



Research Article

Associations of Deciles of Orange Juice Consumption with Nutrient Intake, Diet Quality, and Weight Parameters in Adults: The National Health and Nutrition Examination Survey 2003-2016

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Abstract

Objective: The objective of this study was to examine linear relationships among deciles of orange juice (OJ) consumption with nutrient intake, diet quality, fruit consumption, and weight parameters in adults 19+ years participating in the National Health and Nutrition Examination Survey (NHANES) 2003-2016.

Design: Intake was determined using 24-hour dietary recalls. Primary analyses were based on linear regression of deciles of OJ consumption on energy; nutrients; diet quality, determined by the Healthy Eating Index-2015 (HEI); fruit consumption; and weight parameters: weight, body mass index, and percent overweight and obese. 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 $p < 0.01$.

Setting: NHANES

Participants: Adults 19+ years participating in NHANES 2003-2016.

Results: Most nutrients, including fiber, folate DFE, vitamin C, calcium, magnesium, and potassium showed a positive linear association with deciles of OJ consumption. There was no positive linear association with added sugars. Total HEI scores did not show a positive linear association in the overall population; however, the total fruit subcomponent showed a positive linear association. There was not a linear association with whole fruit, although there were ones for total fruit and fruit juice. There were no associations for any of the weight parameters examined.

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

Introduction

Higher levels of fruit and vegetable consumption has been associated with a decreased risk of cardiovascular disease [1,2], type 2 diabetes [3], stroke [4], genetically associated increases in body weight [5], cancer [1], and all-cause mortality [1] and lower intake has been associated with poor health and increased risk of these chronic diseases [6]. Fruit and vegetables also provide important nutrients including short chain fatty acids, including vitamins A and C, and magnesium, and nutrients of public health concern, particularly dietary fiber and potassium [7]. Recommendations for fruit consumption by adults varies with age and gender. Females 19-30 years of age (years) should consume 2 cup equivalents (cup eq)/day, whereas,

all other adult females should consume 1½ cup eq/day; males of all ages should consume 2 cup eq/day. However, with the exception of young children, fruit consumption falls short of these recommendations [7-9].

"Fruit" is defined as fresh, canned, frozen, or dried fruit and 100% fruit juice (FJ). The US Dietary Guidelines for Americans (DGA) [7] reports that 100% FJ "can be part of healthy eating patterns;" however, it recommends that at least half the fruit recommendation be consumed as whole fruit since that is a better source of fiber than FJ. There are also concerns that consumption of FJ is associated with obesity [10,11]; however, the majority of these studies have been conducted in children. Studies in children have also demonstrated that consumption of FJ contributes to

nutrient intake or adequacy [12-14], consumption of whole fruit [15,16], and diet quality [12,14]; and the majority of studies, including one systematic review [17] and two meta-analyses [18,19] have shown that consumption of FJ is not associated weight parameters in children.

Fewer studies have examined the effect of fruit juices (FJ) [20,21] or specific FJ, such as 100% orange juice (OJ) [20,22,23] on diet and weight in adults. Orange juice is the most popular fruit juice consumed in the US with a per capita availability of 2.45 gallons [24]. Citrus juices, including 100% OJ, are the most nutrient dense of the FJs, regardless of the type of nutrient density measures used in the evaluation [25]. One cup (8 oz) of 100% OJ constitutes 1 cup equivalent (cup eq) from the fruit group [26] and is a rich source of folate, vitamin C, and potassium [27] and phytochemicals [23, 27].

The objective of this study was to examine the linear relationships among OJ consumers and non-consumers by decile for nutrient intake, diet quality, fruit consumption, and weight parameters in adults 19+ years participating in NHANES 2003-2016.

Materials and Methods

Study overview, study population, and analytic sample

This study used methods similar to those used in NHANES studies conducted by this group [12,21]; a description of NHANES and analytical methods are available on line [28,29]. Data from adults 19+ years of age (years) (N=40,544) participating in NHANES 2003-2016 were used after the exclusion of unreliable data (n=4,310) and pregnant or lactating females (n=1,164) for a final analytical sample of N=35,148, that were used in the main analyses. Separate analyses were also conducted for age subgroups: 19-50 years (N=18,754) and 51+ years (N=16,394).

Use of human subjects for NHANES has been approved by The National Center for Health Statistics Research Ethics Review Board [30]. Since the current study was a secondary data analysis lacking personal identifiers, it did not require further Institutional Review Board approval.

Demographic data

Demographic data, including age; gender; self-reported ethnicity: Mexican-American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, and other; poverty index ratio (PIR): $PIR < 1.35$, $1.35 \leq PIR < 1.85$; and physical activity: sedentary, moderate, and vigorous were obtained by questionnaire [31].

Dietary intake data

Dietary data were collected using two 24-hour dietary recalls using an automated multiple-pass method [32]; the first recall was conducted in person by a trained interviewer, and the second recall was conducted 3 to 10 days later via telephone. Detailed descriptions of the

dietary recalls and data collection are available in the NHANES Dietary Interviewer's Training Manual [33].

Determination of energy, nutrients and orange juice intake

Energy and nutrient intake from foods were determined using Food and Nutrient Database for Dietary Studies (FNDDS) appropriate for each NHANES cycle [34,35] which are available from total nutrient intake files. Added sugars were defined by the USDA Food Patterns Equivalent Databases [26]. 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 What We Eat In America: 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) [37].

Individual usual Intake (UI) of nutrients was determined using the preferred National Cancer Institute (NCI) method [38]. The NCI macros (Mixtran and Distrib) were used to generate 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 consumers were then allocated into deciles of OJ consumption for analyses; those not reporting OJ consumption were placed into the first decile [zero gm consumption] and those reporting OJ consumption were then separated into the remaining nine deciles. Analyses of demographic data compared non-consumers, who were defined as having reported no OJ consumption, to OJ consumers, who reported any amount OJ consumption.

Healthy Eating Index (HEI) and Fruit Consumption Categories

The HEI-2015 was used to determine diet quality [39-41]. The overall HEI-2015 score is made up of 13 components that reflect the different food groups and key recommendations in the 2015-2020 Dietary Guidelines for Americans. 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.

Detailed information on the development of the components, scoring standards, and density approach for the HEI-2015 has been described previously [42]. HEI-2015 was calculated using a downloadable SAS program available on the website of the National Cancer Institute [43].

Total fruit, whole fruit, and fruit juice consumption was determined from the respective Food Pattern Equivalents Database for each NHANES survey period database [44].

Weight parameters

Weight and height were obtained according to NHANES protocols [45]. Body mass index (BMI) was calculated as body weight (in kilograms) divided by height (in meters) squared. Overweight was defined as a BMI of 25 to 29.9 and obesity was defined as a person with a BMI ≥ 30 [46].

Statistical analysis

Analyses were adjusted for the complex sampling design of NHANES and incorporated appropriate sample weights as advised by the NHANES analytical guidelines [29]; all analyses were performed using SAS release 9.4 (Cary, NC). Version 2.1 of the National Cancer Institute method [47] was used for estimating individual usual intake (UI) 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, percent [%] overweight, % obese, and % overweight or obese). A p value of <0.01 was considered significant.

Results

Demographics

Demographics for adults 19+ years are presented in Table 1 and demographics for adults 19-50 years and 51+ years are presented in Supplemental Tables 1 and 2, respectively. In adults 19+ years, there were no differences in percent OJ consumers, ethnicity, PIR, or physical activity between OJ consumers and non-OJ consumers. There was no difference between percent overweight among OJ consumers and non-OJ consumers; however, there were inverse relationships between % obese ($36.2 \pm 0.5\%$ vs $30.5 \pm 1.1\%$; $\beta = -3.19$; $p < 0.0001$), % overweight or obese ($69.0 \pm 0.5\%$ vs 65.8 ± 1.0 ; $\beta = -5.72$; $p = 0.0025$), and BMI (28.87 ± 0.08 vs 27.85 ± 0.13 ; $\beta = -1.02$; $p < 0.0001$). There was also a significant difference between total kilocalories (kcal) consumed between OJ consumers and non-OJ consumers (Table 1).

Table 1. Comparison of demographic data for orange juice consumers and non-consumers in adults 19+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Total Population			Non-consumers, OJ			Consumers, OJ ¹			Cons vs Non-Cons		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	Beta	SE	P ²
Orange Juice Cons (%)	35,148	12.7	0.3	30,504	0.0	0.0	4,644	100.0	0.0	.	.	.
Age (Years)	35,148	47.0	0.3	30,504	46.5	0.2	4,644	50.5	0.5	3.9874	0.4441	<0.0001
Gender = Male (%)	35,148	49.2	0.3	30,504	48.7	0.4	4,644	52.9	1.0	4.1682	1.1026	0.0003
Ethnicity ³												
Mexican American (%)	35,148	8.4	0.7	30,504	8.5	0.7	4,644	7.6	0.8	-0.8857	0.4549	0.0541
Other Hispanic (%)	35,148	4.9	0.4	30,504	4.8	0.4	4,644	5.5	0.5	0.6810	0.3991	0.0908
Non-Hispanic White (%)	35,148	68.6	1.3	30,504	68.5	1.3	4,644	68.9	1.5	0.3706	0.9628	0.7010
Non-Hispanic Black (%)	35,148	11.4	0.7	30,504	11.3	0.7	4,644	12.3	0.9	1.0617	0.5484	0.0555
Other (%)	35,148	6.8	0.4	30,504	7.0	0.4	4,644	5.7	0.5	-1.2276	0.4831	0.0125
Poverty Index Ratio (PIR) ³												
PIR < 1.35 (%)	32,446	23.3	0.7	28,171	23.5	0.7	4,275	21.6	1.1	-1.9123	0.8631	0.0288
1.35 \leq PIR < 1.85 (%)	32,446	9.8	0.3	28,171	9.7	0.3	4,275	9.9	0.8	0.1746	0.8032	0.8283
PIR > 1.85 (%)	32,446	67.0	0.9	28,171	66.8	0.9	4,275	68.5	1.5	1.7377	1.2552	0.1691
Physical Activity ³												
Sedentary	35,144	25.0	0.5	30,501	25.2	0.5	4,643	23.6	1.0	-1.5899	0.9242	0.0882
Moderate	35,144	36.2	0.4	30,501	36.0	0.4	4,643	37.6	1.1	1.6924	1.1301	0.1371
Vigorous	35,144	38.8	0.6	30,501	38.9	0.6	4,643	38.7	1.3	-0.1024	1.2518	0.9349
Percent Overweight or Obese ⁴												
Overweight (%)	34,715	33.1	0.4	30,149	32.7	0.5	4,566	35.3	0.9	2.5309	0.9718	0.0105
Obese (%)	34,715	35.5	0.5	30,149	36.2	0.5	4,566	30.5	1.1	-3.1862	1.0294	<0.0001
Overweight or Obese (%)	34,715	68.5	0.5	30,149	69.0	0.5	4,566	65.8	1.0	-5.7171	1.0323	0.0025
Grams of Food	35,148	3393.7	23.3	30,504	3400.2	24.0	4,644	3348.5	37.6	-51.7213	35.8171	0.1516
Body Mass Index (BMI) (kg/m ²)	34,715	28.74	0.08	30,149	28.87	0.08	4,566	27.85	0.13	-1.0162	0.1244	<0.0001

¹Orange 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

²Significance was defined as $p < 0.01$

³Self-reported through the National Health and Nutrition Examination Survey questionnaire

⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

In adults 19-50 years, there were significant differences in ethnicity; other Hispanics had a higher percentage of OJ consumers than non-consumers (5.80±0.48% vs 7.78±0.77%; $\beta=1.99$; $p=0.0052$). A similar pattern was also seen in non-Hispanic Blacks (12.33%±0.78 vs 14.90±1.09%; $\beta=2.57$; $p=0.0045$). However, an inverse relationship was shown in non-Hispanic Whites, who showed a higher percentage of non-OJ consumers (63.21±1.46% vs 58.05±1.87%; $\beta=-5.16$; $p=0.0027$). There was also an inverse relationship for sedentary behavior between OJ consumers and non-consumers (19.68±0.58%

vs 15.62±1.20%; $\beta=-4.06$; $p=0.0015$). Similar to the total population, there was no difference between percent overweight; however, there were inverse relationships between percent obese (34.41±0.65% vs 28.65±1.44%; $\beta=-5.77$; $p=0.0001$), percent overweight or obese (65.50±0.74% vs 58.91±1.48%; $\beta=-6.59$; $p=0.0001$) and BMI (28.57±0.10 vs 27.39±0.20; $\beta=-1.18$; $p<0.0001$). There was also a significant difference between total kcals consumed between OJ consumers and non-OJ consumers (2297±10.6 kcals vs 2504±33.3 kcals; $\beta=207$; $p<0.0001$) (Supplemental Table 1).

Supplemental Table 1. Comparison of demographic data for orange juice consumers and non-consumers in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Total Population			Non-consumers, OJ			Consumers, OJ ¹			Cons vs Non-Cons		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	Beta	SE	P ²
Orange Juice Cons (%)	18,754	10.87	0.38	16,670	0.00	0.00	2,084	100.0	0.00	.	.	.
Age (Years)	18,754	34.65	0.16	16,670	34.73	0.17	2,084	33.99	0.31	-0.7448	0.3042	0.0160
Gender = Male (%)	18,754	51.30	0.42	16,670	50.73	0.43	2,084	55.98	1.49	5.2482	1.5213	0.0008
Ethnicity ³												
Mexican American (%)	18,754	11.06	0.82	16,670	10.97	0.82	2,084	11.79	1.19	0.8207	0.8586	0.3413
Other Hispanic (%)	18,754	6.01	0.48	16,670	5.80	0.48	2,084	7.78	0.77	1.9884	0.6969	0.0052
Non-Hispanic White (%)	18,754	62.65	1.42	16,670	63.21	1.46	2,084	58.05	1.87	-5.1603	1.6794	0.0027
Non-Hispanic Black (%)	18,754	12.61	0.77	16,670	12.33	0.78	2,084	14.90	1.09	2.5668	0.8838	0.0045
Other (%)	18,754	7.67	0.42	16,670	7.69	0.45	2,084	7.47	0.81	-0.2155	0.8834	0.8077
Poverty Index Ratio (PIR) ³												
PIR < 1.35 (%)	17,474	26.46	0.95	15,548	26.49	0.93	1,926	26.20	1.65	-0.2913	1.3221	0.8260
1.35 ≤ PIR ≤ 1.85 (%)	17,474	9.92	0.35	15,548	9.82	0.35	1,926	10.79	1.12	0.9748	1.1283	0.3895
PIR > 1.85 (%)	17,474	63.61	1.01	15,548	63.69	1.00	1,926	63.00	2.02	-0.6835	1.8019	0.7052
Physical Activity Level ³												
Sedentary	18,754	19.24	0.55	16,670	19.68	0.58	2,084	15.62	1.20	-4.0605	1.2477	0.0015
Moderate	18,754	31.53	0.56	16,670	31.65	0.57	2,084	30.58	1.60	-1.0708	1.5972	0.5040
Vigorous	18,754	49.23	0.73	16,670	48.67	0.73	2,084	53.80	1.95	5.1313	1.9161	0.0086
Percent Overweight or Obese ⁴												
Overweight (%)	18,600	30.99	0.54	16,541	31.08	0.57	2,059	30.26	1.27	-0.8244	1.3535	0.5437
Overweight or Obese (%)	18,600	64.78	0.70	16,541	65.50	0.74	2,059	58.91	1.48	-6.5907	1.5639	0.0001
Obese (%)	18,600	33.79	0.64	16,541	34.41	0.65	2,059	28.65	1.45	-5.7663	1.4186	0.0001
Kilocalories consumed	18,754	2319.81	10.32	16,670	2297	10.6	2,084	2504	33.3	206.9829	34.4311	<0.0001
Grams of Food	18,754	3570.26	27.10	16,670	3567.50	27.85	2,084	3592.87	53.84	25.3653	52.9793	0.6331
Body Mass Index (kg/m ²)	18,600	28.44	0.10	16,541	28.57	0.10	2,059	27.39	0.20	-1.1786	0.2019	<0.0001

¹Orange 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

²Significance was defined as $p<0.01$

³Self-reported through the National Health and Nutrition Examination Survey questionnaire

⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

In adults 50+, there were inverse associations between Mexican Americans (4.89±0.55% vs 3.45±0.54%; $\beta=-1.44$; $p=0.0001$) and other ethnicities (5.87±0.44% vs 3.98±0.58%); $\beta=-1.89$; $p=0.0013$). In non-Hispanic Whites there was a higher percentage of OJ consumers than non-consumers (76.17±1.22% vs 79.59±1.51%; $\beta=3.42$; $p=0.0033$). Orange juice consumers had a higher percentage of overweight individuals than non-OJ

consumers (35.11±0.61% vs 40.20±1.32%; $\beta=5.08$; $p=0.0007$); however OJ consumers had a lower percentage of those individuals who were obese (38.82±0.70% vs 32.33±1.53%; $\beta=-6.50$; $p=0.0001$), and who had a lower BMI (29.30±0.10 vs 28.31±0.17; $\beta=-0.9932$; $p<0.0001$). Finally, OJ consumers consumed significantly more kcals than non-OJ consumers (1916±11.7 kcals vs 2057±22.2 kcals; $\beta=140$; $p<0.0001$) (Supplemental Table 2).

Supplemental Table 2. Comparison of demographic data for orange juice consumers and non-consumers in adults 51-99 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Total Population			Non-consumers, OJ			Consumers, OJ ¹			Cons vs Non-Cons		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	Beta	SE	P ²
Orange Juice Cons (%)	16,394	15.12	0.48	13,834	0.00	0.00	2,560	100.00	0.00	.	.	.
Age (Years)	16,394	63.99	0.12	13,834	63.49	0.12	2,560	66.79	0.27	3.3043	0.2695	<0.0001
Gender=Male (%)	16,394	46.34	0.41	13,834	45.73	0.52	2,560	49.76	1.28	4.0342	1.5526	0.0107
Ethnicity ³												
Mexican American (%)	16,394	4.67	0.53	13,834	4.89	0.55	2,560	3.45	0.54	-1.4381	0.3492	0.0001
Other Hispanic (%)	16,394	3.34	0.34	13,834	3.37	0.36	2,560	3.21	0.43	-0.1574	0.4009	0.6954
Non-Hispanic White (%)	16,394	76.69	1.20	13,834	76.17	1.22	2,560	79.59	1.51	3.4189	1.1388	0.0033
Non-Hispanic Black (%)	16,394	9.72	0.70	13,834	9.71	0.71	2,560	9.78	0.88	0.0638	0.6894	0.9265
Other (%)	16,394	5.58	0.41	13,834	5.87	0.44	2,560	3.98	0.58	-1.8872	0.5711	0.0013
Poverty Index Ratio (PIR) ³												
PIR < 1.35 (%)	14,972	18.84	0.76	12,623	19.17	0.80	2,349	16.99	1.15	-2.1842	1.1273	0.0553
1.35 ≤ PIR ≤ 1.85 (%)	14,972	9.52	0.40	12,623	9.61	0.42	2,349	9.02	1.07	-0.5897	1.1413	0.6064
PIR > 1.85 (%)	14,972	71.64	0.99	12,623	71.23	1.03	2,349	74.00	1.64	2.7740	1.6004	0.0859
Physical Activity Level ³												
Sedentary	16,390	32.92	0.66	13,831	33.17	0.69	2,559	31.51	1.27	-1.6578	1.2715	0.1950
Moderate	16,390	42.53	0.54	13,831	42.15	0.57	2,559	44.62	1.46	2.4693	1.5393	0.1116
Vigorous	16,390	24.56	0.65	13,831	24.68	0.67	2,559	23.87	1.43	-0.8115	1.4229	0.5697
Percent Overweight or Obese ⁴												
Overweight (%)	16,115	35.88	0.55	13,608	35.11	0.61	2,507	40.20	1.32	5.0849	1.4614	0.0007
Overweight or Obese (%)	16,115	73.72	0.53	13,608	73.94	0.58	2,507	72.52	1.25	-1.4139	1.3632	0.3020
Obese (%)	16,115	37.84	0.66	13,608	38.82	0.70	2,507	32.33	1.53	-6.4988	1.6175	0.0001
Kilocalories consumed	16,394	1937.69	10.67	13,834	1916	11.7	2,560	2057	22.2	140.3123	24.3162	<0.0001
Grams of Food	16,394	3151.16	29.68	13,834	3158.99	30.77	2,560	3107.24	44.11	-51.7513	41.1256	0.2109
Body Mass Index (kg/m ²)	16,115	29.15	0.10	13,608	29.30	0.10	2,507	28.31	0.17	-0.9932	0.1791	<0.0001

¹Orange 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

²Significance was defined as p<0.01

³Self-reported through the National Health And Nutrition Examination Survey questionnaire

⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

Orange juice consumption and decile definition

Orange juice consumption for all age groups is presented in Table 2. For adults 19+ years (N=10,112), usual intake of OJ was 30.22±1.82 gm; for those 19-50 years (N=5,376) and 51+ years (N=4,736), usual intake of OJ was 32.35±1.85 gm and 27.39±2.35 gm, respectively. Table 3 shows the usual

OJ intake consumption (gm) per decile for adults. For adults 19+, there were 12% OJ consumers. For adults 19-50 and 51+, there were 11% and 16% OJ consumers, respectively. Consumption (gm)/day of OJ in decile 10 was 788 gm, 949 gm, and 613 gm for adults 19+ years, 19-50 years, and 51+ years, respectively.

Table 2. Day 1 and usual intake of orange juice¹ (gm) by adults 19+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Age	Day 1 Intake			Usual Intake ²			Usual Intake Percentiles						
	N	Mean	SE	N	Mean	SE	P5	P10	P25	P50	P75	P90	P95
19+	10,112	30.08	1.44	10,112	30.22	1.82	0.07	0.18	0.87	4.93	26.10	92.48	157.85
19-50	5,376	31.73	2.20	5,376	32.35	1.85	0.07	0.18	0.88	4.92	26.18	97.16	172.15
51+	4,736	28.07	1.95	4,736	27.39	2.35	0.07	0.18	0.85	4.83	25.49	86.70	142.67

¹Orange 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

²Individual usual Intake (UI) of nutrients was determined using the National Cancer Institute method

Table 3. Usual orange juice consumption¹ (grams [oz]) by decile for adults 19+ years (N=35,148), 19-50 years (N=18,754), and 51+ year (N=16,394) participating in the National Health and Nutrition Examination Survey 2003-2016.

Decile	19+ years		19-50 years		51+ years	
	N	Consumption	N	Consumption	N	Consumption
1	30,503	0 [0]	16,669	0 [0]	13,834	0 [0]
2	510	100 [3.4]	180	104 [3.5]	259	92 [3.1]
3	477	146 [4.9]	245	167 [5.6]	227	125 [4.2]
4	478	167 [5.6]	194	221 [7.5]	231	155 [5.2]
5	571	216 [7.3]	285	253 [8.6]	362	167 [5.6]
6	539	249 [8.4]	199	324 [11.0]	298	212 [7.2]
7	497	308 [10.4]	273	353 [11.9]	236	246 [8.3]
8	508	351 [11.9]	214	425 [14.4]	304	279 [9.4]
9	491	446 [15.1]	239	530 [17.9]	318	348 [11.8]
10	574	788 [26.6]	256	949 [32.1]	325	613 [20.7]

¹Orange 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.

Energy and Nutrient Intake

Table 4 shows the results of linear analyses of the usual intake of energy and nutrients across the deciles of OJ consumption for adults 19+ years. Energy, protein, added sugars, total choline, vitamin K, selenium, and sodium were the only elements that did not show a significant linear association across the deciles of OJ consumption. Of particular import in relation to OJ consumers and non-OJ

consumers were dietary fiber (16.5±0.1 gm for non-OJ consumers [decile 1] to 21.2±0.6 gm for consumers in decile 10; $\beta=0.0061$; $p<0.0001$), folate DFE (527±3µg for non-OJ consumers to 792±23µg for those in decile 10; $\beta=0.36$; $p<0.0001$), vitamin C (71.0±0.8mg for non-OJ consumers to 357±12mg for those in decile 10; $\beta=0.35$; $p<0.0001$), and potassium (2632±13mg for non-OJ consumers to 4446±97mg for those in decile 10; $\beta=2.12$; $p<0.0001$).

Table 4. Usual nutrient intake¹ across deciles of orange juice intake in adults 19+ years participating in the National Health and Nutrition Examination Survey 2003-2016.

Variable	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
0	100	146	167	216	249	308	351	446	788				
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Protein (gm)	82.8 ± 0.4	71.4 ± 2.4	79.7 ± 1.9	78.6 ± 2	83.4 ± 2	80.0 ± 2.2	92.9 ± 2.5	88.7 ± 2.5	94.5 ± 2.2	106 ± 3	0.0201	0.0078	0.0336
Carbohydrate (gm)	255 ± 1	222 ± 5	253 ± 7	257 ± 5	268 ± 6	264 ± 6	310 ± 7	298 ± 6	314 ± 7	395 ± 9	0.1297	0.0291	0.0021
Total Sugar, (gm)	113 ± 1	96.3 ± 3.0	111 ± 3	120 ± 3	124 ± 4	121 ± 3	149 ± 4	139 ± 3	154 ± 5	207 ± 6	0.0850	0.0189	0.0020
Added Sugars (tsp eq.)	18.5 ± 0.2	12.9 ± 0.60	14.2 ± 0.6	15.1 ± 0.7	15.8 ± 0.9	14.4 ± 0.6	18.5 ± 0.9	16.8 ± 0.8	17.8 ± 1.0	22.4 ± 1.2	-0.0027	0.0047	0.5804
Dietary fiber (gm)	16.5 ± 0.1	15.9 ± 0.6	18.1 ± 0.6	18.0 ± 0.5	18.1 ± 0.4	18.1 ± 0.7	18.6 ± 0.5	18.7 ± 0.6	18.9 ± 0.6	21.2 ± 0.6	0.0061	0.0006	<0.0001
Folate, DFE (mcg)	527 ± 3	510 ± 21	614 ± 26	614 ± 22	592 ± 16	614 ± 23	721 ± 30	674 ± 20	680 ± 24	792 ± 23	0.3619	0.0345	<0.0001
Niacin (mg)	25.6 ± 0.1	22.4 ± 0.8	25.4 ± 0.70	24.9 ± 0.8	25.6 ± 0.6	25.2 ± 1	28.7 ± 0.8	28.0 ± 0.8	29.1 ± 0.9	32.7 ± 0.8	0.0072	0.0019	0.0050
Riboflavin (mg)	2.18 ± 0.01	1.97 ± 0.07	2.21 ± 0.06	2.28 ± 0.06	2.22 ± 0.05	2.19 ± 0.06	2.58 ± 0.07	2.38 ± 0.06	2.44 ± 0.08	2.77 ± 0.08	0.0006	0.0001	0.0033
Thiamin (mg)	1.62 ± 0.01	1.50 ± 0.06	1.65 ± 0.04	1.72 ± 0.05	1.74 ± 0.04	1.75 ± 0.05	2.02 ± 0.05	1.93 ± 0.05	1.98 ± 0.05	2.39 ± 0.05	0.0009	0.0001	<0.0001
Total choline (mg)	332 ± 2	294 ± 8	330 ± 10	314 ± 10	351 ± 9	327 ± 10	392 ± 15	388 ± 19	411 ± 11	464 ± 16	0.1260	0.0413	0.0158
Vitamin A, RAE (mcg)	621 ± 6	647 ± 36	728 ± 32	696 ± 28	724 ± 32	704 ± 43	773 ± 38	651 ± 24	692 ± 31	730 ± 31	0.1748	0.0520	0.0099
Vitamin B6 (mg)	2.04 ± 0.01	1.87 ± 0.08	2.16 ± 0.08	2.17 ± 0.07	2.16 ± 0.05	2.23 ± 0.08	2.54 ± 0.08	2.44 ± 0.07	2.56 ± 0.08	2.97 ± 0.07	0.0011	0.0001	<0.0001
Vitamin C (mg)	71.0 ± 0.8	95.2 ± 2.4	128 ± 5	124 ± 3	149 ± 4	160 ± 4	185 ± 5	190 ± 3	235 ± 6	357 ± 12	0.3523	0.0111	<0.0001
Vitamin D (mcg)	4.49 ± 0.05	4.83 ± 0.37	5.39 ± 0.27	5.10 ± 0.29	5.35 ± 0.31	5.43 ± 0.26	6.93 ± 0.47	6.58 ± 0.62	5.69 ± 0.30	6.97 ± 0.41	0.0036	0.0005	0.0001
Vitamin K (mcg)	106 ± 2	106 ± 9	111 ± 8	99.4 ± 4.4	115 ± 7	98.3 ± 5.5	104 ± 6	97.5 ± 5.6	113 ± 11	99.9 ± 5.8	-0.0100	0.0063	0.1504
Calcium (mg)	929 ± 6	860 ± 25	1012 ± 23	973 ± 34	1065 ± 25	1123 ± 35	1319 ± 36	1211 ± 38	1231 ± 36	1551 ± 60	0.7551	0.1146	0.0002
Copper (mg)	1.28 ± 0.01	1.16 ± 0.03	1.35 ± 0.04	1.32 ± 0.04	1.45 ± 0.04	1.41 ± 0.06	1.55 ± 0.04	1.51 ± 0.04	1.56 ± 0.05	1.89 ± 0.04	0.0007	0.0001	<0.0001
Iron (mg)	15.0 ± 0.1	14.3 ± 0.5	15.9 ± 0.5	16.7 ± 0.5	16.4 ± 0.4	16.4 ± 0.6	18.8 ± 0.6	17.3 ± 0.5	17.9 ± 0.7	19.8 ± 0.5	0.0065	0.0008	<0.0001
Magnesium (mg)	297 ± 2	273 ± 9	318 ± 10	308 ± 7	322 ± 7	324 ± 12	358 ± 9	352 ± 8	360 ± 8	426 ± 10	0.1544	0.0170	<0.0001
Phosphorus (mg)	1366 ± 6	1210 ± 36	1363 ± 38	1344 ± 33	1431 ± 29	1380 ± 37	1613 ± 36	1523 ± 40	1594 ± 30	1819 ± 51	0.4815	0.1115	0.0025
Potassium (mg)	2632 ± 13	2534 ± 61	2922 ± 75	2945 ± 63	3057 ± 52	2995 ± 68	3414 ± 63	3340 ± 65	3536 ± 62	4446 ± 97	2.1227	0.1656	<0.0001
Selenium (mcg)	113 ± 1	99.1 ± 3.4	109 ± 3	105 ± 3	113 ± 3	107 ± 3	128 ± 4	121 ± 4	128 ± 4	140 ± 4	0.0226	0.0111	0.0767

Sodium (mg)	3592 ± 15	3076 ± 87	3354 ± 77	3396 ± 75	3529 ± 83	3372 ± 86	3917 ± 96	3778 ± 94	3949 ± 112	4292 ± 114	0.4979	0.3556	0.1990
Zinc (mg)	11.8 ±0.07	10.3 ± 0.4	11.6 ± 0.3	12.1 ± 0.4	12.2 ± 0.3	11.8 ± 0.4	13.4 ± 0.4	12.6 ± 0.4	13.1 ± 0.5	14.7 ± 0.5	0.0031	0.0008	0.0062

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

²Orange 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.

³p<0.01 was considered significant

⁴Energy 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 Tables 3 and 4, respectively, show the results of linear analysis of the usual intake of energy and nutrients across the deciles of OJ consumption for adults 19-50 years and 51+ years, respectively. For adults 19-50 years energy, added sugars, niacin, riboflavin, vitamins A and K, selenium, and sodium were the only elements that did not show a significant linear association across the OJ deciles. Of particular import in relation to OJ consumers and non-OJ

consumers were dietary fiber (16.5±0.2 gm for non-OJ consumers [decile 1] to 21.3±0.8 gm for decile 10; β=0.0063; p=0.0011), folate DFE (549±4μg for decile 1 to 805±42μg for those in decile 10; β=0.35; p=0.0001), vitamin C (71.1±1.1mg for non-OJ consumers to 412±21mg for decile 10; β=0.35; p<0.0001), and potassium (2646±16mg for those in decile 1 to 4452±126mg for decile 10; β=2.08; p<0.0001) (Supplemental Table 3).

Supplemental Table 3. Usual nutrient intake¹ across deciles of orange juice intake in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake, ² g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	104	167	221	253	324	353	425	530	949			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Energy (kcal) ⁴	2298 ± 10	1865 ± 85	2313 ± 84	2411 ± 69	2222 ± 57	2642 ± 86	2456 ± 67	2655 ± 68	2744 ± 88	3142 ± 133	0.6629	0.2080	0.0129
Protein (g)	88.1 ± 0.6	74.5 ± 4.6	88.5 ± 3.6	90.8 ± 3.7	86.0 ± 3.0	99.7 ± 3.8	96.0 ± 5.0	106 ± 6	99.2 ± 3.3	113 ± 5	0.0226	0.0057	0.0041
Carbohydrate (g)	274 ± 1	224 ± 12	284 ± 8	294 ± 10	281 ± 7	338 ± 10	302 ± 8	335 ± 10	358 ± 12	420 ± 17	0.1259	0.0257	0.0012
Total Sugar, (g)	124 ± 1	101 ± 6	123 ± 6	132 ± 7	129 ± 4	158 ± 8	137 ± 5	167 ± 7	176 ± 7	229 ± 11	0.0800	0.0181	0.0022
Added Sugars (tsp eq.)	21.2 ± 0.3	14.2 ± 1.5	16.6 ± 1.1	18.8 ± 1.7	17.6 ± 0.9	20.4 ± 1.4	17.0 ± 0.9	20.6 ± 1.8	21.1 ± 1.4	24.5 ± 2.3	-0.0035	0.0036	0.3583
Dietary fiber (g)	16.5 ± 0.2	14.1 ± 0.8	18.4 ± 0.7	19.0 ± 0.5	17.4 ± 1.0	19.9 ± 1.0	18.9 ± 0.8	20.5 ± 0.8	19.6 ± 0.8	21.3 ± 0.8	0.0063	0.0013	0.0011
Folate, DFE (mcg)	549 ± 4	477 ± 28	633 ± 34	658 ± 27	651 ± 37	764 ± 56	678 ± 33	732 ± 32	744 ± 25	805 ± 42	0.3470	0.0493	0.0001
Niacin (mg)	27.6 ± 0.2	22.8 ± 1.1	27.4 ± 1.2	27.5 ± 1.2	27.4 ± 1.5	30.8 ± 1.8	29.6 ± 1.1	33.2 ± 1.8	30.6 ± 1.2	33.9 ± 1.7	0.0059	0.0022	0.0275
Riboflavin (mg)	2.24 ±0.02	1.85 ±0.10	2.24 ±0.11	2.28 ±0.08	2.17 ±0.07	2.68 ±0.13	2.46 ±0.08	2.67 ±0.16	2.54 ±0.10	2.79 ±0.11	0.0005	0.0002	0.0183
Thiamin (mg)	1.68 ±0.01	1.46 ±0.07	1.80 ±0.07	1.86 ±0.05	1.81 ±0.07	2.20 ±0.11	1.97 ±0.06	2.12 ±0.08	2.18 ±0.08	2.53 ±0.11	0.0009	0.0001	0.0002
Total choline (mg)	342 ± 2	304 ± 12	343 ± 17	366 ± 13	348 ± 15	415 ±19.1	418 ± 29	442 ± 21	414 ± 20	489 ±22	0.1465	0.0319	0.0018
Vitamin A, RAE (mcg)	605 ± 7	618 ± 74	612 ± 35	715 ± 48	660 ± 65	765 ± 85	644 ± 32	743 ± 58	669 ± 38	648 ± 38	0.0932	0.0372	0.0364
Vitamin B6 (mg)	2.16 ±0.02	1.81 ±0.09	2.20 ±0.11	2.26 ±0.08	2.28 ±0.13	2.74 ±0.23	2.55 ±0.09	2.85 ±0.15	2.66 ±0.10	3.19 ±0.14	0.0010	0.0002	0.0009
Vitamin C (mg)	71.1 ± 1.1	101 ± 7	128 ± 5	144 ± 4	160 ± 6	185 ± 7	185 ± 6	233 ± 9	262 ± 7	412 ±21	0.3495	0.0073	<0.0001
Vitamin D (mcg)	4.53 ±0.07	3.90 ±0.41	5.25 ±0.74	5.13 ±0.51	5.32 ±0.35	7.53 ±0.92	7.13 ±0.87	5.64 ±0.53	6.46 ±0.47	6.58 ±0.45	0.0027	0.0005	0.0011

Vitamin K (mcg)	102 ± 2	101 ± 14	95.8 ± 8.7	125 ± 10	89.6 ± 8.5	98.3 ±11.6	93.3 ± 7.8	118 ± 14	104 ± 13	88.0 ± 7.4	-0.0121	0.0081	0.1759
Calcium (mg)	985 ± 8	847 ± 56	1129 ± 39	1137 ± 40	1160 ± 43	1474 ± 66	1294 ± 56	1275 ± 71	1420 ± 66	1606 ± 83	0.7638	0.1084	0.0001
Copper (mg)	1.31 ±0.01	1.09 ±0.05	1.39 ±0.05	1.44 ±0.06	1.47 ±0.09	1.61 ±0.07	1.54 ±0.05	1.65 ±0.08	1.72 ±0.07	1.92 ±0.06	0.0007	0.0001	0.0003
Iron (mg)	15.5 ± 0.1	13.1 ± 0.7	16.9 ± 0.7	18.1 ± 0.5	17.4 ± 0.8	19.6 ± 1.1	18.1 ± 0.9	19.9 ± 1.2	18.9 ± 0.7	20.0 ± 0.9	0.0063	0.0014	0.0019
Magnesium (mg)	304 ± 2	262 ± 2.5	329 ±10	331 ±9	330 ±17	375 ±19	365 ±10	385 ±20	390 ±14	436 ± 12	0.1468	0.0190	0.0001
Phosphorus (mg)	1442 ± 9	1220 ± 63	1500 ± 58	1532 ± 41	1440 ± 44	1760 ± 58	1635 ± 62	1728 ± 75	1701 ± 59	1881 ± 64	0.4781	0.1043	0.0018
Potassium (mg)	2646 ± 16	2359 ± 104	2955 ± 101	3079 ± 53	2891 ± 91	3447 ± 126	3365 ± 78	3734 ± 128	3809 ± 117	4652 ± 126	2.0782	0.1938	<0.0001
Selenium (mcg)	120 ± 1	100 ± 6	120 ± 5	117 ± 4	120 ± 4	138 ± 6	128 ± 6	144 ± 11	135 ± 5	146 ± 6	0.0255	0.0080	0.0126
Sodium (mg)	3827 ± 22	3111 ± 140	3910 ± 156	3850 ± 107	3576 ± 110	4171 ± 133	3977 ± 180	4278 ± 233	4210 ± 165	4410 ± 198	0.4826	0.3336	0.1861
Zinc (mg)	12.3 ±0.1	10.1 ±0.71	11.7 ±0.7	13.2 ±0.5	12.7 ±0.6	14.2 ±0.8	13.1 ±0.6	15 ±0.8	14.2 ±0.7	15.1 ±0.7	0.0031	0.0009	0.0066

¹Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).
²Orange 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.
³p<0.01 was considered significant
⁴Energy 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.

For adults 51+ years, protein, added sugars, total choline, vitamin K, selenium, and sodium were the only elements that did not show a significant linear relationship across the OJ deciles. Of particular import in relation to OJ consumers and non-OJ consumers were dietary fiber (16.5±0.2 gm for non-OJ consumers to 19.7±0.7gm for those in decile 10; β=0.0054; p=0.0002), folate DFE (496±4μg for non-OJ

consumers to 699±30μg for those in decile 10; β=0.40; p<0.0001), vitamin C (70.7±1mg for non-OJ consumers to 306±8mg for those in decile 10; β=0.36; p<0.0001), and potassium (2610±17mg for non-OJ consumers to 4087±133mg for those in decile 10; β=2.20; p<0.0001) (Supplemental Table 4).

Variable	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	92	125	155	167	212	246	279	348	613			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Energy (kcal) ⁴	1921 ± 10	1768 ± 72	1973 ± 53	1966 ± 59	1907 ± 38	2005 ± 50	1940 ± 52	2154 ± 49	2302 ± 68	2529 ± 69	0.7262	0.1757	0.0033
Protein (g)	75.5 ± 0.5	67.5 ± 3.2	76.6 ± 2.3	75.4 ± 1.9	74.3 ± 1.7	78.1 ± 2.3	72.4 ± 2.1	83.4 ± 2.8	82.7 ± 2.6	88.2 ± 3.4	0.0129	0.0064	0.0774
Carbohydrate (g)	227 ± 1	210 ± 7	245 ± 7	245 ± 8	241 ± 5	249 ± 8	247 ± 7	271 ± 7	294 ± 8	326 ± 9	0.1454	0.0217	0.0002
Total Sugar, (g)	98.6 ± 0.8	88.0 ± 3.0	111 ± 5	109 ± 4	115 ± 3	119 ± 5	116 ± 5	132 ± 3	144 ± 5	165 ± 6	0.1039	0.0160	0.0002
Added Sugars (tsp eq.)	14.7 ± 0.2	11.2 ± 0.6	14.0 ± 1.1	13.5 ± 0.6	14.1 ± 0.6	13.5 ± 0.8	13.3 ± 0.9	14.0 ± 0.7	16.9 ± 1.1	15.8 ± 1.0	-0.0008	0.0028	0.7829
Dietary fiber (g)	16.5 ± 0.2	16.1 ± 1	18.3 ± 0.7	18.5 ± 1	17.5 ± 0.5	18.2 ± 0.7	17.3 ± 0.7	17.7 ± 0.5	18.5 ± 0.7	19.7 ± 0.7	0.0054	0.0008	0.0002

Folate, DFE (mcg)	496 ± 4	491 ± 36	579 ± 27	639 ± 35	593 ± 22	562 ± 28	589 ± 32	622 ± 27	679 ± 36	699 ± 30	0.4002	0.0484	<0.0001
Niacin (mg)	23.0 ± 0.2	21.6 ± 1.2	23.9 ± 0.9	24.7 ± 0.72	23.9 ± 0.8	24.3 ± 0.8	23.4 ± 1.2	24.6 ± 0.9	26.4 ± 1.1	27.2 ± 1.1	0.0069	0.0011	0.0002
Riboflavin (mg)	2.10 ± 0.02	1.91 ± 0.11	2.25 ± 0.05	2.28 ± 0.07	2.26 ± 0.07	2.19 ± 0.08	2.27 ± 0.09	2.34 ± 0.06	2.35 ± 0.11	2.56 ± 0.12	0.0008	0.0001	0.0002
Thiamin (mg)	1.52 ± 0.01	1.42 ± 0.07	1.72 ± 0.07	1.64 ± 0.04	1.68 ± 0.05	1.64 ± 0.05	1.70 ± 0.07	1.77 ± 0.06	1.89 ± 0.08	2.02 ± 0.09	0.0008	0.0001	<0.0001
Total choline (mg)	318 ± 2	284 ± 18	318 ± 13	321 ± 11	307 ± 11	337 ± 11	310 ± 9	356 ± 16	351 ± 15	428 ± 17	0.0923	0.0364	0.0350
Vitamin A, RAE (mcg)	643 ± 8	609 ± 60	755 ± 61	801 ± 47	722 ± 30	739 ± 45	742 ± 70	769 ± 36	684 ± 33	785 ± 49	0.2774	0.0752	0.0061
Vitamin B6 (mg)	1.87 ± 0.02	1.84 ± 0.11	2.03 ± 0.09	2.27 ± 0.12	2.13 ± 0.08	2.10 ± 0.09	2.19 ± 0.14	2.26 ± 0.08	2.32 ± 0.10	2.60 ± 0.10	0.0013	0.0001	<0.0001
Vitamin C (mg)	70.7 ± 1	94.2 ± 4.9	107 ± 5	132 ± 7	122 ± 3	159 ± 6	152 ± 3	185 ± 6	195 ± 5	306 ± 8	0.3563	0.0150	<0.0001
Vitamin D (mcg)	4.45 ± 0.06	4.96 ± 0.47	5.21 ± 0.82	6.00 ± 0.48	5.30 ± 0.31	5.63 ± 0.40	5.55 ± 0.30	5.65 ± 0.30	6.12 ± 0.52	6.89 ± 0.64	0.0046	0.0004	<0.0001
Vitamin K (mcg)	112 ± 2	109 ± 14	110 ± 8	114 ± 10	100 ± 5	115 ± 9	112 ± 8	103 ± 7	104 ± 7	112 ± 10	-0.0147	0.0097	0.1703
Calcium (mg)	852 ± 8	778 ± 27	949 ± 30	1028 ± 32	929 ± 32	993 ± 36	1110 ± 41	1129 ± 41	1110 ± 44	1385 ± 74	0.8133	0.1426	0.0005
Copper (mg)	1.24 ± 0.01	1.15 ± 0.05	1.34 ± 0.06	1.33 ± 0.07	1.28 ± 0.04	1.44 ± 0.06	1.34 ± 0.07	1.42 ± 0.04	1.54 ± 0.05	1.66 ± 0.06	0.0007	0.0001	0.0001
Iron (mg)	14.4 ± 0.1	13.9 ± 0.9	16.1 ± 0.8	16.0 ± 0.6	16.2 ± 0.5	15.4 ± 0.5	15.7 ± 0.6	16.5 ± 0.6	17 ± 0.8	17.4 ± 1.0	0.0065	0.0009	0.0001
Magnesium (mg)	285 ± 2	271 ± 14	309 ± 8	321 ± 17	297 ± 7	315 ± 11	305 ± 8	328 ± 8	345 ± 11	388 ± 13	0.1468	0.0181	<0.0001
Phosphorus (mg)	1259 ± 8	1140 ± 52	1317 ± 36	1340 ± 47	1285 ± 31	1333 ± 36	1309 ± 37	1420 ± 44	1420 ± 51	1606 ± 61	0.4414	0.0902	0.0012
Potassium (mg)	2610 ± 17	2546 ± 111	2924 ± 79	2899 ± 88	2906 ± 60	3104 ± 110	2979 ± 64	3284 ± 62	3410 ± 90	4087 ± 113	2.2027	0.1690	<0.0001
Selenium (mcg)	103 ± 1	92.6 ± 4.3	107 ± 3	102 ± 3	99.5 ± 2.7	110 ± 4	97.0 ± 3.0	110 ± 4	117 ± 4	116 ± 4	0.0151	0.0098	0.1638
Sodium (mg)	3257 ± 20	2983 ± 205	3282 ± 100	3132 ± 85	3143 ± 72	3228 ± 93	3175 ± 97	3479 ± 113	3615 ± 129	3755 ± 138	0.4154	0.2615	0.1509
Zinc (mg)	10.9 ± 0.1	10.3 ± 0.6	11 ± 0.5	11.9 ± 0.4	12.0 ± 0.5	11.6 ± 0.5	10.8 ± 0.5	12 ± 0.4	12.2 ± 0.5	12.2 ± 0.7	0.0029	0.0008	0.0092

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

²Orange 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.

³p<0.01 was considered significant

⁴Energy 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.

Healthy Eating Index

Table 5 shows the total HEI score and subcomponent scores for adults 19+years. Table 5 shows a positive linear relationship for the sub-component total fruit only (1.75±0.02 points/gm OJ for non-OJ consumers [decile 1] to 4.80±0.03 points/gm OJ for consumers in decile 10; β=0.0037; p=0.0015). There was a significant inverse relationship for total protein (4.27±0.01 points/gm OJ for non-OJ consumers and 4.07±0.07 points/gm OJ for decile

10; β=-0.0002 points/gm; p=0.0064). Sodium (4.14±0.03 points/gm OJ for non-OJ consumers and 5.94±0.19 points/gm OJ for OJ consumers in decile 10; β=0.0019; p<0.0001), refined grains (6.18±0.04 points/gm OJ for non-OJ consumers and 7.00±0.19 points/gm OJ for the consumers in decile 10; β=0.0011 points/gm OJ; p=0.0001), and SFA sub-component scores (5.89±0.03 points/gm OJ for non-consumers and 7.20±0.20 points/gm OJ for those in decile 10; β=0.0020 points/OJ; p=0.0001) showed significant positive linear relationships.

Table 5. Healthy Eating Index (HEI)¹, total and sub-component scores, across deciles of orange juice intake in adults 19+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

	Orange Juice Decile Mean Intake ² , g/d										Beta/g m OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	100	146	167	216	249	308	351	446	788			
HEI 2015 Components	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
HEI Total Score	49.8 ± 0.2	55.5 ± 0.9	57.2 ± 0.7	56.9 ± 0.8	55.5 ± 0.8	55.6 ± 0.9	54.3 ± 0.7	56.1 ± 0.6	56.0 ± 0.7	55.4 ± 0.7	0.0109	0.0034	0.0119
#1 Total Vegetables	3.07 ± 0.02	3.27 ± 0.10	3.22 ± 0.11	3.31 ± 0.09	3.39 ± 0.09	3.08 ± 0.10	2.94 ± 0.09	2.97 ± 0.09	2.74 ± 0.12	2.59 ± 0.09	-0.0004	0.0002	0.0896
#2 Beans & Greens	1.51 ± 0.03	1.49 ± 0.13	1.57 ± 0.14	1.48 ± 0.12	1.53 ± 0.12	1.50 ± 0.13	1.19 ± 0.12	1.60 ± 0.14	1.51 ± 0.15	1.25 ± 0.13	-0.0003	0.0001	0.0751
#3 Total Fruit	1.75 ± 0.02	3.39 ± 0.09	3.78 ± 0.07	3.94 ± 0.08	3.89 ± 0.06	4.21 ± 0.06	4.22 ± 0.06	4.46 ± 0.05	4.65 ± 0.04	4.80 ± 0.03	0.0037	0.0008	0.0015
#4 Whole Fruit	1.99 ± 0.03	2.78 ± 0.12	3.02 ± 0.12	3.15 ± 0.14	2.48 ± 0.15	2.39 ± 0.14	2.32 ± 0.16	2.47 ± 0.13	2.36 ± 0.16	1.92 ± 0.14	0.0006	0.0006	0.3704
#5 Whole Grains	2.33 ± 0.03	3.43 ± 0.23	3.19 ± 0.22	3.27 ± 0.20	2.94 ± 0.20	3.17 ± 0.21	2.52 ± 0.19	2.76 ± 0.21	2.37 ± 0.18	1.95 ± 0.16	0.0001	0.0006	0.8415
#6 Dairy	5.10 ± 0.04	5.18 ± 0.19	5.42 ± 0.14	5.63 ± 0.17	5.21 ± 0.16	5.43 ± 0.16	5.32 ± 0.21	4.96 ± 0.25	5.17 ± 0.19	4.47 ± 0.20	-0.0002	0.0004	0.6750
#7 Total Protein	4.27 ± 0.01	4.19 ± 0.09	4.28 ± 0.08	4.24 ± 0.08	4.15 ± 0.08	4.21 ± 0.07	4.12 ± 0.08	4.16 ± 0.08	4.30 ± 0.07	4.07 ± 0.07	-0.0002	0.0001	0.0064
#8 Seafood/ Plant Proteins	2.31 ± 0.03	2.48 ± 0.15	2.65 ± 0.14	2.32 ± 0.16	2.41 ± 0.13	2.25 ± 0.16	2.20 ± 0.14	2.52 ± 0.13	2.50 ± 0.15	2.07 ± 0.13	-0.0001	0.0002	0.7938
#9 Fatty Acid Ratio	4.96 ± 0.03	5.38 ± 0.24	5.20 ± 0.20	5.10 ± 0.27	4.95 ± 0.19	4.79 ± 0.23	5.01 ± 0.23	4.96 ± 0.24	4.78 ± 0.24	5.02 ± 0.22	0.0000 ⁴	0.0002	0.9781
#10 Sodium	4.14 ± 0.03	4.15 ± 0.19	4.34 ± 0.24	4.25 ± 0.22	4.55 ± 0.21	4.45 ± 0.19	4.50 ± 0.18	4.76 ± 0.18	4.85 ± 0.23	5.94 ± 0.19	0.0019	0.0002	<0.0001
#11 Refined Grain	6.18 ± 0.04	6.44 ± 0.19	6.32 ± 0.25	6.69 ± 0.18	6.46 ± 0.19	6.34 ± 0.19	6.36 ± 0.24	6.54 ± 0.22	6.86 ± 0.23	7.00 ± 0.19	0.0011	0.0002	0.0001
#12 Saturated Fatty Acids	5.89 ± 0.03	6.05 ± 0.18	6.73 ± 0.17	6.56 ± 0.22	6.28 ± 0.21	6.43 ± 0.19	6.47 ± 0.21	6.76 ± 0.21	6.86 ± 0.17	7.20 ± 0.20	0.0020	0.0003	0.0001
#13 Added Sugars	6.44 ± 0.05	7.53 ± 0.18	7.56 ± 0.16	7.06 ± 0.20	7.19 ± 0.21	7.50 ± 0.13	7.26 ± 0.14	7.30 ± 0.17	7.23 ± 0.19	7.13 ± 0.19	0.0016	0.0006	0.0326

Supplemental Tables 5 and 6, respectively, show the total HEI score and subcomponent scores for adults 19-50 years and 51+ years. Supplemental Table 5 shows a positive linear relationship for the total HEI score, which ranged from (48.0±0.2 points/gm OJ for non-OJ consumers to 54.8 points/OJ ± 1.0 for those in decile 10; β=0.0106 points/gm OJ; p=0.0017). The total fruit sub-score, which ranged from 1.49±0.03 points/gm OJ for non-OJ consumers to 4.69±0.04 points/gm OJ for those in decile 10 (β=0.0036 points/gm OJ; p=0.0014) also had a positive linear relationship.

Sodium (4.23±0.04 points/gm OJ for non-consumers and 6.20±0.31 points/gm OJ for those in decile 10; β=0.0017 points/gm; p<0.0001), refined grains (5.94±0.04 points/gm OJ for decile 1 and 7.07±0.19 points/gm OJ for decile 10; β=0.0011; p=0.0002), and SFA sub-component scores (5.96±0.04 points/gm OJ for non-consumers and 7.55±0.22 points/gm OJ for those in decile 10; β=0.0018 points/gm; p<0.0001) showed significant positive linear relationships (Supplemental Table 5).

Supplemental Table 5. Healthy Eating Index (HEI)¹, total and sub-component scores, across deciles of orange juice intake in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
HEI 2015 Components	1	2	3	4	5	6	7	8	9	10			
	0	104	167	221	253	324	353	425	530	949			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
HEI- Total Score	48.0 ± 0.2	51.9 ± 1.3	52.7 ± 0.8	53.3 ± 0.8	53.0 ± 1.3	52.6 ± 1.2	56.0 ± 1.3	55.3 ± 1.0	54.2 ± 1.0	54.8 ± 1.0	0.0106	0.0023	0.0017
#1 Total Veg	2.93 ± 0.02	3.11 ± 0.12	3.01 ± 0.10	3.35 ± 0.13	2.77 ± 0.16	2.58 ± 0.12	2.90 ± 0.18	2.71 ± 0.13	2.49 ± 0.19	2.44 ± 0.12	-0.0005	0.0002	0.0289
#2 Beans/Greens	1.46 ± 0.03	1.51 ± 0.16	1.42 ± 0.17	1.57 ± 0.16	1.30 ± 0.20	0.98 ± 0.18	1.77 ± 0.20	1.40 ± 0.17	1.54 ± 0.20	1.11 ± 0.18	-0.0002	0.0002	0.2311
#3 Total Fruit	1.49 ± 0.03	3.19 ± 0.21	3.55 ± 0.10	3.65 ± 0.11	4.11 ± 0.07	4.20 ± 0.09	4.36 ± 0.08	4.54 ± 0.06	4.69 ± 0.04	4.85 ± 0.04	0.0036	0.0008	0.0014
#4 Whole Fruit	1.65 ± 0.04	1.87 ± 0.24	2.35 ± 0.18	2.02 ± 0.24	2.30 ± 0.18	2.26 ± 0.27	2.15 ± 0.17	2.25 ± 0.21	1.94 ± 0.27	1.74 ± 0.26	0.0008	0.0004	0.0455
#5 Whole Grains	1.92 ± 0.04	2.28 ± 0.23	2.21 ± 0.22	2.53 ± 0.23	2.95 ± 0.33	2.37 ± 0.30	2.77 ± 0.32	2.35 ± 0.24	2.06 ± 0.26	1.65 ± 0.24	0.0003	0.0004	0.4810
#6 Dairy	5.13 ± 0.04	5.18 ± 0.34	5.33 ± 0.27	5.31 ± 0.32	5.13 ± 0.21	5.44 ± 0.35	5.27 ± 0.32	5.17 ± 0.32	4.69 ± 0.27	4.53 ± 0.25	-0.0004	0.0002	0.0479
#7 Total Protein	4.22 ± 0.01	4.25 ± 0.13	4.13 ± 0.12	4.08 ± 0.12	4.36 ± 0.08	3.94 ± 0.14	4.27 ± 0.11	4.52 ± 0.13	4.21 ± 0.10	4.01 ± 0.08	-0.0001	0.0001	0.2943
#8 Seafood/ Plant Proteins	2.19 ± 0.03	2.28 ± 0.20	2.35 ± 0.16	2.25 ± 0.17	2.09 ± 0.23	2.15 ± 0.26	2.58 ± 0.21	2.63 ± 0.33	2.38 ± 0.25	1.87 ± 0.15	-0.0001	0.0002	0.4747
#9 Fatty Acid Ratio	4.87 ± 0.05	5.35 ± 0.49	5.08 ± 0.30	4.93 ± 0.35	4.64 ± 0.27	5.01 ± 0.32	4.96 ± 0.29	4.71 ± 0.35	4.82 ± 0.27	5.04 ± 0.29	0.0001	0.0001	0.5959
#10 Sodium	4.23 ± 0.04	3.78 ± 0.31	3.95 ± 0.21	4.63 ± 0.29	4.33 ± 0.27	4.79 ± 0.29	4.59 ± 0.33	4.73 ± 0.42	5.32 ± 0.30	6.20 ± 0.31	0.0017	0.0003	0.0008
#11 Refined Grain	5.94 ± 0.04	6.08 ± 0.35	5.39 ± 0.34	6.00 ± 0.30	5.65 ± 0.28	5.57 ± 0.43	6.39 ± 0.30	6.76 ± 0.23	6.32 ± 0.30	7.07 ± 0.19	0.0011	0.0002	0.0018
#12 SFA ⁴	5.96 ± 0.04	6.18 ± 0.49	6.52 ± 0.30	6.16 ± 0.32	6.48 ± 0.25	6.75 ± 0.28	6.72 ± 0.28	7.04 ± 0.25	6.76 ± 0.29	7.55 ± 0.22	0.0018	0.0001	<0.0001
#13 Added Sugars	6.02 ± 0.06	7.11 ± 0.44	7.16 ± 0.25	6.85 ± 0.24	7.08 ± 0.21	7.10 ± 0.24	7.50 ± 0.22	6.96 ± 0.36	6.96 ± 0.27	6.77 ± 0.30	0.0018	0.0006	0.0158

¹Healthy Eating Index is a measure of adherence to the Dietary Guidelines for Americans and an indicator of diet quality; a perfect score is 100.
²Orange 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.
³Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).

Supplemental Table 6. Healthy Eating Index (HEI)¹, total and sub-component scores, across deciles of orange juice intake in adults 51+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
HEI 2015 Components	1	2	3	4	5	6	7	8	9	10			
	0	92	125	155	167	212	246	279	348	613			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
HEI- Total Score	52.5 ± 0.2	56.6 ± 1.1	58.5 ± 1.5	58.7 ± 1.1	58.2 ± 0.8	58.3 ± 1.3	57.2 ± 1.2	56.5 ± 0.8	56.5 ± 0.8	58.5 ± 0.9	0.0127	0.0033	0.0045
#1 Total Veg	3.27 ± 0.02	3.46 ± 0.16	3.39 ± 0.14	3.26 ± 0.16	3.37 ± 0.10	3.52 ± 0.13	3.31 ± 0.16	3.31 ± 0.09	3.17 ± 0.12	3.00 ± 0.15	-0.0001	0.0002	0.6529
#2 Beans/Greens	1.57 ± 0.04	1.55 ± 0.18	1.60 ± 0.16	1.66 ± 0.23	1.41 ± 0.13	1.56 ± 0.17	1.79 ± 0.17	1.25 ± 0.24	1.44 ± 0.13	1.39 ± 0.16	-0.0003	0.0002	0.1436
#3 Total Fruit	2.12 ± 0.03	3.42 ± 0.13	3.82 ± 0.09	3.92 ± 0.13	4.09 ± 0.07	4.17 ± 0.07	4.23 ± 0.09	4.47 ± 0.05	4.51 ± 0.05	4.83 ± 0.03	0.0042	0.0008	0.0008
#4 Whole Fruit	2.49 ± 0.04	3.10 ± 0.19	3.36 ± 0.13	3.24 ± 0.24	3.37 ± 0.13	3.11 ± 0.19	2.44 ± 0.17	2.63 ± 0.15	2.73 ± 0.13	2.54 ± 0.21	0.0008	0.0007	0.2969

#5 Whole Grains	2.91 ±0.05	3.69 ±0.24	3.87 ±0.28	3.81 ±0.27	3.57 ±0.22	3.46 ±0.31	3.43 ±0.37	2.60 ±0.20	2.68 ±0.27	2.51 ±0.27	0.0004	0.0008	0.9762
#6 Dairy	5.04 ±0.05	4.93 ±0.30	5.61 ±0.19	5.27 ±0.25	5.71 ±0.18	5.07 ±0.25	5.74 ±0.33	5.31 ±0.22	4.78 ±0.24	4.92 ±0.27	0.0003	0.0006	0.5971
#7 Total Protein	4.35 ±0.02	4.28 ±0.10	4.18 ±0.13	4.25 ±0.12	4.28 ±0.07	4.28 ±0.11	3.87 ±0.12	4.20 ±0.10	4.19 ±0.08	4.04 ±0.11	-0.0006	0.0001	0.0034
#8 Seafood/Plant Proteins	2.48 ±0.04	2.55 ±0.23	2.70 ±0.20	2.73 ±0.24	2.40 ±0.20	2.68 ±0.26	2.23 ±0.18	2.17 ±0.16	2.53 ±0.15	2.22 ±0.18	-0.0003	0.0002	0.1836
#9 Fatty Acid Ratio	5.11 ±0.05	5.30 ±0.29	5.39 ±0.42	5.23 ±0.37	5.13 ±0.21	5.05 ±0.32	4.97 ±0.36	5.03 ±0.26	5.00 ±0.36	5.15 ±0.33	-0.0001	0.0002	0.7522
#10 Sodium	4.00 ±0.05	4.32 ±0.33	4.11 ±0.28	4.58 ±0.31	4.42 ±0.22	4.62 ±0.29	4.50 ±0.30	4.39 ±0.28	4.92 ±0.32	5.43 ±0.33	0.0023	0.0002	<0.0001
#11 Refined Grain	6.48 ±0.06	6.62 ±0.24	6.53 ±0.23	7.01 ±0.28	6.97 ±0.20	7.00 ±0.25	6.89 ±0.33	6.88 ±0.23	6.87 ±0.25	7.55 ±0.21	0.0017	0.0002	<0.0001
#12 SFA ⁵	5.79 ±0.05	5.81 ±0.20	6.61 ±0.49	6.53 ±0.20	6.60 ±0.25	6.45 ±0.33	6.44 ±0.24	6.59 ±0.26	6.55 ±0.36	6.93 ±0.27	0.0024	0.0004	0.0003
HEI #13 Added sugars	6.95 ±0.05	7.97 ±0.24	7.65 ±0.25	7.47 ±0.19	7.18 ±0.18	7.56 ±0.20	7.58 ±0.25	7.71 ±0.17	7.15 ±0.34	8.02 ±0.20	0.0020	0.0004	0.0022

¹Healthy Eating Index is a measure of adherence to the Dietary Guidelines for Americans and an indicator of diet quality; a perfect score is 100.

²Orange 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.

³Individual usual intakes were determined using the National Cancer Institute method and deciles of intake established (non-consumers are in decile 1).

⁴p<0.01 is considered significant

⁵Actual beta value is -0.00003

⁶Saturated fatty acids

Supplemental Table 6, which shows results from adults 51+ years, shows a positive linear relationship for the total HEI score, which ranged from (52.5±0.2 for non-OJ consumers to 58.5 ± 1.0 for those in decile 10; β=0.0127 points/gm OJ; p=0.0045). The total fruit sub-score, which ranged from 2.12±0.03 points/gm OJ for non-OJ consumers to 4.83±0.04 points/gm OJ for those decile 10 (β=0.0042 points/gm OJ; p=0.0008) also had a positive linear relationship. Sodium (4.00±0.05 points/gm OJ for non-consumers and 5.43±0.33

points/gm OJ for those in decile 10; β=0.0023 points/gm; p<0.0001), refined grains (6.48±0.06 points/gm OJ for non-OJ consumers and 7.55±0.21 points/gm OJ for those in decile 10; β=0.0017; p<0.00001), and SFA sub-component scores (5.79±0.05 points/gm OJ for non-consumers and 6.93±0.22 points/gm OJ for those in decile 10; β=0.0024 points/gm; p=0.0003) showed significant positive linear relationships (Supplemental Table 7).

Supplemental Table 7. Mean total fruit, whole fruit, and fruit juice¹ (all cup equivalents) across deciles of orange juice intake in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	104	167	221	253	324	353	425	530	949			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Total Fruit	0.70 ±0.02	1.22 ±0.10	1.69 ±0.06	1.67 ±0.09	1.90 ±0.09	2.37 ±0.13	2.17 ±0.07	2.83 ±0.10	3.17 ±0.13	4.85 ±0.23	0.0046	0.0002	<0.0001
Whole Fruit	0.54 ±0.01	0.49 ±0.07	0.72 ±0.07	0.57 ±0.09	0.68 ±0.08	0.75 ±0.12	0.58 ±0.05	0.85 ±0.09	0.73 ±0.10	0.70 ±0.12	0.0003	0.0001	0.0183
Fruit Juice	0.17 ±0.01	0.64 ±0.003	0.93 ±0.05	1.00 ±0.02	1.15 ±0.06	1.42 ±0.08	1.51 ±0.04	1.88 ±0.04	2.36 ±0.07	4.04 ±0.21	0.0041	0.0002	<0.0001

¹Total 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

²Orange 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).

³p<0.01 is considered significant

Whole total, whole fruit, and fruit juice

Table 6 shows the results of the linear regression analysis using the FPED for intake of total fruit, whole fruit, and fruit juice for adults 19+ years. For adults 19+ years, total fruit intake ranged from 0.76±0.01 cup eq/day for non-OJ

consumers to 4.22±0.12 cup eq/day ($\beta=0.0047$ cup eq/gm OJ; $p<0.0001$) for those in decile 10; and fruit from fruit juice intake ranged from 0.15±0.00 cup eq/day for non-consumers to 3.37±0.10 cup eq/day ($\beta=0.0039$ cup eq/gm OJ; $p<0.0001$) for those in decile 10.

Table 6. Mean total fruit, whole fruit, and fruit juice¹ (all cup equivalents) across deciles of orange juice intake in adults 19+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	100	146	167	216	249	308	351	446	788			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Total Fruit	0.76 ±0.01	1.30 ±0.05	1.65 ±0.06	1.73 ±0.07	1.88 ±0.08	2.02 ±0.07	2.32 ±0.08	2.30 ±0.05	2.87 ±0.08	4.22 ±0.12	0.0047	0.0002	<0.0001
Whole Fruit	0.62 ±0.01	0.73 ±0.04	0.84 ±0.06	0.91 ±0.07	0.76 ±0.06	0.78 ±0.06	0.75 ±0.08	0.71 ±0.04	0.84 ±0.07	0.74 ±0.08	0.0004	0.0001	0.0261
Fruit Juice	0.15 ±0.00	0.56 ±0.03	0.73 ±0.02	0.77 ±0.02	0.98 ±0.02	1.16 ±0.02	1.43 ±0.05	1.51 ±0.02	1.94 ±0.05	3.37 ±0.10	0.0039	0.0000*	<0.0001

¹Total 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

²Orange 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).

³p<0.01 is considered significant

⁴Actual Standard Error is 0.00005

Supplemental Tables 7 and 8 show the results of linear regression analysis using the FPED for intake of total fruit, whole fruit, and fruit juice for adults 19-50 years and 51+ years, respectively. For adults 19-50 years, total fruit intake ranged from 0.70±0.02 cup eq/day for consumers in non-OJ consumers to 4.85±0.23 cup eq/day ($\beta=0.0046$ cup

eq/gm OJ; $p<0.0001$) for those in decile 10 and fruit from fruit juice intake ranged from 0.17±0.01 cup eq/day for non-OJ consumers to 4.04±0.21 cup eq/day ($\beta=0.0041$ cup eq/gm OJ; $p<0.0001$) for those in decile 10. There was no significant difference for consumers of whole fruit by decile (Supplemental Table 7).

Supplemental Table 7. Mean total fruit, whole fruit, and fruit juice¹ (all cup equivalents) across deciles of orange juice intake in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake ² , g/d										Beta/gm OJ	SE	P ³
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	104	167	221	253	324	353	425	530	949			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Total Fruit	0.70 ±0.02	1.22 ±0.10	1.69 ±0.06	1.67 ±0.09	1.90 ±0.09	2.37 ±0.13	2.17 ±0.07	2.83 ±0.10	3.17 ±0.13	4.85 ±0.23	0.0046	0.0002	<0.0001
Whole Fruit	0.54 ±0.01	0.49 ±0.07	0.72 ±0.07	0.57 ±0.09	0.68 ±0.08	0.75 ±0.12	0.58 ±0.05	0.85 ±0.09	0.73 ±0.10	0.70 ±0.12	0.0003	0.0001	0.0183
Fruit Juice	0.17 ±0.01	0.64 ±0.003	0.93 ±0.05	1.00 ±0.02	1.15 ±0.06	1.42 ±0.08	1.51 ±0.04	1.88 ±0.04	2.36 ±0.07	4.04 ±0.21	0.0041	0.0002	<0.0001

¹Total 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

²Orange 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).

³p<0.01 is considered significant

Supplemental Table 8 shows the results of the linear regression analysis using the FPED for adults 51+ years. Total fruit intake for non-OJ consumers was 0.85±0.02 cup eq/day, as compared with consumers in decile 10

(3.57±0.13 cup eq/day) ($\beta=0.0048$ cup eq/day; $p<0.0001$). Fruit juice consumption showed a mean of 0.13±0.01 cup eq/day for non-OJ consumers and 2.65±0.11 cup eq for those in decile 10 ($\beta=0.0039$; $p<0.0001$).

Supplemental Table 8. Mean total fruit, whole fruit, and fruit juice¹ (all cup equivalents) across deciles of orange juice intake in adults 51+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

	Orange Juice Decile Mean Intake ² , g/d												
	Deciles										Beta/ gm OJ	SE	P ³
Variable	1	2	3	4	5	6	7	8	9	10			
	0	92	125	155	167	212	246	279	348	613			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Total Fruit	0.85 ±0.02	1.28 ±0.08	1.57 ±0.06	1.72 ±0.11	1.74 ±0.06	2.08 ±0.10	1.91 ±0.08	2.35 ±0.08	2.53 ±0.08	3.57 ±0.13	0.0048	0.0002	<0.0001
Whole Fruit	0.73 ±0.01	0.79 ±0.07	0.94 ±0.06	0.95 ±0.11	0.95 ±0.07	0.98 ±0.09	0.73 ±0.06	0.86 ±0.08	0.88 ±0.06	0.88 ±0.10	0.0004	0.0002	0.0362
Fruit Juice	0.13 ±0.01	0.43 ±0.02	0.60 ±0.03	0.71 ±0.03	0.77 ±0.02	0.98 ±0.03	1.10 ±0.03	1.40 ±0.07	1.59 ±0.04	2.65 ±0.11	0.0039	0.0001	<0.0001

¹Total 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
²Orange 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).
³p<0.01 is considered significant

Weight Parameters

Table 7 and Supplemental Tables 9 and 10 show weight parameters across usual intake of OJ (gm) of for adults 19+ years, 19-50 years, and 51+ years, respectively. Weight

(kg), BMI, % overweight, % obese, and % overweight or obese showed no significant linear trend across the deciles of OJ consumption.

Table 7. Mean weight parameters across deciles of orange juice intake in adults 19+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

	Orange Juice Decile Mean Intake ¹ , g/d												
	Deciles										Beta/gm OJ	SE	P ²
Variable	1	2	3	4	5	6	7	8	9	10			
	0	100	146	167	216	249	308	351	446	788			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Weight (kg) ³	82.5 ±0.2	77.5 ±1.0	77.1 ±1.1	78.0 ±1.1	77.8 ±1.1	78.6 ±1.3	80.3 ±1.2	81.9 ±1.4	84.6 ±1.2	82.4 ±1.2	-0.0025	0.0038	0.5407
Body Mass Index (mg/m ²)	28.9 ±0.1	28.2 ±0.3	27.5 ±0.3	27.6 ±0.3	27.5 ±0.3	27.7 ±0.4	27.9 ±0.4	28.0 ±0.3	28.8 ±0.5	27.5 ±0.3	-0.0022	0.0007	0.0157
(%) Overweight ⁴	32.7 ±0.4	36.1 ±2.9	38.6 ±2.8	34.9 ±2.7	38.5 ±2.8	34.9 ±2.7	32.9 ±2.7	36.1 ±3.3	28.4 ±2.7	36.1 ±2.9	0.0036	0.0037	0.3540
(%) Obese ⁴	36.2 ±0.5	33.9 ±2.7	27.5 ±2.9	27.5 ±2.6	27.6 ±2.9	27.7 ±2.8	31.1 ±3.1	32.0 ±2.6	40.0 ±3.2	28.2 ±2.5	-0.0115	0.0051	0.0525
(%) Overweight or Obese ⁴	68.9 ±0.5	70.0 ±2.4	66.1 ±2.9	62.4 ±3.0	66.1 ±2.8	62.6 ±2.8	64.0 ±3.3	68.0 ±3.1	68.4 ±3.5	64.3 ±3.1	-0.0077	0.0031	0.0406

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)
²p<0.01 is considered significant
³Measured weight; measured weight and height were used to calculate body mass index scores
⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

Supplemental Table 9. Mean weight parameters across deciles of orange juice intake in adults 19-50 years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake ¹ , g/d										Beta/gm OJ	SE	P ²
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	104	167	221	253	324	353	425	530	949			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Weight (kg) ³	82.7 ± 0.3	76.6 ± 1.5	77.1 ± 1.6	77.1 ± 1.9	77.3 ± 2.2	82.4 ± 2.0	80.9 ± 1.9	82.2 ± 2.0	83.3 ± 1.8	82.2 ± 1.7	-0.0021	0.0031	0.5171
Body Mass Index ³	28.6 ± 0.1	27.5 ± 0.5	27.0 ± 0.5	26.7 ± 0.5	27.3 ± 0.7	27.8 ± 0.7	27.4 ± 0.5	27.6 ± 0.7	28.1 ± 0.6	27.2 ± 0.5	-0.0019	0.0007	0.0218
(%) Overweight ⁴	31.1 ± 0.6	31.5 ± 4.7	30.6 ± 3.8	34.1 ± 4.7	28.2 ± 3.3	23.3 ± 3.7	32.6 ± 4.3	26.7 ± 4.1	27.3 ± 3.6	37.7 ± 4.2	-0.0005	0.0036	0.8928
(%) Obese ⁴	34.4 ± 0.6	32.8 ± 4.7	26.2 ± 3.9	22.4 ± 3.9	23.5 ± 3.3	33.8 ± 4.7	27.3 ± 3.6	34.5 ± 4.7	36.5 ± 4.4	23.0 ± 3.3	-0.0120	0.0046	0.0326
(%) Overweight or Obese ⁴	65.5 ± 0.7	64.3 ± 4.7	56.9 ± 4.8	56.5 ± 4.8	51.8 ± 3.8	57.1 ± 5.2	59.9 ± 4.5	61.2 ± 5.2	63.8 ± 4.4	60.6 ± 4.3	-0.0098	0.0050	0.0841

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)

²p<0.01 is considered significant

³Measured weight; measured weight and height were used to calculate body mass index scores

⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

Supplemental Table 10. Mean weight parameters across deciles of orange juice intake in adults 51+ years participating in the National Health and Nutrition Examination Survey from 2003-2016.

Variable	Orange Juice Decile Mean Intake ¹ , g/d										Beta/gm OJ	SE	P ²
	Deciles												
	1	2	3	4	5	6	7	8	9	10			
	0	92	125	155	167	212	246	279	348	613			
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE			
Weight (kg) ³	82.2 ± 0.3	76.7 ± 1.8	80.0 ± 1.4	75.4 ± 1.6	78.5 ± 1.3	78.1 ± 1.2	79.3 ± 1.4	79.8 ± 1.5	82.7 ± 1.7	85.6 ± 1.4	-0.0014	0.0048	0.5145
Body Mass Index ³	29.3 ± 0.1	28.1 ± 0.5	28.9 ± 0.5	27.0 ± 0.4	28.0 ± 0.4	28.0 ± 0.4	28.2 ± 0.5	28.4 ± 0.5	28.8 ± 0.4	29.2 ± 0.5	-0.0021	0.0014	0.1020
(%) Overweight ⁴	35.1 ± 0.6	38.1 ± 4.0	38.3 ± 4.4	45.9 ± 3.9	35.7 ± 3.1	44.8 ± 4.2	35.2 ± 4.2	43.9 ± 4.0	41.7 ± 4.0	39.0 ± 3.8	0.0139	0.0058	0.0239
(%) Obese ⁴	38.8 ± 0.7	30.0 ± 3.5	35.6 ± 4.2	23.8 ± 4.0	29.4 ± 3.1	30.3 ± 3.7	35.9 ± 4.9	29.6 ± 4.2	37.2 ± 4.1	38.3 ± 4.4	-0.0151	0.0095	0.0981
(%) Overweight or Obese ⁴	73.9 ± 0.6	68.1 ± 3.5	73.9 ± 3.8	69.7 ± 3.6	65.1 ± 3.7	75.2 ± 3.9	71.1 ± 4.0	73.5 ± 3.8	79.0 ± 3.4	77.4 ± 3.6	0.0023	0.0057	0.7661

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)

²p<0.01 is considered significant

³Measured weight; measured weight and height were used to calculate body mass index scores

⁴In adults, a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight; and a BMI of 30 kg/m² or higher is considered obese.

Discussion

Consumption of OJ, by decile, showed a positive linear association for most nutrients and for FJ and total fruit consumption. Total HEI score did not show a significant association across the deciles in the population 19+ years but did in adults 19-50 years and 51+ years. All three age groups showed a significant linear association for the total fruit sub-score, Consumption of 100% OJ did not show a significant linear trend for any age group for weight, BMI, % overweight, % obese, and % overweight or obese.

Few studies have looked at nutrient intake or diet quality of adults consuming FJ [13,21,48] or specifically OJ [20,22,23]. These studies have shown that consumption of OJ contributes to both diet quality and nutrient intake or adequacy. However, one randomized controlled study of weight loss in 63 obese adults showed that OJ contributed few nutrients to the diet other than folate and vitamin C; however, results from potassium were not presented [49].

In this study in all age groups studied, the majority of nutrients showed a significant positive linear relationship with decile of OJ consumption. This includes a small, but significant increased intake of dietary fiber, a nutrient of public health concern (DGA). Intake of dietary fiber in previous studies of nutrient intake of adults who consumed OJ are contradictory. O'Neil, et al. [20] showed that OJ consumers consumed more dietary fiber than non-OJ consumers; whereas, Malliot, et al., [23] did not show this relationship. The essential lack of dietary fiber in any type of FJ has contributed to the recommendation that the majority of fruit be consumed as whole fruit [7,26]. Additional studies need to confirm these results and study foods consumed with OJ or other fruit juices. Of note, added sugars did not show a significant positive linear relationship in any age group. Since the USDA definition for added sugars [36] was used, OJ did not contribute any added sugars to the diet.

Folate, vitamin C, and potassium are important nutrients found in OJ; vitamin C and potassium are underconsumed nutrients and potassium has been named a nutrient of public health concern [7]. There were linear relationships between OJ deciles and each of these nutrients in adults 19+ years, 19-50 years, and 51+ years. For adults 19+ years, four ounces of OJ was predicted to provide 43.4 µg folate DFE/d (11% daily value [DV]); 42.2 mg/d vitamin C (47% DV), and 254.7mg/d of potassium (5% DV) [50]. For adults 19-50 years and 51+ years, both the predictive values and the numbers were similar. For adults 19-50 years, four ounces of OJ was predicted to provide 41.6 µg/d (10% DV) folate DFE/d; 41.9 mg/d (47% DV) vitamin C; and 249.4 mg/d (5% DV) potassium. For adults 50+ years, four ounces of OJ was predicted to provide 48.0 µg/d (12% DV) folate it is also important to examine weight parameters in adults who consume FJ/OJ. All three of the age groups examined in this study showed increased energy intake between OJ consumers and non-consumers; however, only the adult consumers of OJ showed a significant linear relationship over the deciles of OJ consumption. None of the three age groups showed a significant positive or negative linear

DFE; 42.8 mg/d (48% DV) vitamin C; and 264.3 mg/d (6%) potassium.

There were several differences among the three age groups for the total diet quality score, as determined using the HEI. The adult population 19+ years did not show a significant linear relationship for total HEI across the deciles of OJ intake; whereas, both subgroups of the population, 19-50 years and 51+ years both showed a significant linear relationship across the HEI scores. This differs from previous studies of adult consumers of OJ. Using NHANES 2003-2006 data and the HEI-2005 ($p<0.05$) showed a significant difference was shown between OJ consumers and non-consumers [12]. Using NHANES 2013-2016 data and the HEI-2015, with a ($p<0.0001$), Malliot, et al. [23] also showed a significant difference in total HEI scores between consumers and non-consumers. When the association of four levels of total FJ consumption in adults participating in NHANES 2013-2016 were compared, there was also a significant difference ($p<0.0001$) [21]. Thus, our results in this study were unexpected for the adults 19+ years. One possible explanation is that in non-OJ consumers the score for the total HEI-2015 score was 49.8 and the score for those decile 2 total score was 55.5; the scores remained approximately within this score until decile 10, thus negating any linear relationship. Overall, total HEI-2015 scores were low, in that the maximum score is 100. This clearly suggests that improvement is needed in the diet.

There were some commonalities in the HEI sub-scores among the total population and the two separate age groups, total fruit sub-scores showed a significant linear relationship across the OJ deciles in all groups analyzed. However, there was no significant linear relationship across the OJ deciles for the whole fruit sub-scores. This finding differs from previous studies in adults who consumed OJ [12], and in adults who consumed FJ, regardless of type [21]. The reasons for this finding are not clear but are supported by the FPED results, which was used to obtain a fuller understanding of intake of total and whole fruit and FJ, since the HEI does not include FJ as a sub-score. The FPED results showed a significant linear relationship among deciles OJ consumption of total fruit and fruit juice in adults, but not whole fruit. Total fruit consumption was generally low, especially in non-OJ consumers.

Since there was a significant increase in energy intake between OJ consumers and non-consumers, and a significant increase in the percentage of overweight individuals in the 51-99 year age group for OJ consumers, it was important to look at additional weight parameters in all three age groups. Most of the studies of weight and FJ/OJ consumption have been done in children [12-16,18,19], but relationship between decile of OJ consumption and any weight parameter suggesting there was no association between OJ consumption and weight. Yang, et al., [22].

Showed an inverse relationship between OJ consumption and multiple weight parameters; and Malliot, et al., [23]

showed an inverse relationship between BMI and waist circumference between adult OJ consumers and non-consumers. The strengths of this study were that it included a large nationally representative sample of adults, which was attained by combining data from NHANES cycles 2003 to 2016, which produces estimates of greater precision and smaller sampling errors. Individual usual intake was also calculated to improve the quality of the data. This study also examined three separate age groups of adults: 19+ years, 19-50 years, and 51+ 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 [51]. Usual intake from 24-hour dietary recalls is the "method of choice" for reporting actual intake [52,53]; however, the recalls remain memory driven and under-reporting of energy has been reported, especially in those who are overweight or obese [54]. There is also the possibility that participants may mistake 100% fruit juice with fruit drinks or fruit cocktails; although the lack of linear associations of deciles of OJ consumption with added sugars limits this possibility. Finally, it must be acknowledged that when looking at the effect of a single food, such as OJ, the total diet, also contributes to the results.

In conclusion, the 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 adults participating in NHANES 2003-2016. Dietary fiber also showed a significant linear relationship with decile of OJ consumers. There were no significant linear relationships with deciles of OJ consumption and added sugars. Total HEI scores for age groups 19-50 years and 51+ years, and total editing of the manuscript. All authors have read and approved the final manuscript.

Ethical Standards Disclosure: "This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by The National Center for Health Statistics Research Ethics Review Board. Written informed consent was obtained from all subjects/patients."

References

1. Aune D, Giovannucci E, Boffetta P, et al. (2017) Fruit and Vegetable Intake and the Risk of Cardiovascular Disease, Total Cancer and All-Cause Mortality-A Systematic Review and Dose-Response Meta-Analysis of Prospective Studies. *Int J Epidemiol* 46, 1029-1056. doi: 10.1093/ije/dyw319.
2. Alissa EM, Ferns GA. (2017) Dietary Fruits and Vegetables and Cardiovascular Diseases Risk. *Crit Rev Food Sci Nutr* 57, 1950-1962. doi: 10.1080/10408398.2015.1040487.
3. Li M, Fan Y, Zhang X, et al. (2014) Fruit and Vegetable Intake and Risk of Type 2 Diabetes Mellitus: Meta-Analysis of Prospective Cohort Studies. *BMJ Open* 4, :e005497. doi: 10.1136/bmjopen-2014-005497.
4. Hu D, Huang J, Wang Y, et al. (2014) Fruits and Vegetables Consumption and Risk of Stroke: A Meta-Analysis of Prospective Cohort Studies. *Stroke* 45, 1613-1619. doi: 10.1161/STROKEAHA.114.004836.
5. Wang T, Heianza Y, Sun D, et al. (2019) Improving Fruit and Vegetable Intake Attenuates the Genetic Association With Long-Term Weight Gain. *Am J Clin Nutr* 110, 759-768. doi: 10.1093/ajcn/nqz136.
6. Yip CSC, Chan W, Fielding R. (2019) The Associations of Fruit and Vegetable Intakes with Burden of Diseases: A Systematic Review of Meta-Analyses. *J Acad Nutr Diet* 119, 464-481. doi: 10.1016/j.jand.2018.11.007.
7. 2015-2020 Dietary Guidelines for Americans. <https://www.dietaryguidelines.gov/current-dietary-guidelines/2015-2020-dietary-guidelines>. (accessed May 7, 2020).
8. Guenther PM, Dodd KW, Reedy J, et al. (2006) Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc* 106, 1371-1379. doi: 10.1016/j.jada.2006.06.002.
9. Drewnowski A, Rehm CD. (2015) Socioeconomic gradient in consumption of whole fruit and 100% fruit juice among US children and adults. *Nutr J* 14, 3. doi: 10.1186/1475-2891-14-3.

10. Dennison BA, Rockwell HL, Baker SL. (1997) Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity. *Pediatrics* 99, 15-22.
11. Faith MS, Dennison BA, Edmunds LS, et al. (2006) Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by environment interaction. *Pediatrics* 118, 2066-2075. doi: 10.1542/peds.2006-1117.
12. O'Neil CE, Nicklas TA, Rampersaud GC, et al. (2011) One hundred percent orange juice consumption is associated with better diet quality, improved nutrient adequacy, and no increased risk for overweight/obesity in children. *Nutr Res* 31, 673-682. doi: 10.1016/j.nutres.2011.09.002.
13. O'Neil CE, Nicklas TA, Zanovec M, et al. (2012) Fruit juice consumption is associated with improved nutrient adequacy in children and adolescents: the National Health and Nutrition Examination Survey (NHANES) 2003-2006. *Public Health Nutrition* 15, 1871-1878. doi:10.1017/S1368980012000031.
14. Nicklas T, O'Neil C, Fulgoni V, III. (2015). Consumption of 100% fruit juice is associated with better nutrient intake and diet quality but not with weight status in children: NHANES 2007-2010. *Int. J. Child Heal. Nutr* 4, 112-121.
15. Nicklas TA, O'Neil CE, Kleinman R. (2008) Association between 100% juice consumption and nutrient intake and weight of children aged 2 to 11 years. *Arch Pediatr Adolesc Med.* 162:557-65. doi: 10.1001/archpedi.162.6.557.
16. O'Neil CE, Nicklas TA, Kleinman, R. (2010) Relationship between 100% juice consumption and nutrient intake and weight of adolescents. *Am. J. Heal. Promot* 24, 31-37. doi.org/10.4278/ajhp.080603-QUAN-76.
17. O'Neil CE, Nicklas TA. (2008). A review of the relationship between 100% fruit juice consumption and weight in children and adolescents. *Am. J. Lifestyle Med* 2, 315-354. doi.org/10.1177/1559827608317277.
18. Crowe-White K, O'Neil CE, Parrott JS, et al. (2016) Impact of 100% Fruit Juice Consumption on Diet and Weight Status of Children: An Evidence-based Review. *Crit Rev Food Sci Nutr* 56,871-84. doi: 10.1080/10408398.2015.1061475.
19. Auerbach BJ, Wolf FM, Hikida A, et al. (2017) Fruit juice and change in BMI: a meta-analysis. *Pediatrics.* 139, pii: e20162454. doi: 10.1542/peds.2016-2454.
20. O'Neil CE, Nicklas TA, Rampersaud GC, et al. (2012) 100% orange juice consumption is associated with better diet quality, improved nutrient adequacy, decreased risk for obesity, and improved biomarkers of health in adults: National Health and Nutrition Examination Survey, 2003-2006. *Nutr J* 11, 107. doi: 10.1186/1475-2891-11-107.
21. Agarwal S, Fulgoni III VL, Welland D. (2019) Intake of 100% Fruit Juice Is Associated with Improved Diet Quality of Adults: NHANES 2013-2016 Analysis. *Nutrients* 11, 2513. doi: 10.3390/nu11102513.
22. Yang M, Lee SG, Wang YL. et al. (2013) Orange juice, a marker of diet quality, contributes to essential micronutrient and antioxidant intakes in the United States population. *J Nutr Educ Behav* 45, 340-348. doi: 10.1016/j.jneb.2012.07.005.
23. Maillot M, Vieux F, Rehm C, et al. (2020) Consumption of 100% Orange Juice in Relation to Flavonoid Intakes and Diet Quality Among US Children and Adults: Analyses of NHANES 2013-16 Data. *Frontiers in Nutrition* 7, 1-8. https://doi.org/10.3389/fnut.2020.00063
24. United States Department of Agriculture. Economic Research Service. Food Availability (Per Capita) Data System. (2019) <https://www.ers.usda.gov/data-products/food-availability-per-capita-data-system>. (accessed May 7, 2020).
25. Rampersaud GC. (2007) A comparison of nutrient density scores for 100% fruit juices. *J Food Sci* 72, S261-266. DOI: 10.1111/j.1750-3841.2007.00324.x.
26. United States Department of Agriculture. Choose MyPlate. <https://www.choosemyplate.gov/eathealthy/new-fruits>. (accessed May 7, 2020).
27. United States Department of Agriculture. Agricultural Research Service. FoodData Central. Orange juice, 100% NFS. (2020) <https://fdc.nal.usda.gov/fdc-app.html#/food-details/786578/nutrients>. (accessed May 7, 2020).
28. National Health and Nutrition Examination Survey. About the National Health and Nutrition Examination Survey. (2017) https://www.cdc.gov/nchs/nhanes/about_nhanes.htm. (accessed April 27, 2020).
29. National Health and Nutrition Examination Survey. NHANES Survey Methods and Analytic Guidelines. (2020) <https://wwwn.cdc.gov/nchs/nhanes/AnalyticGuidelines.aspx#plan-and-operations>. (accessed April 27, 2020).
30. National Health and Nutrition Examination Survey. NCHS Research Ethics Review Board (ERB) Approval. (2017) <https://www.cdc.gov/nchs/nhanes/irba98.htm>. (accessed April 27, 2020).
31. National Health and Nutrition Examination Survey. NHANES Questionnaire Data. (2020) <https://wwwn.cdc.gov/nchs/nhanes/Search/DataPage.aspx?Component=Questionnaire>. (accessed April 27, 2020).
32. Moshfegh AJ, Rhodes DG, Baer DJ, et al. (2008) The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *Am J Clin Nutr* 88, 324-32. <https://doi.org/10.1093/ajcn/88.2.324>
33. National Health and Nutrition Examination Survey. NHANES Dietary Data. (2020) <https://wwwn.cdc.gov/nchs/nhanes/Search/DataPage.aspx?Component=Dietary>. (accessed April 27, 2020).

34. United States Department of Agriculture. Ag Data Commons. Food and Nutrient Database for Dietary Studies. (2019) <https://data.nal.usda.gov/dataset/food-and-nutrient-database-dietary-studies-fndds>. (accessed April 27, 2020).
35. United States Department of Agriculture. Ag Data Commons. Food and Nutrient Database for Dietary Studies. FNDDS at a Glance. Foods and Beverages. (2019) <https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fndds-download-databases>. (accessed April 27, 2020).
36. Added sugars: Definition and estimation in the USDA Food Patterns Equivalents Databases. (2017) https://www.researchgate.net/publication/318348069_Added_sugars_Definition_and_estimation_in_the_USDA_Food_Patterns_Equivalents_Databases. (accessed May 15, 2020).
37. What We Eat in America Food Categories. Food Surveys Research Group. (2020) Available from: <https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/dmr-food-categories>. (accessed June 1, 2020).
38. Tooze JA, Kipnis V, Buckman DW, et al. (2010) A mixed-effects model approach for estimating the distribution of usual intake of nutrients: The NCI method *Stat Med* 29, 2857-2868. doi: 10.1002/sim.4063
39. Reedy J, Lerman JL, Krebs-Smith SM, et al. (2018). Evaluation of the Healthy Eating Index-2015. *J Acad Nutr Diet* 118, 1622-1633. doi: 10.1016/j.jand.2018.05.019.
40. Krebs-Smith SM, Pannucci TE, Subar AF, et al. (2018) Update of the Healthy Eating Index: HEI-2015. *J Acad Nutr Diet* 118, 1591-1602. doi: 10.1016/j.jand.2018.05.021.
41. National Cancer Institute. Division of Cancer Control & Population Sciences. Developing the Healthy Eating Index. <https://epi.grants.cancer.gov/hei/developing.html>. (accessed April 27, 2020).
42. United States Department of Agriculture. Food and Nutrition Service. Center for Nutrition Policy and Promotion. How the HEI is Scored. (2018) <https://www.fns.usda.gov/how-hei-scored>. (accessed April 27, 2020).
43. National Cancer Institute. Division of Cancer Control & Population Sciences. SAS Code. <https://epi.grants.cancer.gov/hei/sas-code.html>. (accessed April 27, 2020).
44. United States Department of Agriculture. Agricultural Research Service. (2019) Food Surveys Research Group: Beltsville, MD. <https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fped-overview>. (accessed May 7, 2020).
45. National Health and Examination Survey. Anthropometric Procedures Manual. (2017) https://wwwn.cdc.gov/nchs/data/nhanes/2017-2018/manuals/2017_Anthropometry_Procedures_Manual.pdf. (accessed April 27, 2020).
46. National Cholesterol Education Program. National Heart, Lung, and Blood Institute. National Institutes of Health. Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III); 2002. NIH Publication No. 02-5215. (2002) <https://www.nhlbi.nih.gov/files/docs/resources/heart/atp-3-cholesterol-full-report.pdf>. (accessed April 27, 2020).
47. National Cancer Institute. Division of Cancer Control & Population Sciences. Usual Dietary Intakes. (2020) <https://epi.grants.cancer.gov/diet/usualintakes>. (accessed April 27, 2020).
48. Bellisle F, Hébel P, Fourniret A, et al. (2018) Consumption of 100% Pure Fruit Juice and Dietary Quality in French Adults: Analysis of a Nationally Representative Survey in the Context of the WHO Recommended Limitation of Free Sugars. *Nutrients* 10, 459. doi: 10.3390/nu10040459.
49. Ribeiro C, Dourado G, Cesar T. (2017) Orange juice allied to a reduced-calorie diet results in weight loss and ameliorates obesity-related biomarkers: A randomized controlled trial. *Nutrition* 38, 13-19. doi: 10.1016/j.nut.2016.12.020.
50. National Institutes of Health. Dietary Supplement Label Database. <https://dslid.od.nih.gov/dslid/dailyvalue.jsp>. (accessed June 15, 2020).
51. Willett WC. (2013) *Nutritional Epidemiology*. 3rd ed. Oxford, United Kingdom: Oxford University Press.
52. Dao MC, Subar AF, Warthon-Medina M, et al. (2019) Dietary Assessment Toolkits: An Overview. *Public Health Nutr* 22, 404-418. doi: 10.1017/S1368980018002951
53. Ahluwalia N, Dwyer J, Terry A, et al. (2016) Update on NHANES Dietary Data: Focus on Collection, Release, Analytical Considerations, and Uses to Inform Public Policy. *Adv Nutr* 7, 121-134. doi: 10.3945/an.115.009258
54. Johnson RK, Soutanakis RP, Matthews DE. (1998) Literacy and body fatness are associated with underreporting of energy intake in US low-income women using the multiple-pass 24-hour recall: a doubly labeled water study. *J Am Diet Assoc* 98:1136-1140. doi: 10.1016/S0002-8223(98)00263-6.