included in the analyses.

Orange juice consumption, in grams, was determined using the following orange juice food codes from the WWEIA: 61210000 Orange juice, NFS; 61210010 Orange juice, freshly squeezed; 61210220 Orange juice, canned, bottled or in a carton; 61210250 Orange juice, with calcium added, canned, bottled or in a carton; 61210620 Orange juice, frozen (reconstituted with water); 61210720 Orange juice, frozen, not reconstituted; 61210820 Orange juice, frozen, with calcium added (reconstituted with water); and 67205000 Orange juice, baby food (Beech-Nut; Gerber) [41].

Individual usual Intake (UI) of nutrients was determined using the preferred National Cancer Institute (NCI) method [42]. The NCI macros (Mixtran and Distrib) were used to generate the parameter effects after covariate adjustments and to estimate the distribution of UI. The one part NCI model was used since fruit juices were consumed on most days by most subjects. The covariates for the analyses were the day of the week of the 24-h recall [weekend [Friday-Sunday] vs weekday [Monday-Thursday]) and the sequence of the dietary recalls (first [interview administered] or second [telephone]); variance estimates were obtained using the two days of intake with one-day sampling weights.

Orange juice consumption was then divided into deciles for analyses; those not reporting orange juice consumption were placed into the first decile and those reporting orange juice consumption were then separated into the remaining deciles. For certain analyses non-consumers were defined as having reported no orange juice consumption.

Healthy Eating Index (HEI) and Fruit Consumption Categories

The HEI–2015 was used to determine diet quality [43-45]. The overall HEI-2015 score is made up of 13 components that reflect the different food groups and key recommendations in the 2015-2020 DGA. These components can be divided into "Adequacy": total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids; and foods or nutrients to be consumed in "Moderation": refined grains, sodium, added sugars, and saturated fatty acids (SFA).

Detailed information on the development of the components, scoring standards, and density approach for the HEI-2015 has been described previously [46]. HEI-2015 was calculated using a downloadable SAS program available on the website of the National Cancer Institute [47].

In addition to HEI, total fruit, whole fruit, and fruit juice consumption was also determined from the respective (FPED) for each NHANES survey period database [48].

Weight parameters

Weight and height and were obtained according to NHANES protocols [49]. Body mass index (BMI) was calculated as body weight (in kilograms) divided by height (in meters) squared [50]. The Centers for Disease Control and Prevention's growth chart programs were used to determine BMI for age [51]; children with a BMI greater than or equal to the 85th and less than 95th, and greater than or equal to the 95th percentile were considered overweight or obese, respectively [52].

Statistical analysis

All analyses were adjusted for complex sampling design of NHANES and incorporated appropriate sample weights as recommended by the NHANES analytical guidelines [33]; all analyses were performed using SAS release 9.4 (Cary, NC). Version 2.1 of the National Cancer Institute method [53] was used for estimating individual usual intake of OJ, energy, and nutrients. Regression analyses were used to assess: 1) differences in demographic characteristics of consumers and non-consumers of orange juice; 2) association across deciles of orange juice intake with the mean of each decile as an independent variable of intake for: a) energy and nutrients, b) HEI-2015 total and subcomponent scores, c) total fruit, whole fruit, and fruit from fruit juice, and d) body weight related measures (weight, BMI-z-score, percent (%) overweight, % obese, and % overweight or obese). A p value of <0.01 was considered significant.

Results

Demographics

Demographics for children 2-8 years and 9-8 years comparing OJ consumers and non-OJ consumers are

presented in Tables 1 and 2, respectively. OJ consumers were 16.6±0.8% and 12.7±0.5% for children 2-8 year and 9-18 years, respectively.

Overall, there were no differences in gender or weight parameters in any of the age groups; however, there were differences in ethnicity, PIR, physical activity; kilocalories (kcals) consumed, and grams of OJ consumed in each of the age groups. However, these were not consistent. For children 2-8 years the percentage of non-Hispanic whites that consumed OJ was lower (β= -9.6% units; p=0.0003) than the percentage of non-consumers whereas the percentage of non-Hispanic blacks that consumed OJ was higher (β=3.% units7; p=0.0038) than non-consumers. There were no other ethnic differences in these children. In this age group, energy in kilocalories (kcals) (β=92.4 kcals; p=0.0010) and grams of food consumed was higher (β=87.8 kcals; p=0.0030) in consumers when compared with non-consumers.

In children 9-18 years (Table 2), Mexican American (β=7.4 % units; p<0.0001), and other Hispanics (β=3.8 % units; p=0.0012) had a higher percentage of OJ consumers than non-consumers; whereas, non-Hispanic whites (β=-13.6 % units; p<0.0001) had a lower percentage of OJ consumers than non-consumers. Children in the lowest PIR (<1.35%) had a higher percentage of OJ consumers than non-consumers (β=6.8 % units; p=0.0004). Orange juice consumers also had a higher (β=4.7 % units; p=0.0050) percentage of those doing vigorous physical activity than non-consumers. Similar to the younger children, energy (β=278 kcals; p<0.0001) and grams (β=218 kcals; p<0.0001) of food consumed were higher in OJ consumers than non-consumers.

Overall, in children 2-18 years (Supplemental Table 1), OJ consumers were younger (β=-0.81 units; p<0.0001). Ethnic differences were seen in consumers of OJ for Mexican American (β=5.9; p<0.0001), Other Hispanic (β=3.2; p=0.0001, non-Hispanic Whites (β=-11.98; p<0.0001), and non-Hispanic Blacks (β=3.2; p=0.004). There were also differences in the PIR with children in the lowest category showing a positive relationship with OJ consumption (β=5.8;

Table 1. Comparison of demographic data for the total population, for orange juice non-consumers, for children 2-8 years participating in the National Health And Nutrition Examination Survey from 2003-2016.

	Total Population			Non-consumers, OJ			Consumers, OJ[1]			Cons vs Non-Cons		
Variable	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**Beta**	**SE**	**P[2]**
Orange Juice Cons (%)	9,284	16.6	0.8	7,634	0.0	0.0	1,650	100.0	0.0	.	.	.
Age (Years)	9,284	5.0	0.03	7,634	5.0	0.03	1,650	4.9	0.1	-0.1109	0.0783	0.1596
Gender = Male (%)	9,284	51.4	0.7	7,634	50.7	0.8	1,650	55.2	2.1	4.4901	2.3286	0.0564
Ethnicity[3]												
Mexican American (%)	9,284	15.2	1.2	7,634	14.6	1.1	1,650	18.5	1.9	3.8947	1.5252	0.0120
Other Hispanic (%)	9,284	7.1	0.6	7,634	6.7	0.6	1,650	9.1	1.1	2.4609	0.9550	0.0113
Non-Hispanic White (%)	9,284	55.0	1.9	7,634	56.6	1.9	1,650	47.0	3.0	-9.6557	2.5871	**0.0003**
Non-Hispanic Black (%)	9,284	14.5	1.1	7,634	13.9	1.1	1,650	17.5	1.5	3.6456	1.2339	**0.0038**
Other (%)	9,284	8.3	0.6	7,634	8.3	0.6	1,650	8.0	1.3	-0.3455	1.2371	0.7805
Poverty Index Ratio (PIR)[3]												
PIR < 1.35 (%)	8,713	37.3	1.4	7,159	36.7	1.4	1,554	40.4	2.3	3.7252	2.2546	0.1014
1.35 ≤ PIR < 1.85 (%)	8,713	10.8	0.6	7,159	10.6	0.6	1,554	11.7	1.5	1.1084	1.5637	0.4799
PIR > 1.85 (%)	8,713	51.9	1.5	7,159	52.7	1.5	1,554	47.9	2.7	-4.8336	2.6618	0.0721
Physical Activity[3]												
Sedentary	9,102	12.7	0.7	7,502	12.3	0.7	1,600	14.8	1.4	2.4851	1.4902	0.0983
Moderate	9,102	17.1	0.8	7,502	16.9	0.7	1,600	18.0	2.3	1.1139	2.2998	0.6291
Vigorous	9,102	70.2	1.0	7,502	70.8	1.0	1,600	67.2	2.8	-3.5991	2.8004	0.2015
Weight Status[4]												
% Overweight	9,096	13.74	0.53	7,478	13.82	0.59	1,618	13.34	1.52	-0.4746	1.6646	0.7761
% Obese	9,096	13.87	0.59	7,478	14.14	0.61	1,618	12.51	1.31	-1.6314	1.3417	0.2267
% Overweight/Obese	9,096	27.61	0.80	7,478	27.96	0.85	1,618	25.85	1.81	-2.1060	1.9282	0.2772
Kilocalories consumed	9,284	1693	9.0	7,634	1677	9.5	1,650	1770	25.6	92.3820	27.2165	**0.0010**
Grams of Food	9,284	1750.8	11.6	7,634	1736.3	12.7	1,650	1824.1	26.5	87.8127	28.9353	**0.0030**
BMI z-score	9,093	0.41	0.02	7,476	0.41	0.02	1,617	0.42	0.04	0.0145	0.0427	0.7348

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls
[2]Significance was defined as p<0.01
[3]Self-reported through the National Health And Nutrition Examination Survey questionnaire
[4]Children with a body mass index greater than or equal to the 85th and less than 95th, and greater than or equal to the 95th percentile were considered overweight or obese, respectively.

Table 2. Comparison of demographic data for the total population, for orange juice non-consumers, for children 9-18 years participating in the National Health And Nutrition Examination Survey from 2003-2016.

	Total Population			Non-consumers, OJ			Consumers, OJ[1]			Cons vs Non-Cons		
Variable	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**Beta**	**SE**	**P[2]**
Orange Juice Cons (%)	12,711	12.7	0.5	10,831	0.0	0.0	1,880	100.0	0.0	.	.	.
Age (Years)	12,711	13.6	0.04	10,831	13.6	0.1	1,880	13.4	0.1	-0.2175	0.1158	0.0630
Gender = Male (%)	12,711	50.3	0.7	10,831	50.0	0.8	1,880	52.4	1.6	2.3248	1.7228	0.1800
Ethnicity[3]												
Mexican American (%)	12,711	13.8	1.1	10,831	12.8	1.0	1,880	20.2	1.9	7.3483	1.4222	**<0.0001**
Other Hispanic (%)	12,711	6.2	07	10,831	5.7	0.5	1,880	9.5	1.4	3.7930	1.1375	**0.0012**
Non-Hispanic White (%)	12,711	58.1	1.7	10,831	59.8	1.7	1,880	46.2	2.7	-13.5909	2.0798	**<0.0001**
Non-Hispanic Black (%)	12,711	14.3	1.0	10,831	13.9	0.9	1,880	16.8	1.5	2.8319	1.1069	0.0119
Other (%)	12,711	7.7	0.5	10,831	7.8	0.5	1,880	7.4	1.0	-0.3823	0.8905	0.6685
Poverty Index Ratio (PIR)[3]												
PIR < 1.35 (%)	11,878	32.0	1.3	10,137	31.2	1.3	1,741	37.9	2.1	6.7550	1.8378	**0.0004**
1.35 ≤ PIR < 1.85 (%)	11,878	10.8	0.6	10,137	11.0	0.6	1,741	9.5	1.0	-1.5733	1.0959	0.1540
PIR > 1.85 (%)	11,878	57.1	1.4	10,137	57.8	1.4	1,741	52.6	2.5	-5.1817	2.1290	0.0166
Physical Activity[3]												
Sedentary	12,418	11.9	0.4	10,590	12.0	0.5	1,828	11.0	1.1	-1.0031	1.2576	0.4268
Moderate	12,418	23.4	0.6	10,590	23.9	0.7	1,828	20.2	1.3	-3.6781	1.5062	0.0162
Vigorous	12,418	64.7	0.7	10,590	64.1	0.8	1,828	68.8	1.5	4.6812	1.6321	**0.0050**
Weight Status[4]												
% Overweight	12,616	16.94	0.49	10,744	16.83	0.53	1,872	17.71	1.28	0.8861	1.3750	0.5207
% Obese	12,616	18.88	0.67	10,744	18.96	0.73	1,872	18.31	1.35	-0.6484	1.5167	0.6699
% Overweight/Obese	12,616	35.81	0.81	10,744	35.78	0.87	1,872	36.02	1.83	0.2377	1.9666	0.9040
Kilocalories consumed	12,711	2119	14.0	10,831	2083	14.4	1,880	2362	37.6	278.0963	38.4925	**<0.0001**
Grams of Food	12,711	2433.7	24.5	10,831	2405.9	24.9	1,880	2624.3	45.3	218.3933	42.5295	**<0.0001**
BMI z-score	12,604	0.55	0.02	10,735	0.55	0.02	1,869	0.55	0.04	-0.0038	0.0425	0.9287

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls
[2]Significance was defined as p<0.01
[3]Self-reported through the National Health And Nutrition Examination Survey questionnaire
[4]Children with a body mass index greater than or equal to the 85th and less than 95th, and greater than or equal to the 95th percentile were considered overweight or obese, respectively.

p=0.0004) and those in the highest category showing an inverse relationship (β=-5.4; p=0.0044). There were no differences in physical activity or weight status. Orange juice consumers also consumed more energy (β=160; 0<0.0001) and grams of food (β=107; p=0.0002).

Orange juice consumption and decile definition

Orange juice consumption for all age groups is presented in Table 3. For children 2-8 years (N=9,284), 9-18 years (N=12,710), and 2-18 years (N=21,993) usual take of OJ was 35.8±2.0 gm/day, 40.8±1.8 gm/day, and 38.7 gm/day, respectively. Table 4 shows the usual intake of OJ consumed by decile for all age groups. Decile 1 (0 gm) constitutes non-consumers. Usual intake varied by decile from 64-552 gm/day, 86-808 gm/day, and 81-714 gm/day for children 2-8 years, 9-18 years, and 2-18 years, respectively.

Energy and Nutrient Intake

Table 5 shows the results of linear regression analyses of the usual intake of energy and nutrients across the deciles for children 2-8 years. These children showed more variability in linear trends of intake of nutrients. Energy; total carbohydrates; total and added sugars, riboflavin; vitamins A, D, and K; selenium; sodium; and zinc did not show significant linear trends across deciles of OJ. Protein showed an increasing linear trend from decile 1 (57.9±0.41 gm/day) to decile 10 (65.3±2.35

Table 3. Day 1 and usual orange juice consumption[1] (grams) for children 2-18 years participating in the National Health And Nutrition Examination Survey 2003-2016.

Age (yrs)	Day 1 Intake		Usual Intake[2]		Usual Intake Percentiles						
	N	**Mean±SE**	**N**	**Mean±SE**	**P5**	**P10**	**P25**	**P50**	**P75**	**P90**	**P95**
2-8	9,284	35.7±1.9	9,288	35.7±1.7	0.94	1.79	5.26	16.65	46.90	97.87	135.95
9-18	12,709	42.9±2.2	12,710	40.8±1.8	0.92	1.78	5.22	16.83	49.85	112.85	165.50
2-18	21,993	40.0±1.7	21,998	38.7±1.6	0.93	1.79	5.24	16.75	48.51	106.22	152.84

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls
[2]Individual usual Intake (UI) of nutrients was determined using the National Cancer Institute method

Table 4. Usual orange juice consumption[1] (grams [oz]) by decile for children 2-8 (N=9,284), 9-18 years (N=12,711), and 2-18 (N=21,995), participating in the National Health And Nutrition Examination Survey 2003-2016.

Decile	N	2-8 years	N	9-18 years	N	2-18 years
1	7,634	0	10,829	0	18,463	0
2	134	64 [2.1]	91	86 [2.9]	293	81 [2.7]
3	139	109 [3.6]	302	132 [4.4]	425	122 [4.1]
4	198	124 [4.1]	206	188 [6.3]	359	142 [4.7]
5	85	127 [4.2]	91	230 [7.7]	422	182 [6.0]
6	276	136 [4.5]	326	257 [8.6]	243	225 [7.5]
7	220	213 [7.1]	190	330 [11.0]	549	252 [8.4]
8	140	248 [8.3]	234	362 [12.1]	374	327 [10.9]
9	236	293 [9.8]	186	488 [16.3]	391	395 [13.2]
10	222	552 [18.4]	256	808 [26.9]	476	714 [23.8]

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls
[2]Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).

Table 5. Usual intake of Energy and Nutrients across deciles of orange juice intake (gm) with linear trend analysis of children 2-8 years participating in the National Health And Nutrition Examination Survey 2003-2016.

	Decile of orange juice intake[1] (gm)										Linear Trend Across Deciles		
	0	64	109	124	127	163	213	248	293	552			
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Beta	SE	P[2]
Energy (kilocalories)[3]	1678±9.32	1503±41.9	1584±81.6	1866±73.3	1625±53.5	1735±54.6	1783±68.4	1898±60.4	1890±51.5	1936.0±58.92	0.5154	0.1819	0.0220
Protein (g)	57.9±0.41	56.4±2.25	60.2±4.09	66.2±2.19	55.2±2.38	65.1±2.35	60.3±2.27	64.0±2.46	66.5±2.16	65.3±2.35	0.0171	0.0071	**0.0087**
Carbohydrate (g)	228±1.46	199±5.50	212±11.3	244±8.62	218±6.54	233±7.04	246±11.7	267±9.22	265±7.37	281±7.77	0.0935	0.0315	0.0181
Total Sugars (g)	115±0.99	93.6±3.30	104±5.40	119±4.71	110±5.45	109±4.13	123±6.47	126±7.66	136±4.45	154±5.09	0.0548	0.0236	0.0484
Added Sugars (tsp eq)	15.5±0.19	10.7±0.69	12.2±0.99	15.0±1.21	12.9±0.78	11.4±0.60	14.0±0.90	13.9±1.27	14.4±0.85	13.6±1.00	-0.0068	0.0041	0.1399
Dietary Fiber (g)	11.9±0.10	11.8±0.44	12.7±0.81	13.1±0.53	13.5±0.94	13.3±0.48	13.0±0.55	14.6±0.67	14.6±0.75	14.0±0.57	0.0054	0.0011	**0.0010**
Folate (DFE)	459±4.88	435±34.2	445±28.7	507±21.1	456±23.5	468±24.7	505±22.4	577±20.9	637±44.3	626±30.5	0.3196	0.0630	**0.0010**
Niacin (mg)	17.3±0.14	16.2±0.94	17.8±1.35	19.7±0.74	16.0±0.82	18.9±0.82	18.8±0.75	20.2±0.69	19.7±0.71	19.8±1.00	0.0069	0.0019	**0.0072**
Riboflavin (mg)	1.91±0.02	1.81±0.08	1.73±0.08	2.09±0.06	1.66±0.07	1.96±0.09	1.98±0.09	2.07±0.08	2.26±0.09	2.16±0.09	0.0005	0.0003	0.1120
Thiamin (mg)	1.36±0.01	1.26±0.06	1.29±0.06	1.50±0.04	1.31±0.07	1.42±0.06	1.51±0.05	1.68±0.05	1.69±0.07	1.73±0.08	0.0008	0.0002	**0.0022**
Total choline (mg)	217±1.88	224±14.5	237±15.2	242±8.55	228±9.47	263±9.08	235±12.1	256±11.0	268±9.30	274±11.3	0.1352	0.0202	**0.0002**
Vitamin A, RAE (mcg)	578±6.82	571±39.4	499±41.6	611±22.9	474±33.5	560±26.8	537±34.4	700±39.7	647±38.3	644±30.3	0.1096	0.0904	0.2601
Vitamin B6 (mg)	1.47±0.01	1.40±0.10	1.55±0.09	1.70±0.06	1.37±0.07	1.69±0.08	1.70±0.07	1.81±0.07	1.85±0.08	2.15±0.12	0.0012	0.0002	**0.0003**
Vitamin C (mg)	71.5±1.46	69.1±4.42	103±5.30	112±6.15	125±6.84	124±4.31	142±6.40	156±9.28	167±6.09	258±5.45	0.3368	0.0172	**<0.0001**
Vitamin D (mcg)	6.09±0.08	6.04±0.52	5.27±0.46	6.44±0.30	4.97±0.38	6.54±0.37	6.13±0.32	7.26±0.49	7.35±0.33	7.32±0.40	0.0023	0.0010	0.0526
Vitamin K (mcg)	48.5±0.84	50.3±5.20	53.6±4.81	51.9±3.87	50.8±4.66	50.4±3.59	47.4±4.94	73.6±7.95	59.3±6.11	55.9±4.97	0.0194	0.0079	0.0396
Calcium (mg)	964±9.61	981±46.3	957±49.4	1081±40.6	888±50.1	1085±40.6	1084±46.0	1216±44.4	1252±51.5	1368±64.0	0.7657	0.1257	**0.0003**
Copper (mg)	0.86±0.01	0.85±0.03	0.90±0.05	0.96±0.04	0.93±0.03	0.96±0.04	0.96±0.05	1.06±0.04	1.12±0.05	1.11±0.04	0.0006	0.0001	**<0.0001**
Iron (mg)	12.4±0.10	11.8±0.72	12.4±0.99	13.2±0.54	11.3±0.60	12.8±0.53	13.4±0.81	14.8±0.55	14.7±0.76	14.9±0.74	0.0052	0.0014	**0.0074**
Magnesium (mg)	205±1.30	204±9.01	201±10.4	224±7.07	212±8.93	229±8.21	230±9.23	250±8.82	254±9.09	262±7.22	0.1165	0.0137	**<0.0001**
Phosphorus (mg)	1132±9.01	1108±47.7	1082±54.8	1253±30.2	1068±43.8	1211±45.8	1201±59.0	1289±44.5	1309±41.2	1288±36.5	0.3637	0.0989	**0.0063**
Potassium (mg)	1998±15.0	1929±59.2	2076±84.3	2325±59.9	2135±80.9	2293±78.4	2366±103	2579±99.8	2633±66.4	3031±81.0	1.9478	0.1790	**<0.0001**
Selenium (mcg)	78.9±0.61	77.6±3.22	78.9±4.82	83.7±2.98	73.4±5.03	87.8±3.43	79.0±3.21	91.0±5.43	89.7±2.74	83.1±3.36	0.0171	0.0071	0.0420
Sodium (mg)	2553±17.3	2293±89.2	2512±173	2779±99.0	2543±119	2675±107	2546±127	2970±118	2786±84.6	2601±101	0.3998	0.2650	0.1698
Zinc (mg)	8.96±0.07	8.34±0.44	9.34±0.87	9.57±0.33	9.06±0.62	9.53±0.46	9.02±0.31	9.38±0.49	10.1±0.41	10.1±0.57	0.0022	0.0007	0.0101

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls.
[2]Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
[2]p<0.01
[3]Energy and nutrient intake from foods were determined using respective Food and Nutrient Database for Dietary Studies for each NHANES cycle available from total nutrient intake files. Added sugars were defined by the USDA Food Patterns Equivalent Databases.

gm/day) (β=0.02 gm/g OJ; p=0.0087). Dietary fiber showed an increasing linear trend from decile 1 (11.9±0.10 gm/day) to 10 (14.0±0.57 gm/day) (β=0.005 gm/gm OJ; p=0.001). Usual intake of vitamin C showed an increasing linear trend from decile 1 (71.5±1.46 mg) to (258±5.45 mg) (β=0.34 mg/gm OJ; p<0.0001). As with the younger age group, folate DFE (β=0.32; p=0.0010) and potassium (β=1.95 µg/gm OJ; p<0.0001) also showed a significant positive linear trend.

In children 9-18 years (Table 6), energy and all nutrients examined, with the exceptions of added sugars and vitamin K showed a significant positive linear component via regression analyses. In children 2-18 years (Supplemental Table 2) energy and all nutrients examined, with the exceptions of total and added sugars, niacin, and sodium showed a significant positive linear component via regression analysis.

Healthy Eating Index (HEI)

Tables 7 and 8 show total HEI score and sub-component scores for children 2-8 years and 9-18 years, respectively. Table 7, showed a significant positive linear relationship for the total HEI score ranged from 49.43±0.24 for decile 1 to 55.45±1.03 for decile 10 (β=0.013 points/gm OJ; p=0.0043). The total fruit sub-score, which ranged from 2.93±0.04 for decile 1 to 4.90±0.02 for decile 10 (β=0.003 points/gm OJ; p=0.0003) also had a positive linear relationship. Sodium (β=0.0024 points /

Table 6. Usual intake of Energy and Nutrients across deciles of orange juice intake[1] (gm) with linear trend analysis of children 9-18 years participating in the National Health And Nutrition Examination Survey 2003-2016.

	Decile of orange juice intake[1] (gm)										Linear Trend Across Deciles		
	0	86	132	188	230	257	330	362	488	808			
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Beta	SE	P[2]
Energy (kilocalories)[3]	2079±14.3	2062±179	2154±63.3	2173±83.6	2065±106	2255±82.0	2318±99.9	2476±95.7	2662±114	2880±101	0.9302	0.0993	**<0.0001**
Protein (g)	74.6±0.63	74.6±6.49	80.7±2.86	75.0±2.70	69.5±3.84	81.3±3.06	82.4±3.12	87.3±4.21	97.6±5.02	103±4.29	0.0311	0.0058	**0.0007**
Carbohydrate (g)	273±1.87	266±20.3	283±8.82	294±10.4	280±10.5	303±10.5	316±13.3	331±10.5	360±16.9	399±12.8	0.1442	0.0137	**<0.0001**
Total Sugars (g)	131±1.20	114±9.37	133±5.28	144±6.05	133±6.77	141±6.75	152±7.69	164±6.14	186±10.7	209±9.64	0.0832	0.0127	**0.0002**
Added Sugars (tsp eq)	21.9±0.27	17.3±1.73	19.3±1.03	20.7±1.38	18.0±1.29	18.6±1.34	20.6±1.91	21.4±1.22	24.0±2.20	22.6±1.94	-0.0023	0.0029	0.4408
Dietary Fiber (g)	14.0±0.14	15.2±1.12	15.8±0.60	15.6±0.54	15.6±0.54	16.8±0.74	16.7±1.06	16.5±0.93	17.8±1.08	18.5±0.83	0.0067	0.0007	**<0.0001**
Folate (DFE)	547±6.49	558±35.3	606±24.3	575±41.4	585±64.6	638±24.5	636±41.6	655±41.0	714.8±41.7	802±30.7	0.3175	0.0163	**<0.0001**
Niacin (mg)	23.4±0.24	22.8±1.83	23.9±0.69	22.6±1.36	22.2±1.10	24.8±0.87	23.8±0.98	26.9±0.96	28.7±1.61	31.8±1.45	0.0077	0.0019	**0.0037**
Riboflavin (mg)	2.08±0.02	1.96±0.10	2.20±0.08	2.22±0.15	2.14±0.17	2.21±0.08	2.29±0.11	2.45±0.13	2.63±0.14	2.79±0.11	0.0009	0.0001	**<0.0001**
Thiamin (mg)	1.63±0.02	1.71±0.14	1.80±0.06	1.71±0.12	1.70±0.15	1.86±0.06	1.92±0.13	2.05±0.11	2.08±0.08	2.39±0.08	0.0009	0.0001	**<0.0001**
Total choline (mg)	262±2.76	256±16.7	280±12.6	283±10.5	282±30.9	314±13.0	361±28.3	328±19.9	388±24.2	419±23.5	0.1955	0.0200	**<0.0001**
Vitamin A, RAE (mcg)	585±8.95	545±34.1	630±36.8	697±58.0	596±61.0	636±27.9	654±50.6	651±42.7	721±46.9	719±43.3	0.1950	0.0369	**0.0007**
Vitamin B6 (mg)	1.81±0.02	1.65±0.14	1.92±0.06	1.91±0.13	1.94±0.12	2.04±0.08	2.07±0.08	2.35±0.14	2.62±0.15	3.12±0.16	0.0013	0.0002	**0.0001**
Vitamin C (mg)	63.1±1.30	83.2±7.25	115±4.23	132±5.49	145±5.52	153±4.36	178±6.79	192±6.06	240±6.01	377±14.7	0.3623	0.0069	**<0.0001**
Vitamin D (mcg)	5.24±0.09	5.10±0.73	6.22±0.31	6.00±0.49	5.16±0.44	6.78±0.43	6.23±0.49	6.71±0.69	7.44±0.70	7.41±0.77	0.0035	0.0007	**0.0011**
Vitamin K (mcg)	65.0±1.27	75.0±13.6	71.6±4.36	84.8±9.88	63.4±6.47	73.6±5.92	74.5±9.66	71.9±10.0	68.8±5.87	77.8±6.73	0.0161	0.0057	0.0216
Calcium (mg)	1007±11.2	990±72.5	1213±49.6	1187±66.9	1118±94.4	1230±46.4	1311±62.0	1368±92.3	1478±64.4	1515±99.3	0.8351	0.0834	**<0.0001**
Copper (mg)	1.04±0.01	1.09±0.10	1.10±0.04	1.19±0.05	1.16±0.05	1.19±0.04	1.31±0.07	1.42±0.08	1.42±0.06	1.73±0.08	0.0008	0.0001	**<0.0001**
Iron (mg)	15.2±0.14	16.5±1.00	15.9±0.68	15.4±1.19	14.9±1.02	16.5±0.67	15.9±0.82	17.7±0.99	18.7±0.96	20.6±0.86	0.0061	0.0008	**<0.0001**
Magnesium (mg)	241±2.06	240±16.6	256±6.48	260±9.39	258±10.2	280±9.76	296±15.4	316±15.8	334±13.9	377±13.6	0.1635	0.0131	**<0.0001**
Phosphorus (mg)	1309±10.9	1310±115	1422±43.7	1388±57.1	1330±83.8	1478±50.8	1518±50.7	1587±83.1	1724±67.9	1737±70.6	0.6182	0.0614	**<0.0001**
Potassium (mg)	2187±20.1	2165±125	2525±72.9	2548±96.5	2579±88.9	2778±87.8	2881±73.5	3103±130.7	3491±147	4229±135	2.3741	0.1293	**<0.0001**
Selenium (mcg)	102±0.89	104±8.56	110±4.01	105±4.31	93.3±5.38	112±3.88	115±6.78	121±5.48	129±7.51	135±6.27	0.0386	0.0076	**0.0009**
Sodium (mg)	3377±30.5	3366±329	3505±107	3323±153	3235±184	3639±148	3760±167	4048±189	4113±203	4269±166	1.1291	0.1881	**0.0003**
Zinc (mg)	11.1±0.10	10.6±0.56	11.8±0.50	11.1±0.55	11.7±0.96	11.6±0.55	11.4±0.50	13.1±0.85	14.0±0.78	14.6±0.74	0.0037	0.0008	**0.0012**

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls.

[2]Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).

[2]p<0.01

[3]Energy and nutrient intake from foods were determined using respective Food and Nutrient Database for Dietary Studies for each NHANES cycle available from total nutrient intake files. Added sugars were defined by the USDA Food Patterns Equivalent Databases.

Table 7. Healthy Eating Index (HEI)[1]—total score and component scores across deciles of usual orange juice intake (gm)[2] of children 2-8 years participating in the National Health And Nutrition Examination Survey 2003-2016.

	Decile of orange juice intake[2] (gm)										Linear Trend Across Deciles		
Decile of OJ (gm)	**0**	**64**	**109**	**124**	**126**	**163**	**213**	**248**	**293**	**552**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[42]**
Total score	49.43±0.24	55.21±1.16	54.39±1.63	49.57±1.23	55.78±1.80	53.96±1.07	53.11±1.18	52.71±1.31	53.71±0.90	55.45±1.03	0.0130	0.0033	**0.004**3
#1 Total Vegetable	2.02±0.03	2.00±0.17	2.13±0.16	2.23±0.17	2.54±0.21	2.05±0.15	1.99±0.12	2.35±0.13	2.02±0.12	2.13±0.16	0.0003	0.0003	0.2534
#2 Beans & Greens	0.82±0.03	0.99±0.20	1.24±0.21	0.62±0.09	0.70±0.18	0.70±0.11	1.10±0.16	1.11±0.26	0.97±0.17	1.08±0.15	0.0004	0.0003	0.2776
#3 Total Fruit	2.93±0.04	3.75±0.15	4.23±0.12	3.90±0.17	3.99±0.16	4.37±0.10	4.39±0.10	4.38±0.07	4.72±0.05	4.90±0.02	0.0030	0.0005	**0.000**3
#4 Whole Fruit	2.75±0.05	3.44±0.20	3.68±0.21	3.21±0.23	3.04±0.40	3.51±0.25	2.64±0.31	2.90±0.18	2.83±0.19	2.86±0.27	0.0006	0.0007	0.4160
#5 Whole Grains	2.43±0.07	3.66±0.43	2.68±0.37	1.86±0.27	4.02±0.55	2.91±0.36	2.33±0.41	2.55±0.36	1.93±0.37	1.75±0.22	-0.0011	0.0007	0.1592
#6 Dairy	7.84±0.05	8.50±0.28	7.24±0.81	7.65±0.32	7.68±0.29	7.68±0.22	7.10±0.33	7.61±0.50	8.20±0.22	7.10±0.25	-0.0008	0.0006	0.1978
#7 Total Protein	3.38±0.03	3.43±0.13	3.94±0.23	3.54±0.14	3.68±0.16	3.68±0.14	3.60±0.20	3.31±0.13	3.51±0.15	3.35±0.09	0.00004	0.0002	0.8914
#8 Seafood/Plant Protein	1.59±0.04	1.80±0.25	1.59±0.35	1.40±0.20	2.10±0.44	1.40±0.15	1.85±0.30	1.56±0.22	1.70±0.24	1.48±0.14	-0.0002	0.0002	0.3288
#9 Fatty Acid Ratio	3.43±0.06	3.71±0.39	4.16±0.57	2.97±0.24	4.24±0.42	3.49±0.33	3.82±0.23	3.80±0.35	3.30±0.33	3.35±0.25	0.0001	0.0005	0.8281
#10 Sodium	5.41±0.06	5.41±0.38	4.90±0.44	5.24±0.30	4.85±0.42	5.32±0.23	6.11±0.34	5.03±0.34	5.97±0.23	7.08±0.23	0.0024	0.0006	**0.0060**
#11 Refined Grain	5.65±0.07	5.72±0.32	5.66±0.37	5.41±0.37	6.40±0.39	5.73±0.30	5.58±0.36	5.38±0.35	5.51±0.26	6.51±0.38	0.0006	0.0005	0.3239
#12 SFA[4]	5.32±0.07	5.59±0.49	6.18±0.50	4.78±0.32	5.99±0.33	5.66±0.28	5.78±0.27	5.96±0.47	5.95±0.31	6.44±0.19	0.0020	0.0004	**0.0007**
#13 Added Sugars	5.89±0.06	7.44±0.34	7.04±0.30	6.96±0.29	6.82±0.34	7.60±0.20	6.84±0.27	7.36±0.39	7.24±0.27	7.56±0.25	0.0041	0.0010	**0.0039**

[1]Healthy Eating Index is a measure of adherence to the Dietary Guidelines for Americans and an indicator of diet quality; a perfect score is 100.
[2]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls.
[2]Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
[3]p<0.01
[4]SFA=saturated fatty acids

Table 8. Healthy Eating Index (HEI)[1]—total score and component scores across deciles of usual orange juice intake[2] (gm) of children 9-18 years participating in the National Health And Nutrition Examination Survey 2003-2016.

	Decile of orange juice intake[2] (gm)										Linear Trend Across Deciles		
Decile of OJ (gm)	**0**	**86**	**132**	**188**	**230**	**257**	**330**	**362**	**488**	**808**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[3]**
Total score	44.67±0.22	47.50±1.93	47.70±0.79	48.20±1.24	53.02±2.32	50.46±1.06	50.39±1.96	49.23±1.43	49.84±0.93	51.55±0.92	0.0102	0.0017	**0.000**3
#1 Total Vegetable	2.27±0.03	2.24±0.20	2.33±0.14	2.01±0.15	2.84±0.17	2.30±0.13	2.38±0.22	2.19±0.15	2.22±0.17	2.47±0.14	0.0002	0.0002	0.4135
#2 Beans & Greens	0.88±0.04	1.88±0.31	0.97±0.15	1.06±0.18	0.79±0.21	1.03±0.14	1.10±0.33	0.85±0.22	0.94±0.17	0.98±0.15	0.0002	0.0002	0.4554
#3 Total Fruit	1.79±0.04	3.03±0.23	3.40±0.12	3.80±0.14	4.27±0.21	4.16±0.09	4.37±0.14	4.46±0.09	4.71±0.07	4.87±0.03	0.0033	0.0006	**0.000**4
#4 Whole Fruit	1.84±0.05	2.07±0.30	2.27±0.22	2.53±0.22	3.05±0.50	2.58±0.22	2.05±0.35	1.90±0.24	1.78±0.23	1.56±0.15	-0.0001	0.0004	0.7405
#5 Whole Grains	2.09±0.05	2.15±0.34	1.77±0.23	2.39±0.37	2.50±0.48	2.14±0.22	1.66±0.23	2.01±0.42	1.93±0.28	1.33±0.24	-0.0007	0.0002	0.0127
#6 Dairy	6.43±0.07	6.04±0.79	7.05±0.26	6.99±0.39	6.24±0.53	6.59±0.27	6.28±0.41	6.24±0.42	6.25±0.36	5.26±0.34	-0.0008	0.0005	0.1143
#7 Total Protein	3.67±0.03	4.02±0.13	3.80±0.12	3.48±0.13	3.76±0.23	3.75±0.13	4.04±0.08	3.61±0.17	3.86±0.17	3.88±0.10	0.0003	0.0002	0.1046
#8 Seafood/Plant Protein	1.53±0.04	2.00±0.29	1.28±0.16	1.50±0.17	1.66±0.32	1.69±0.18	1.70±0.26	1.75±0.17	1.51±0.23	1.50±0.18	0.0000[3]	0.0002	0.8271
#9 Fatty Acid Ratio	4.08±0.07	4.16±0.44	3.99±0.25	3.27±0.30	4.31±0.50	4.28±0.30	4.25±0.35	4.32±0.40	3.52±0.37	4.46±0.34	0.0001	0.0004	0.7924
#10 Sodium	4.54±0.07	4.47±0.44	4.52±0.21	5.18±0.34	4.84±0.57	4.75±0.23	4.66±0.25	4.64±0.37	5.16±0.28	5.35±0.31	0.0010	0.0002	**0.001**8
#11 Refined Grain	4.88±0.06	3.89±0.46	4.56±0.27	5.19±0.40	5.58±0.36	4.32±0.28	5.13±0.48	4.88±0.42	5.56±0.51	5.82±0.30	0.0009	0.0005	0.1063
#12 SFA[4]	5.49±0.06	5.29±0.36	5.49±0.26	5.35±0.42	6.30±0.62	6.30±0.26	6.44±0.29	6.28±0.30	5.75±0.42	6.96±0.18	0.0019	0.0002	**<0.000**1
#13 Added Sugars	5.11±0.07	6.22±0.34	6.26±0.20	5.47±0.37	6.77±0.27	6.68±0.27	6.34±0.42	6.18±0.33	6.37±0.30	6.90±0.28	0.0028	0.0007	**0.003**3

[1]Healthy Eating Index is a measure of adherence to the Dietary Guidelines for Americans and an indicator of diet quality; a perfect score is 100.
[2]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls.
[2]Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).[3]p<0.01
[4]Actual beta value is 0.00004
[5]SFA=saturated fatty acids

gm OJ; p=0.0060), SFA (β=0.002 points /gm OJ; p=0.0007), and added sugars sub-component scores (β=0.0041 points /gm OJ; p=0.0039) all had inverse linear relationships.

Table 8 shows that children 9-18 years had a similar pattern for HEI total and sub-scores. For this age group, the total HEI score showed a positive linear association and values ranged from 44.67±0.22 for decile 1 and 51.55±0.92 for decile 10 (β=0.0102 points/gm OJ; p=0.0003) and the total fruit sub-component scores also showed a positive linear relationship ranged from 1.79±0.04 from decile 1 to 4.87±0.03 for decile 10 (β=0.0033 points/gm OJ; p=0.0004). Sodium (β=0.0010 points/gm OJ; p=0.0018), SFA (β=0.0019 points/gm OJ; p<0.0001), and added sugars (β=0.0028 points/gm OJ; p=0.0033) sub-component scores all had an linear relationship with OJ consumption.

Supplemental Table 3 shows the total HEI score and sub-component scores for children 2-18 years. For this age group, the total HEI score showed a positive linear association and values ranged from 46.6±0.2 in decile 1 to 52.0±0.8 in decile 10 (β=0.01 points/gm; p=0.0094). The total fruit sub-component scores also showed a positive linear association and values ranged from 2.2±0.04 in decile 1 to 4.8±0.03 in decile 10 (β=0.003 points/gm; p=0.0016). Sodium showed an inverse linear association with values ranging from 4.9±0.1 in decile 1 to 5.9±0.2 in decile 10 (β=0.0012 points/gm; p=0.0053). Saturated fatty acids also showed an inverse linear association with a score of 5.4±0.1 in decile 1 and 6.5±0.2 in decile 10 (β=0.0002 points/gm; p<0.0001).

Whole total, whole fruit, and fruit juice

Table 9 shows the results of linear regression analysis using the FPED, rather than the HEI, for children aged 2-8 and 9-18 years. For children 2-8, total fruit intake ranged from 1.12±0.02 cup eq/day for decile 1 to 3.31±0.08 cup eq/day (β=0.0040 cup eq/gm OJ; p<0.0001) and fruit from fruit juice intake ranged from 0.42±0.01 cup eq/day for decile 1 to 2.57±0.11 cup eq/day (β=0.0036 cup eq/gm OJ; p<0.0001). For children 9-18 total fruit intake ranged from 0.76±0.02 cup eq/day for decile 1 to 4.21±0.17 cup eq/day for decile 10 (β=0.0045 cup eq/gm OJ; p<0.0001). Fruit from fruit juice intake ranged from 0.21±0.01 cup eq/day to 3.77±0.004 cup eq for decile 10 (β=0.0040 cup eq/gm OJ; p<0.0001). Similar results were seen in children 2-18 years.

Weight Parameters

Table 10 shows weight parameters across usual intake of orange juice (gm) of children 2-8 years, 9-18, and 2-18 years. Weight (kg), BMI-z score, % overweight, % obese, and % overweight or obese showed no significant linear trend across the deciles OJ consumption.

Table 9. Usual intake of Total Fruit, Whole Fruit, and Fruit Juice[1] across deciles of orange juice intake (gm) of children 2-18 years participating in the National Health And Nutrition Examination Survey 2003-2016.

	Decile of orange juice intake[2] (gm)										Linear Trend Across Deciles		
Children 2-8 years													
	0	**64**	**109**	**124**	**127**	**163**	**213**	**248**	**293**	**552**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[3]**
Total Fruit (cup eq)	1.12±0.02	1.15±0.07	1.82±0.11	1.63±0.08	1.61±0.16	2.01±0.10	1.90±0.13	2.08±0.16	2.29±0.09	3.31±0.08	0.0040	0.0002	**<0.000**1
Whole Fruit (cup eq)	0.71±0.02	0.68±0.05	1.19±0.11	0.86±0.07	0.74±0.19	0.97±0.09	0.69±0.11	0.78±0.11	0.80±0.10	0.77±0.11	0.0003	0.0003	0.2483
Fruit Juice (cup eq)	0.42±0.01	0.45±0.05	0.68±0.04	0.77±0.03	0.89±0.07	1.02±0.05	1.23±0.05	1.36±0.05	1.46±0.04	2.57±0.11	0.0036	0.0002	**<0.000**1
Children 9-18 years													
	0	**86**	**132**	**188**	**230**	**257**	**330**	**362**	**488**	**808**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**p**
Total Fruit (cup eq)	0.76±0.02	1.27±0.14	1.51±0.09	1.70±0.08	1.88±0.09	2.21±0.12	2.23±0.19	2.27±0.09	2.92±0.10	4.21±0.17	0.0045	0.0002	**<0.000**1
Whole Fruit (cup eq)	0.56±0.02	0.63±0.11	0.70±0.09	0.71±0.08	0.83±0.14	0.86±0.10	0.66±0.16	0.51±0.08	0.57±0.07	0.50±0.07	0.0000[4]	0.0001	0.9691
Fruit Juice (cup eq)	0.21±0.01	0.51±0.04	0.72±0.02	0.93±0.04	1.08±0.06	1.21±0.06	1.49±0.04	1.65±0.09	2.25±0.07	3.77±0.004	0.0040	0.0001	**<0.000**1
Children 2-18 years													
	0	**81**	**122**	**142**	**182**	**225**	**252**	**327**	**395**	**714**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**p**
Total Fruit (cup eq)	0.91±0.02	1.41±0.09	1.51±0.06	1.74±0.08	1.91±0.07	1.81±0.06	2.20±0.08	2.26±0.10	2.50±0.06	3.89±0.12	0.0043	0.0002	**<0.0001**
Whole Fruit (cup eq)	0.62±0.02	0.85±0.09	0.79±0.06	0.82±0.07	0.81±0.07	0.70±0.06	0.87±0.08	0.66±0.08	0.59±0.06	0.58±0.06	0.0001	0.0002	0.7030
Fruit Juice (cup eq)	0.29±0.01	0.51±0.03	0.72±0.02	0.89±0.03	1.09±0.03	1.08±0.02	1.24±0.02	1.52±0.03	1.83±0.04	3.23±0.11	0.0038	0.0001	**<0.0001**

[1]Total fruit, whole fruit, and fruit juice consumption was also determined from the respective Food Pattern Equivalents Database for each National Health And Nutrition Examination Survey period[2]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls. Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
[3]p<0.01
[4]Actual beta value 0.000005

Table 10. Weight Parameters across deciles of usual intake of orange juice (gm) of children participating in the National Health And Nutrition Examination Survey 2003-2016.

Decile of orange juice intake[1] (gm)											Linear Trend Across Deciles		
Children 2-8 years													
	0	**64**	**109**	**124**	**127**	**163**	**213**	**248**	**293**	**552**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[2]**
Weight (kg)[3]	22.03±0.15	19.19±0.94	19.22±0.52	23.71±0.78	22.03±1.17	20.72±0.54	21.91±0.72	23.93±1.25	23.19±0.83	21.65±0.57	-0.0007	0.0024	0.7857
BMI-z score	0.41±0.02	0.13±0.12	0.23±0.12	0.41±0.12	0.43±0.17	0.35±0.07	0.54±0.12	0.62±0.15	0.58±0.11	0.51±0.09	0.0002	0.0002	0.2453
% overweight[4]	13.82±0.59	7.38±2.17	15.56±4.47	15.78±4.61	20.86±7.90	7.26±1.79	13.50±4.00	20.62±8.89	10.32±2.43	17.88±3.08	-0.0027	0.0078	0.7357
% obese[4]	14.14±0.61	8.11±2.76	7.90±2.65	10.58±2.78	10.10±3.56	8.28±1.99	19.93±4.17	16.10±4.21	17.97±5.00	11.92±3.09	-0.0065	0.0075	0.4091
% overweight/obese[6]	27.96±0.86	15.49±3.31	23.45±5.38	26.36±4.94	30.97±7.84	15.54±2.65	33.43±4.99	36.72±8.29	28.29±5.42	29.80±3.73	-0.0030	0.0128	0.8184
Children 9-18 years													
	0	**86**	**132**	**188**	**230**	**257**	**330**	**362**	**488**	**808**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**p**
Weight (kg)[3]	58.44±0.37	51.27±2.47	50.48±1.52	51.71±1.85	54.97±2.57	53.86±1.56	62.93±1.87	61.48±1.80	62.78±2.01	63.02±1.94	0.0038	0.0056	0.5149
BMI-z score	0.55±0.02	0.42±0.15	0.63±0.10	0.57±0.10	0.61±0.13	0.43±0.09	0.63±0.10	0.48±0.11	0.67±0.11	0.55±0.08	0.0000[5]	0.0001	0.8607
% overweight[4]	16.83±0.53	11.14±4.49	17.65±3.09	15.55±2.97	23.46±6.58	18.11±2.77	17.87±4.25	20.12±4.06	15.53±2.89	18.43±4.27	0.0014	0.0025	0.5822
% obese[4]	18.96±0.74	20.86±4.65	23.32±3.16	17.68±5.08	10.55±3.54	14.65±2.90	21.11±4.15	15.37±3.51	24.01±5.01	16.23±2.59	-0.0037	0.0036	0.3318
% overweight/obese4	35.79±0.87	32.01±6.45	40.98±3.80	33.24±5.29	34.00±7.25	32.77±3.90	38.98±5.71	35.49±4.76	39.54±5.17	34.66±4.05	-0.0001	0.0030	0.9827
Children 2-18 years													
Decile of OJ (gm)	**0**	**81**	**122**	**142**	**182**	**225**	**252**	**327**	**395**	**714**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**p**
Weight (kg)[3]	44.02±0.37	24.78±0.94	35.85±1.41	31.24±1.31	33.03±1.56	41.96±2.11	39.93±1.34	50.81±1.47	51.59±1.76	53.10±1.70	0.0001	0.0001	0.5071
BMI-z score	0.50±0.02	0.21±0.08	0.56±0.08	0.41±0.08	0.45±0.08	0.59±0.09	0.46±0.08	0.57±0.08	0.65±0.09	0.52±0.06	0.0078	0.0161	0.6406
% overweight[4]	15.64±0.41	10.13±2.08	16.21±2.80	15.58±2.87	10.79±1.71	19.91±4.33	15.52±2.81	19.25±3.35	17.02±2.38	17.93±2.97	0.0011	0.0045	0.8112
% obese[4]	17.06±0.56	10.66±1.76	18.36±2.49	10.47±2.16	16.95±3.36	13.30±2.70	15.14±2.10	16.56±2.51	22.70±3.90	14.16±1.95	-0.0037	0.0044	0.4265
% overweight/obese[5]	32.70±0.72	20.78±2.83	34.57±3.28	26.05±3.37	27.74±3.36	33.21±4.89	30.66±3.36	35.82±3.95	39.72±4.21	32.09±2.98	0.0003	0.0068	0.9687

[1] Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls. Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1)
[2] $p<0.01$
[3] Measured weight; measured weight and height were used to calculate body mass index z-scores
[4] Children with a body mass index greater than or equal to the 85th and less than 95th percentile, and greater than or equal to the 95th percentile were considered overweight or obese, respectively
[5] Actual beta value is 0.00001

Discussion

Consumption of 100% OJ showed a positive linear trend for most nutrients, total HEI score and total fruit sub-score, and FJ and total fruit consumption. In the HEI analyses, inverse linear relationships were shown for sodium, SFA, and added sugars for both age groups indicating lower intake of these entities to be consumed in moderation. Consumption of 100% OJ did not show a significant linear trend for any age group for weight, BMI z-score, percent overweight, percent obese, and percent overweight or obese.

When considering the demographics, where children were considered as OJ consumers or non-consumers only, and linear relationships were not determined, both children 2-8 years and 9-18 years showed higher energy intake and higher total grams of food consumed. However, when data were examined using linear analyses across deciles, only those children in the 9-18 age group showed a significant positive relationship for energy across the deciles. The reason for this is not clear, but the finding of higher energy intake in children consuming OJ is consistent with previous findings of OJ consumers vs non-consumers who examined children 2-18 years participating in NHANES 2003-2006 [16]. This finding warrants further study to determine the source and effect of the additional energy in children 9-18 years since it is simplistic to suggest that the additional energy can solely be attributed to OJ consumption. Additional studies could include further examination of lifestyle factors, such as physical activity or income; a longitudinal study could also be used to help determine the effect of the higher energy intake in the higher deciles of OJ consumption.

In both age groups, the majority of nutrients showed a significant positive linear relationship with decile of OJ consumption. Only nutrients that are common in OJ are discussed. Added sugars did not show a significant positive linear relationship in any age group. Since the USDA definition for added sugars [40; 41] was used, none of the OJ consumed contained any

added sugars. The virtual lack of dietary fiber in any type of FJ has been part of the impetus to recommend that the majority of the fruit recommended for children [3; 4] be consumed as whole fruit. Results of previous NHANES studies of dietary fiber in children who were OJ consumers vs non-consumers are conflicting, with O'Neil et al., [16] showing higher dietary fiber intake in consumers, whereas, Malliot et al., [8] showed no difference between consumers and non-consumers. In our study which used linear regression for 10 deciles of OJ consumption, there was a significant positive relationship between OJ consumption and dietary fiber intake in all age groups. These findings also need further study since there was not a significant linear relationship across the deciles for consumption of whole fruit in either of the age groups.

Folate, vitamin C, and potassium are important nutrients in OJ; vitamin C and potassium are underconsumed nutrients and potassium is a nutrient of public health concern [3]. As expected, there was a linear relationship between orange juice consumption and each of these three nutrients in both age groups. For children 2-8 years, consumption of one-half cup of OJ was predicted to provide 38.4 ug/day DFE folate, 40.8 mg/day vitamin C, and 234 mg/day potassium. Finally, for children 9-18 years, consumption of one-half cup of OJ was predicted to provide 38.4 ug/d DFE folate, 43.2 mg/day vitamin C, and 284 mg/day potassium.

The total diet quality score, as determined using the HEI-2015, showed a significant positive linear relationship with increasing decile of consumption in both age groups. Children 2-8 years and 9-18 years showed a mean difference across the deciles of 11% and 15%, respectively. Several components, other than OJ, may have played a role in the higher scores, including total fruit and the inverse scoring of sodium and SFA seen in most of the age groups.

For children 2-8 years and 8-19 years consumption of one-half cup of OJ was predicted to increase the total HEI score by 1.56 and 1.22 points, respectively. This suggests that other healthful foods consumed by these children also contributed to the higher total scores seen in those children in decile 10. Despite the improvement seen in diet quality with OJ consumption all total scores were low. The highest score, 55.4/100, was in children 2-8 years in the highest decile of OJ consumption. O'Neil, et al., [16], using NHANES 2003 to 2006 and HEI-2005 showed that OJ consumers had a total HEI score of 52.4±0.4 compared with non-OJ consumers with a total score of 48.5±0.3. Suggesting that overall scores have not notably improved.

Malliot, et al., [8] has recently shown that total HEI scores in children are higher in OJ consumers when compared with non-consumers. That group also looked at diet quality using the Nutrient Rich Foods (NRF9.3) score [54] as a determinant of nutrient density and showed that OJ consumers had higher scores [8].

The HEI is commonly used to assess overall diet and adherence to the DGA recommendations. However, the diet assessment tools used by the investigators may not take into account all components or sub-component scores with equal exactitude [44] and may not capture all aspects of the diet [43]. Further, an earlier study in children has shown that the HEI correlates with the total amount of food eaten [55]. Thus, results of the HEI should be interpreted with caution.

Although the HEI sub-components include "total fruit" and "whole fruit," only a score is provided. The score provides a maximum of 5 points for each sub-component. For a maximum score for total fruits, the standard is ≥0.8 cup eq/1,000 kcal and for whole fruit the score is ≥0.4 cup eq/1,000 kcals [46]. We used the FPED to obtain a fuller understanding of intake of total and whole fruit and FJ. It's clear that FJ made a significant contribution to total fruit intake; although for most children, especially those in the 9-18 year age group, overall fruit intake was low in the lower deciles of OJ consumption. This was not surprising since it has been shown that fruit intake in children, especially older children, is low [56].

Since there was a positive linear trend with energy intake and OJ consumption in all age groups except those 2-8 years, it was important to assess whether there was a positive linear trend on any of the weight parameters tested. The literature regarding weight and FJ consumption in children has been long and contentious, stretching back more than 20 years, when Dennison, et al. [24], published her initial paper on "excess fruit juice consumption" as it related to short stature and obesity in 116 children 2 years and 107 children 5 years participating in a small, regional cross-sectional study in upstate New York. It should be noted that these authors used a non-standard definition and non-standard terminology for obesity in children. Although a subsequent paper [57] using a population apparently similar to her earlier paper [24], identified apple juice as the only FJ associated with self-reported obesity in children. However, the initial paper prompted a number of cross-sectional studies initially using small, regional populations [58], which were followed by nationally representative studies using NHANES databases [12; 14; 15; 17; 59]. These studies assessed all types of FJ, and found no association with FJ consumption and weight in children.

Fewer studies have looked exclusively at OJ and weight parameters in children. O'Neil, et al., [16] used NHANES 2003-2006 data, Wang, et al., [29] used 2003-2006 data, and Malliot, et al., [8] used NHANES 2013-2016 data to assess children who consumed OJ vs those who did not and weight parameters. The current paper is the first to use the novel approach of looking at linear trends of usual intake of deciles of OJ and weight parameters in a very large population, rather than simply examining consumers vs non-consumers. Although there was a high percentage of children who were overweight or obese in all age groups, none of the age groups showed positive linear trends across deciles of OJ consumption with any weight parameter.

These results are slightly different from a recent meta-analysis which looked at 8 prospective cohort studies which showed

that with children (n=34,470), a daily 6-8 oz serving of FJ was associated with a slight increase in BMI z-score in children 1-6 years (4% unit increase in BMI z-score); however for children 7-18 years there was no association with BMI z-score [26]. It should be noted that the study designs between the current study and the meta-analysis are different, as are the age designations of the children, and the emphasis on OJ in the present study.

The strengths of this study were that it included a very large nationally representative sample of children, which was achieved by combining data from NHANES cycles 2003 to 2016. This study also examined two age groups of children: 2-8 years, and 9-18 years and used the novel approach of linear trend analyses of deciles of usual intake of OJ.

The limitations of the study were that NHANES is a cross-sectional study; thus, causal relationships cannot be determined and reverse causation is possible [60]. Although usual intake from 24-hour dietary recalls is considered to be the "method of choice" for actual intake [61; 62], it is still memory driven. An additional issue with children is that proxies either report for or assist children and may not know what their children consume outside of the home [63], for example at day care or school, which could result in mis-reporting. There is also the possibility that proxies or older children may confuse 100% fruit juice with fruit drinks. Finally, it must be acknowledged that when looking at the effect of a single food, such as OJ, other foods consumed either with OJ or in other combinations, may also contribute to the results.

In conclusion, analyses of linear relationships of deciles of OJ consumption showed that energy and most nutrients, including folate DFE, vitamin C, and potassium, showed significant positive linear relationships in groups of children 2-8 years and 9-18 years participating in NHANES 2003-2016. There were no significant linear relationship with deciles of OJ consumption and added sugars. Total HEI scores and total fruit subcomponent scores also showed a positive linear relationship with deciles of OJ consumption and an inverse relationship with SFA. Although there was a significant positive relationship with energy, there were no linear relationships in any of the age groups for weight, BMI z-score, percent overweight, percent obese, or percent overweight and obese. Consumption of OJ should be encouraged by children as part of an overall healthy diet, since it improves nutrient intake and diet quality and is not associated with weight parameters.

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Supplemental Tables

Supplemental Table 1. Comparison of demographic data for the total population, for orange juice non-consumers, and from children 2-18 years participating in the National Health And Nutrition Examination Survey from 2003-2016.

	Total Population			Non-consumers, OJ			Consumers, OJ[1]			Cons vs Non-Cons		
Variable	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**Beta**	**SE**	**P[2]**
Orange Juice Cons (%)	21,995	14.3	0.5	18,465	0.0	0.0	3,530	100.0	0.0	.	.	.
Age (Years)	21,995	10.1	0.1	18,465	10.2	0.1	3,530	9.4	0.1	-0.8086	0.1368	**<0.0001**
Gender = Male (%)	21,995	50.8	0.6	18,465	50.3	0.6	3,530	53.7	1.4	3.3909	1.5177	0.0275
Ethnicity[3]												
Mexican American (%)	21,995	14.3	1.1	18,465	13.5	1.0	3,530	19.4	1.8	5.8530	1.1968	**<0.0001**
Other Hispanic (%)	21,995	6.5	0.6	18,465	6.1	0.5	3,530	9.3	1.1	3.2381	0.8081	**0.0001**
Non-Hispanic White (%)	21,995	56.8	1.7	18,465	58.6	1.7	3,530	46.6	2.5	-11.9766	1.8689	**<0.0001**
Non-Hispanic Black (%)	21,995	14.4	0.9	18,465	13.9	0.9	3,530	17.1	1.3	3.2085	0.8797	**0.0004**
Other (%)	21,995	7.9	0.5	18,465	8.0	0.5	3,530	7.7	0.9	-0.3230	0.7435	0.6648
Poverty Index Ratio (PIR)[3]												
PIR < 1.35 (%)	20,591	34.2	1.2	17,296	33.4	1.2	3,295	39.1	1.9	5.7644	1.5698	**0.0004**
1.35 ≤ PIR < 1.85 (%)	20,591	10.8	0.5	17,296	10.9	0.5	3,295	10.5	1.0	-0.3248	0.9635	0.7367
PIR > 1.85 (%)	20,591	55.0	1.3	17,296	55.8	1.3	3,295	50.4	2.2	-5.4396	1.8682	**0.0044**
Physical Activity[3]												
Sedentary	21,520	12.2	0.4	18,092	12.1	0.4	3,428	12.8	1.0	0.6657	1.0454	0.5256
Moderate	21,520	20.8	0.5	18,092	21.1	0.5	3,428	19.2	1.2	-1.9330	1.2198	0.1159
Vigorous	21,520	67.0	0.6	18,092	66.8	0.6	3,428	68.1	1.5	1.2674	1.5401	0.4123
Weight Status[4]												
% Overweight	21,712	15.64	0.38	18,222	15.64	0.41	3,490	15.67	1.00	0.0272	1.0797	0.9800
% Obese	21,712	16.85	0.52	18,222	17.06	0.56	3,490	15.60	1.03	-1.4643	1.0857	0.1802
% Overweight/Obese	21,712	32.50	0.68	18,222	32.70	0.72	3,490	31.27	1.47	-1.4371	1.5362	0.3516
Kilocalories consumed	21,995	1946	10.1	18,465	1923	10.0	3,530	2083	25.4	160.2527	24.8407	**<0.0001**
Grams of Food	21,995	2156.1	16.5	18,465	2140.9	17.0	3,530	2247.6	28.8	106.7579	27.7969	**0.0002**
BMI z-score	21,697	0.50	0.02	18,211	0.50	0.02	3,486	0.49	0.03	-0.0058	0.0328	0.8593

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls.
[2]Significance was defined as p<0.01
[3]Self-reported through the National Health And Nutrition Examination Survey questionnaire
[4]Children with a body mass index greater than or equal to the 85th and less than 95th, and greater than or equal to the 95th percentile were considered overweight or obese, respectively.

Supplemental Table 2. Usual intake of Energy and Nutrients across deciles of orange juice intake (gm) of children 2-18 years participating in NHANES 2003-2016.

	Decile of orange juice intake[1] (gm)										Linear Trend Across Deciles		
	0	**81**	**122**	**142**	**182**	**225**	**252**	**327**	**395**	**714**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[2]**
Energy (kilocalories)[3]	1921±9.89	1637±47.6	1974±57.7	1796±52.2	1964±55.8	1948±80.9	2061±59.4	2185±63.9	2326±90.8	2701±67.7	0.8381	0.2457	**0.0092**
Protein (g)	67.9±0.45	61.5±2.29	71.5±2.42	66.8±2.52	68.5±1.93	66.8±2.76	73.0±2.20	76.1±2.55	84.8±4.03	95.7±2.92	0.0298	0.0069	**0.0025**
Carbohydrate (g)	255±1.31	215±6.55	259±6.47	239±6.78	267±7.66	265±11.74	284±8.08	300±8.62	318±10.1	376±9.17	0.1366	0.0344	**0.0041**
Total Sugars (g)	124±0.86	103±3.80	124±4.18	111±2.74	134±4.02	128±6.88	137±4.99	147±4.77	159±5.68	199±6.25	0.0713	0.0252	0.0222
Added Sugars (tsp eq)	19.3±0.20	12.6±0.90	16.4±0.78	13.6±0.61	17.0±0.81	16.2±1.41	16.7±0.94	18.6±0.99	18.8±1.12	21.6±1.27	-0.0034	0.0053	0.5403
Dietary Fiber (g)	13.2±0.10	12.6±0.52	14.2±0.38	13.9±0.52	14.1±0.47	14.7±0.52	15.5±0.53	16.0±0.75	16.2±0.72	17.9±0.62	0.0069	0.0007	**<0.0001**
Folate (DFE)	511±4.71	458±21.2	538±19.8	504±25.4	540±22.8	550±34.9	628±28.3	622±23.7	654±24.7	769±22.48	0.3464	0.0448	**0.0001**
Niacin (mg)	21.0±0.17	18.2±0.95	21.4±0.57	19.6±0.68	20.6±0.79	20.7±1.12	22.5±0.71	22.7±0.69	25.3±0.93	29.3±1.12	0.0080	0.0024	0.0112
Riboflavin (mg)	2.01±0.01	1.80±0.06	2.13±0.09	1.90±0.07	2.11±0.08	2.06±0.11	2.20±0.07	2.19±0.07	2.48±0.09	2.66±0.09	0.0008	0.0002	**0.0065**
Thiamin (mg)	1.52±0.01	1.34±0.04	1.63±0.05	1.49±0.06	1.60±0.06	1.62±0.09	1.77±0.05	1.81±0.06	1.99±0.08	2.25±0.06	0.0010	0.0002	**0.0005**

Total choline (mg)	244±1.95	236±8.99	254±7.35	262±10.6	266±9.32	266±15.4	289±10.5	317±16.9	337±16.9	376±15.2	0.1769	0.0201	**<0.0001**
Vitamin A, RAE (mcg)	582±6.22	539±27.1	610±26.2	568±28.8	599±28.7	601±45.5	656±27.1	628±35.0	669±25.5	719±34.1	0.1923	0.0369	**0.0008**
Vitamin B6 (mg)	1.67±0.02	1.51±0.07	1.77±0.05	1.65±0.06	1.83±0.08	1.77±0.09	1.93±0.06	2.02±0.07	2.31±0.09	2.89±0.12	0.0013	0.0002	**0.0006**
Vitamin C (mg)	66.6±1.01	82.1±3.97	111±3.86	119±4.25	134±4.14	142±3.92	151±3.40	177±4.81	202±4.31	335±9.84	0.3494	0.0098	**<0.0001**
Vitamin D (mcg)	5.57±0.06	5.60±0.36	6.44±0.39	5.82±0.33	6.26±0.30	5.79±0.37	6.91±0.33	6.49±0.36	7.29±0.44	7.55±0.50	0.0033	0.0005	**0.0001**
Vitamin K (mcg)	58.2±0.89	54.7±3.60	62.9±4.01	55.0±3.42	62.6±4.72	58.6±7.65	67.4±4.62	72.5±6.18	65.3±6.29	75.3±5.52	0.0235	0.0061	**0.0049**
Calcium (mg)	991±7.93	988±35.6	1121±54.3	1055±35.4	1113±48.7	1162±51.0	1211±36.5	1259±53.8	1394±60.7	1546±64.0	0.8098	0.0628	**<0.0001**
Copper (mg)	0.97±0.01	0.92±0.04	1.00±0.03	0.99±0.04	1.07±0.03	1.08±0.04	1.12±0.03	1.23±0.05	1.36±0.06	1.57±0.06	0.0007	0.0001	**<0.0001**
Iron (mg)	14.1±0.11	12.8±0.56	14.2±0.51	13.7±0.62	14.5±0.71	13.9±0.81	15.6±0.51	15.5±0.52	17.0±0.71	19.6±0.61	0.0065	0.0011	**0.0005**
Magnesium (mg)	227±1.36	209±6.81	235±5.95	228±7.39	247±6.90	246±7.81	263±7.56	282±10.02	304±12.6	352±10.1	0.1522	0.0226	**0.0001**
Phosphorus (mg)	1239±7.90	1136±37.3	1310±40.5	1230±33.4	1292±45.8	1276±49.6	1377±39.5	1414±47.6	1566±67.0	1671±50.2	0.5487	0.1022	**0.0007**
Potassium (mg)	2113±14.1	2028±53.3	2390±60.5	2239±66.0	2465±66.1	2472±84.1	2659±69.3	2797±70.6	3121±107	3918±102	2.2632	0.2213	**<0.0001**
Selenium (mcg)	93.1±0.64	83.8±3.09	94.0±2.88	90.7±4.15	91.7±2.95	90.2±4.16	100±2.92	106±3.87	115±6.48	125±4.28	0.0340	0.0095	**0.0071**
Sodium (mg)	3047±21.5	2579±114	3055±95.4	2919±102	2934±107	2937±128	3233±105	3412±110	3719±186	3926±114	1.0106	0.3203	0.0135
Zinc (mg)	10.3±0.07	9.43±0.49	10.1±0.39	10.2±0.43	10.1±0.31	10.6±0.70	10.7±0.39	10.8±0.39	12.5±0.55	13.9±0.55	0.0035	0.0009	**0.0060**

[1]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls. Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
[2]Significance was defined as p<0.01
[3]Energy and nutrient intake from foods were determined using respective Food and Nutrient Database for Dietary Studies for each NHANES cycle available from total nutrient intake files. Added sugars were defined by the USDA Food Patterns Equivalent Databases.

Supplemental Table 3. Healthy Eating Index (HEI)[1]—total score and component scores across deciles of usual orange juice intake (gm)[2] of children 2-18 years participating in NHANES 2003-2016.

	Decile of orange juice intake[2] (gm)										Linear Trend Across Deciles		
Decile of OJ (gm)	**0**	**81**	**122**	**142**	**182**	**225**	**252**	**327**	**395**	**714**			
	Mean±SE	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Beta**	**SE**	**P[3]**
Total score	46.6±0.2	53.4±1.0	49.3±0.9	52.1±1.0	51.1±0.9	52.8±1.2	52.0±0.8	50.8±0.9	51.1±0.8	52.0±0.8	0.0102	0.0030	**0.0094**
#1 Total Vegetable	2.2±0.02	2.1±0.1	2.3±0.1	2.3±0.1	1.9±0.1	2.4±0.2	2.2±0.1	2.3±0.1	2.2±0.1	2.3±0.1	0.0001	0.0001	0.2672
#2 Beans & Greens	0.9±0.03	1.2±0.1	0.9±0.1	0.9±0.1	0.9±0.1	1.0±0.2	1.0±0.1	1.2±0.2	0.9±0.1	1.1±0.1	0.0003	0.0001	0.0646
#3 Total Fruit	2.2±0.04	3.7±0.2	3.6±0.1	4.0±0.1	4.1±0.1	4.3±0.1	4.3±0.1	4.5±0.1	4.6±0.1	4.8±0.03	0.0031	0.0007	**0.0016**
#4 Whole Fruit	2.2±0.04	3.2±0.2	2.8±0.2	3.1±0.2	2.8±0.2	2.7±0.2	2.8±0.2	2.3±0.2	2.1±0.2	1.9±0.2	0.0000[4]	0.0006	0.9908
#5 Whole Grains	2.2±0.1	3.1±0.3	1.7±0.2	3.1±0.3	2.3±0.2	2.7±0.4	2.2±0.2	1.7±0.2	2.0±0.2	1.6±0.2	-0.0008	0.0004	0.0954
#6 Dairy	7.0±0.1	7.5±0.5	7.5±0.3	7.2±0.2	7.2±0.2	6.7±0.3	7.2±0.2	6.5±0.3	6.8±0.2	5.8±0.3	-0.0008	0.0005	0.1200
#7 Total Protein	3.6±0.02	3.7±0.1	3.6±0.1	3.9±0.1	3.5±0.1	3.7±0.1	3.6±0.1	3.7±0.1	3.7±0.1	3.7±0.1	0.0003	0.0001	0.0609
#8 Seafood/Plant Protein	1.6±0.03	1.7±0.2	1.5±0.2	1.5±0.2	1.6±0.2	1.8±0.2	1.6±0.1	1.9±0.2	1.7±0.2	1.5±0.2	0.0001	0.0001	0.6952
#9 Fatty Acid Ratio	3.8±0.1	4.0±0.3	3.7±0.2	3.6±0.3	3.7±0.3	3.7±0.3	4.1±0.2	3.8±0.3	3.8±0.3	4.0±0.3	0.0002	0.0002	0.3345
#10 Sodium	4.9±0.1	5.1±0.4	5.0±0.3	4.7±0.3	5.7±0.2	5.5±0.4	5.1±0.2	5.2±0.3	5.0±0.3	5.9±0.2	0.0012	0.0003	**0.0053**
#11 Refined Grain	5.2±0.1	5.5±0.3	4.9±0.3	5.5±0.3	5.5±0.3	5.7±0.3	4.9±0.2	5.1±0.3	5.4±0.4	5.9±0.2	0.0007	0.0004	0.0885
#12 SFA[4]	5.4±0.1	5.8±0.3	5.4±0.3	5.4±0.2	5.6±0.3	5.7±0.4	6.2±0.2	6.3±0.3	6.1±0.2	6.5±0.2	0.0017	0.0002	**<0.0001**
#13 Added Sugars	5.5±0.1	7.1±0.3	6.6±0.2	7.1±0.2	6.4±0.2	6.7±0.3	6.8±0.2	6.5±0.2	6.8±0.3	6.9±0.2	0.0029	0.0009	0.0124

[1]Healthy Eating Index is a measure of adherence to the Dietary Guidelines for Americans and an indicator of diet quality; a perfect score is 100.
[2]Orange juice consumption, in grams, was determined using all orange juice food codes from the What We Eat in America; consumers were defined as having any consumption of orange juice in the 24 hour dietary recalls. Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
[3]Significance was defined as p<0.01
[4]Actual beta value is -0.00001
[5]SFA=saturated fatty acids