

Top food sources of percentage of energy, nutrients to limit and total gram amount consumed among US adolescents: National Health and Nutrition Examination Survey 2011–2014

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Abstract

Objective: To identify most commonly consumed foods by adolescents contributing to percentage of total energy, added sugars, SFA, Na and total gram intake per day.

Design: Data from the National Health and Nutrition Examination Survey (NHANES) 2011–2014.

Setting: NHANES is a cross-sectional study nationally representative of the US population.

Participants: One 24 h dietary recall was used to assess dietary intake of 3156 adolescents aged 10–19 years. What We Eat in America food category classification system was used for all foods consumed. Food sources of energy, added sugars, SFA, Na and total gram amount consumed were sample-weighted and ranked based on percentage contribution to intake of total amount.

Results: Three-highest ranked food subgroup sources of total energy consumed were: sugar-sweetened beverages (SSB; 7·8%); sweet bakery products (6·9%); mixed dishes – pizza (6·6%). Highest ranked food sources of total gram amount consumed were: plain water (33·1%); SSB (15·8%); milk (7·2%). Three highest ranked food sources of total Na were: mixed dishes – pizza (8·7%); mixed dishes – Mexican (6·7%); cured meats/poultry (6·6%). Three highest ranked food sources of SFA were: mixed dishes – pizza (9·1%); sweet bakery products (8·3%); mixed dishes – Mexican (7·9%). Three highest ranked food sources of added sugars were: SSB (42·1%); sweet bakery products (12·1%); coffee and tea (7·6%).

Conclusions: Identifying current food sources of percentage energy, nutrients to limit and total gram amount consumed among US adolescents is critical for designing strategies to help them meet nutrient recommendations within energy needs.

Keywords
Energy
Grams
Sodium
SFA
Added sugars
Adolescents
Food sources
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Energy intake in excess of energy expenditure and higher intakes of added sugars, SFA and Na contribute to unhealthy weight gain and/or chronic non-communicable diseases, including CHD and type 2 diabetes^(1–3). Adolescence is an important period to understand dietary intake, because it is a period of transition from childhood to adulthood when teens become more independent in their food choices⁽⁴⁾. Given the overabundance of foods and beverages available, targeting reductions in the amounts and percentage contribution of the most commonly consumed foods with these nutrients among

adolescents may be an effective strategy to more closely align their diets with current dietary recommendations⁽⁵⁾. This approach may have the positive effect of increasing intakes of foods and beverages that contain the food groups to encourage and of decreasing nutrients to limit in the diets of adolescents^(5–9).

Cross-sectional data from six nationally representative surveys of food intake (1989 to 2010) with US children and adolescents revealed that total energy intake increased considerably from 1989 to 2004, and subsequently declined through 2010⁽¹⁰⁾. Seven food sources were

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consistently major contributors to total energy intake across all time points: sugar-sweetened beverages (SSB), pizza, higher-fat milk, grain-based desserts, breads, pasta dishes and savoury snacks. Intakes of higher-fat milk, meats and processed meat products, ready-to-eat cereals, hamburgers, fried potatoes, 100% juice and vegetables decreased from 1989 to 2010, while intakes of low-fat milk, poultry, sweet snacks, candies, and tortillas and corn-based dishes increased over this period⁽¹⁰⁾. Although there may have been a decrease in total energy intake, adolescents were still consuming foods high in energy, which might affect overall diet quality^(11–13). Food sources of energy, added sugars and SFA make major contributions to intakes of nutrients of public health concern (i.e. dietary fibre, vitamin D, Ca and K) as well as other essential nutrients^(11–14).

SFA and Na are considered overconsumed nutrients that may pose a public health concern due to cardiovascular and metabolic diseases⁽⁵⁾. In addition, the 2015 Dietary Guidelines for Americans recommend limiting intakes of energy from solid fat (i.e. SFA and *trans*-fatty acids) and added sugars⁽¹⁵⁾. Linear trends in intakes of solid fats and added sugars decreased in adolescents aged 2–18 years from 1994 to 2010, but the mean intakes continue to exceed recommended limits⁽¹³⁾. The top food sources of SFA were: cheese; milk; frankfurters, sausages, luncheon meats; beef; other fats and oils (e.g. butter and animal fats, margarine, cream cheese); milk desserts; cake, cookies, quick breads, pastry pies; and crackers, popcorn, pretzels, chips⁽¹⁾. The US population is consuming Na in excess of dietary guideline levels and snacking behaviours are contributing to the excessive intake over the 30 years, especially among adolescents. Salty snacks and desserts and sweets (i.e. grain-based desserts) were the top food sources of Na⁽¹⁶⁾. Average daily Na intake was highest among older (14–18 years old) school-aged children (3565 (SE 120) mg) and lowest among females (2919 (SE 74) mg) compared with younger (6–10 years old) children (3051 (SE 61) mg) and males (3584 (SE 102) mg), all exceeding recommended amounts⁽¹²⁾.

Understanding current food sources of energy intake and nutrients to limit among adolescents in the USA is important for designing age-specific strategies to help meet current dietary recommendations⁽⁵⁾. Although detailed lists of food sources of energy and nutrients among US children (2–18 years) and adults (≥ 19 years) from the National Health and Nutrition Examination Survey (NHANES) 2003–2006 have been published^(1,17), no study using recent NHANES data has examined the top food sources consumed by adolescents aged 10–19 years. The present study identifies the most commonly consumed food sources by adolescents (10–19 years) in terms of their contribution to energy, nutrients to limit and the total gram amount of foods consumed using nationally representative data from NHANES 2011–2014.

Methods

NHANES overview

The NHANES is a cross-sectional survey that uses a multi-stage stratified area probability sample of non-institutionalized individuals, that provides nationally representative estimates of the US population⁽¹⁸⁾. An overview of NHANES⁽¹⁸⁾ including the purpose, plan and operations, sample design, weighting procedures, analytic guidelines⁽¹⁹⁾ and response rates and population totals⁽²⁰⁾ is available elsewhere. In addition, a recent review article has been published describing NHANES in more detail, including analytical considerations and uses to inform public policy⁽²¹⁾. The survey examines approximately 5000 persons each year and data are released in 2-year cycles. Data were collected via a mobile examination centre throughout the year on both weekends and weekdays⁽²²⁾.

Study sample

The WHO defines adolescents as those people between 10 and 19 years of age⁽²³⁾. Therefore, data from adolescents aged 10–19 years participating in the NHANES 2011–2012 and 2013–2014 were combined to increase sample size, resulting in a final analytic sample of 3156 after excluding those with unreliable records as defined by US Department of Agriculture (USDA) staff. The unweighted response rates for the adolescents aged 10–19 years for NHANES 2011–2012 and 2013–2014 were 75.8 and 78.5%, respectively^(24,25). Demographic information⁽²⁶⁾ and self-reported physical activity levels⁽²⁷⁾ were determined from the NHANES survey. Physical activity was classified into three levels: sedentary, moderate and vigorous, according to the individuals' intensity level in a typical week⁽²⁷⁾. The NHANES employs protocols and procedures that ensure confidentiality and protect individual participants from identification^(26,27).

Determination of dietary intake data

Dietary intake data were obtained from the in-person 24 h dietary recall interview using an automated multiple-pass method⁽²⁸⁾. The source of food composition data was based on the 2011–2012 and 2013–2014 Food Patterns Equivalents Databases, which convert the foods and beverages in the Food and Nutrient Database for Dietary Studies to USDA Food Patterns components⁽²⁹⁾. Added sugars were defined by the USDA as all sugars used as ingredients in processed and prepared foods such as breads, cakes, soft drinks, jams, chocolates and ice cream, or eaten separately or added to foods at the table (MyPlate). Added sugars were determined using the NHANES cycle appropriate MyPyramid Equivalents Databases for USDA Survey Food Codes from 2001 to 2008 (versions 1.0 and 2.0) until these were replaced by the Food Patterns Equivalents Database in 2005 for each

NHANES release (Food Patterns). Trained interviewers collected the recall data in English or Spanish, as appropriate. Participants aged 12 years or older completed the dietary interview on their own, but proxy-assisted interviews were conducted with participants aged 10 and 11 years. Detailed description of the dietary interview methods is provided in the NHANES Dietary Interview Procedure Manual⁽³⁰⁾. A single 24 h dietary recall administered in a sufficiently large population sample can adequately provide data to estimate population mean intakes⁽³¹⁾.

Food groupings

The What We Eat In America (WWEIA) food category classification system⁽³²⁾ was used to classify all foods consumed (obtained from the individual food file and combination foods were evaluated at the item level of each food in the combination). From fifteen main groups of the 2011–2012 and 2013–2014 WWEIA food categorization system⁽³²⁾, only twelve were included in the present study: Milk and Dairy; Protein Foods; Mixed Dishes; Grains; Snacks and Sweets; Fruits; Vegetables; Beverages, Non-alcoholic; Fats and Oils; Condiments and Sauces; Sugars; and Water. The other food groups were excluded because they were not commonly consumed in this target population (e.g. Infant Formula and Baby Food; Other (e.g. protein and nutritional powders); Alcoholic Beverages). From these twelve main groups, forty-one food subgroups (e.g. quick breads and bread products, ready-to-eat cereals, flavoured milk, yoghurt, cheese) were included to determine the rank order of contributors to total energy, Na, SFA, added sugars and total gram amount of foods/beverages consumed⁽³²⁾. The food categories in the online supplementary material, Supplemental Table 1, describe the assignment of the 137 specific WWEIA food categories to major food groups (*n* 12) and subgroups (*n* 41)⁽⁵⁾.

Anthropometric measures

Height and weight were measured using procedures outlined in the NHANES Anthropometry Procedures Manual⁽³³⁾. BMI was calculated as body weight (in kilograms) divided by the square of height (in metres)⁽³⁴⁾. The Centers for Disease Control and Prevention's growth chart programs were used to determine BMI-for-age percentiles; children with BMI \geq 85th and $<$ 95th percentile and BMI \geq 95th percentile were considered overweight or obese, respectively⁽³⁵⁾.

Statistical analysis

Analyses were conducted using the statistical software packages SAS version 9.2 and SUDAAN version 11. Appropriate weights were used to adjust for oversampling of certain groups, non-response by some sample persons

and the complex sample design of NHANES to obtain nationally representative estimates. Descriptive statistics (means and percentages, with their standard errors) for food sources on a population level using SAS PROC RATIO were determined for energy, Na, SFA, added sugars and total gram amount consumed reported on the day of the 24 h dietary recall. Mean per capita energy, total grams, Na, SFA and added sugars consumed from each food group were expressed as a percentage of the total to allow relativity across sex and age groups.

Results

Demographics and lifestyle characteristics

The sample from NHANES 2011–2014 included 3156 respondents aged 10–19 years with 53% of the adolescents aged 10–14 years, who were equally represented by sex. Mean BMI was 23.3 (SE 0.2) kg/m², with 63.3 (SE 1.6)% normal weight, 16.2 (SE 0.9)% overweight and 20.5 (SE 1.4)% obese. Most adolescents reported being non-Hispanic White (54.5 (SE 3.3)%) and head of household education status being more than high school (56.8 (SE 2.4)%). Most adolescents reported vigorous physical activity status (59.6 (SE 1.51)%) followed by moderate (28.3 (SE 1.4)%). On the day of the 24 h dietary recall, the mean energy intake was 8774 (SE 95) kJ (2097 (SE 22.7) kcal; Table 1).

Table 1 Demographic and lifestyle characteristics of US adolescents aged 10–19 years (*n* 3156), National Health and Nutrition Examination Survey 2011–2014

Age group	<i>n</i>	%
Total	3156	100.0
Sex		
Female	1579	50.2
Male	1577	49.8
Weight status		
Normal weight	1924	63.3
Overweight	546	16.2
Obese	656	20.5
Race/ethnicity		
Hispanic	665	15.1
Non-Hispanic White and other	784	54.5
Non-Hispanic Black	863	14.6
Non-Hispanic non-Black Asian	844	15.9
Head of household education		
Low (less than high school)	806	21.6
Mid (high school)	700	21.6
High (more than high school)	1560	56.8
Physical activity		
Sedentary	406	12.1
Moderate	845	28.3
Vigorous	1873	59.6
	Mean	SE
BMI (kg/m ²)	23.3	0.2
Alcohol intake (g)	0.9	0.2
Poverty index ratio	2.3	0.1
Total energy intake (kJ)	8774	95
Total energy intake (kcal)	2097	22.7

Contribution of foods to total energy intake

Table 2 shows the dietary sources of energy consumed from the WWEIA's food subgroups. The more specific food categories are presented in the online supplementary material, Supplemental Table 2. The ten highest ranked subgroups contributed 55.1% of total energy intake, including: 7.8% from SSB (4.4% from soft drinks); 6.9% from sweetened bakery products (2.8% from cookies and brownies); 6.6% from mixed dishes – pizza; 5.8% from bread, rolls and tortillas (3.0% from yeast bread); 5.3% from mixed dishes – grain-based (2.3% from pasta mixed dishes, excludes macaroni and cheese); 5.1% from mixed dishes – Mexican (3.2% from burritos and tacos); 4.6% from savoury snacks (2.0% from tortilla, corn, other chips); 4.6% from mixed dishes – sandwiches (1.2% from hamburgers and 1.1% from chicken/turkey sandwiches); 4.4% from milk (2.4% from milk, reduced

fat); and 4.0% from poultry (2.2% from chicken, whole pieces).

Contribution of foods to total grams consumed

All the top beverage sources (*n* 9) contributed 67.2% of total grams consumed. Plain water contributed 33.1% with tap water the most consumed category (19.5%). The other three highest ranked beverage subgroups (and categories) were: 15.8% from SSB (8.6% from soft drinks); 7.2% from milk (3.9% from milk, reduced-fat); and 4.9% from coffee and tea (3.8% from tea). Further, all the top food sources (*n* 32) contributed 31.5% of total grams consumed and the five highest ranked food subgroups (and categories) were: 2.9% from fruits (0.8% from apples); 2.7% from mixed dishes – grain-based (1.4% from pasta mixed dishes, excludes macaroni and cheese); 1.9% from mixed dishes – pizza; 1.7% from mixed dishes – Mexican (1.2% from

Table 2 Food sources* of mean and percentage of energy (kcal)† intake among US adolescents aged 10–19 years (*n* 3156), National Health and Nutrition Examination Survey 2011–2014

Rank	Main group	Subgroup	Cons	Mean	SE	PCT	SE
1.	Beverages, Non-alcoholic	Sweetened Beverages	2087	163.1	6.3	7.8	0.3
2.	Snacks and Sweets	Sweet Bakery Products	1257	144.2	7.8	6.9	0.4
3.	Mixed Dishes	Mixed Dishes – Pizza	705	138.7	11.5	6.6	0.5
4.	Grains	Breads, Rolls, Tortillas	1659	122.2	4.3	5.8	0.2
5.	Mixed Dishes	Mixed Dishes – Grain-based	715	110.2	5.8	5.3	0.3
6.	Mixed Dishes	Mixed Dishes – Mexican	495	105.9	9.6	5.0	0.5
7.	Snacks and Sweets	Savoury Snacks	1379	97.3	5.4	4.6	0.2
8.	Mixed Dishes	Mixed Dishes – Sandwiches	553	97.2	8.9	4.6	0.4
9.	Milk and Dairy	Milk	1433	91.2	3.9	4.4	0.2
10.	Protein Foods	Poultry	957	84.9	7.3	4.0	0.3
11.	Vegetables	White Potatoes	874	67.7	4.0	3.2	0.2
12.	Grains	Ready-to-Eat Cereals	879	56.4	3.4	2.7	0.2
13.	Protein Foods	Meats	625	53.6	3.8	2.6	0.2
14.	Snacks and Sweets	Other Desserts	608	52.1	5.1	2.5	0.2
15.	Mixed Dishes	Mixed Dishes – M/P/F	429	50.8	4.9	2.4	0.2
16.	Grains	Quick Breads and Bread Products	475	48.9	4.7	2.3	0.2
17.	Snacks and Sweets	Candy	914	45.2	4.3	2.2	0.2
18.	Milk and Dairy	Cheese	1017	45.0	3.3	2.1	0.2
19.	Protein Foods	Cured Meats/Poultry	874	42.2	3.7	2.0	0.2
20.	Fruit	Fruits	1251	42.0	2.4	2.0	0.1
21.	Fats and Oils	Fats and Oils	1074	41.9	3.2	2.0	0.2
22.	Protein Foods	Plant-based Protein Foods	520	40.7	3.6	1.9	0.2
23.	Beverages, Non-alcoholic	100% Juice	727	34.7	3.5	1.7	0.2
24.	Mixed Dishes	Mixed Dishes – Asian	238	33.9	5.9	1.6	0.3
25.	Beverages, Non-alcoholic	Coffee and Tea	704	32.0	4.2	1.5	0.2
26.	Grains	Cooked Grains	463	30.7	2.2	1.5	0.1
27.	Protein Foods	Eggs	473	30.4	2.6	1.4	0.1
28.	Milk and Dairy	Flavoured Milk	382	27.2	2.7	1.3	0.1
29.	Snacks and Sweets	Crackers	353	23.8	2.9	1.1	0.1
30.	Sugars	Sugars	688	22.6	2.9	1.1	0.1
31.	Vegetables	Vegetables, excluding Potatoes	1181	20.4	1.3	1.0	0.1
32.	Mixed Dishes	Mixed Dishes – Soups	337	19.7	2.0	0.9	0.1
33.	Condiments and Sauces	Condiments and Sauces	1282	16.9	1.3	0.8	0.1
34.	Snacks and Sweets	Snack/Meal Bars	181	15.2	2.3	0.7	0.1
35.	Milk and Dairy	Dairy Drinks and Substitutes	121	13.4	2.1	0.6	0.1
36.	Protein Foods	Seafood	210	10.9	1.8	0.5	0.1
37.	Milk and Dairy	Yoghurt	126	5.7	0.8	0.3	0.0
38.	Grains	Cooked cereals	86	4.5	1.0	0.2	0.0
39.	Water	Flavoured or Enhanced Water	73	1.5	0.4	0.1	0.0
40.	Beverages, Non-alcoholic	Diet Beverages	234	0.7	0.1	0.0	0.0
41.	Water	Plain Water	2447	0.0	0.0	0.0	0.0

Cons, number of consumers; PCT, percentage contribution; M/P/F, meat/poultry/fish.

*All forty-one weighted subgroups of foods' contribution to daily intake of energy.

†To convert to kJ, multiply kcal values by 4.184.

burritos and tacos); and 1.7% from vegetables, excluding potatoes (0.3% from other vegetables and combinations). Results are presented in Table 3 and the online supplementary material, Supplemental Table 3.

Contribution of foods to total sodium consumed

Table 4 and the online supplementary material, Supplemental Table 4, present food subgroups (and categories) contributing to total Na consumed. The top ten sources contributed 58.0% of the total and included: 8.7% from mixed dishes – pizza; 6.7% from mixed dishes – Mexican (4.6% from burritos and tacos); 6.6% from cured meats/poultry (4.7% from cold cuts and cured meats); 6.5% from mixed dishes – sandwiches (1.7% from chicken/turkey sandwiches); 6.3% from breads, rolls and tortillas (3.3% from yeast breads); 6.1% from mixed dishes – grain-based (3.1% from pasta mixed dishes, excludes macaroni and cheese); 5.5% from poultry (3.0% from chicken, whole

pieces); 4.1% from condiments and sauces; 3.9% from mixed dishes – meat/poultry/fish (2.6% from meat mixed dishes); and 3.6% from cheese.

Contribution of foods to total SFA consumed

The food subgroups (and categories) that contributed to total SFA are presented in Table 5 and the online supplementary material, Supplemental Table 5. The ten highest food sources contributed 64.4% of total SFA consumed and included: 9.1% from mixed dishes – pizza; 8.3% from sweet bakery products (3.4% from cookies and brownies); 7.9% from mixed dishes – Mexican (5.2% from burritos and tacos); 7.6% from milk (4.8% from milk, reduced fat); 6.9% from cheese; 6.3% from mixed dishes – sandwiches (2.0% from burgers); 5.4% from mixed dishes – grain-based (2.9% from macaroni and cheese); 4.8% from other desserts (4.6% from ice cream and frozen dairy desserts); 4.2% from fats and oils; and 3.9% from meats (2.0% from ground beef).

Table 3 Food sources* of mean and percentage of grams among US adolescents aged 10–19 years (n 3156), National Health and Nutrition Examination Survey 2011–2014

Rank	Main group	Subgroup	Cons	Mean	SE	PCT	SE
1.	Water	Plain Water	2447	875.6	34.8	33.1	0.9
2.	Beverages, Non-alcoholic	Sweetened Beverages	2087	417.6	15.4	15.8	0.6
3.	Milk and Dairy	Milk	1433	190.1	8.6	7.2	0.3
4.	Beverages, Non-alcoholic	Coffee and Tea	704	129.5	11.5	4.9	0.4
5.	Fruit	Fruits	1251	77.1	4.9	2.9	0.2
6.	Mixed Dishes	Mixed Dishes – Grain-based	715	72.0	3.8	2.7	0.2
7.	Beverages, Non-alcoholic	100% Juice	727	71.7	6.8	2.7	0.2
8.	Mixed Dishes	Mixed Dishes – Pizza	705	48.9	4.0	1.9	0.2
9.	Mixed Dishes	Mixed Dishes – Mexican	495	45.1	4.2	1.7	0.2
10.	Vegetables	Vegetables, excluding Potatoes	1181	44.0	2.7	1.7	0.1
11.	Grains	Breads, Rolls, Tortillas	1659	43.6	1.6	1.6	0.1
12.	Beverages, Non-alcoholic	Diet Beverages	234	42.8	4.9	1.6	0.2
13.	Milk and Dairy	Flavoured Milk	382	38.2	3.9	1.4	0.1
14.	Mixed Dishes	Mixed Dishes – Sandwiches	553	38.0	3.4	1.4	0.1
15.	Vegetables	White Potatoes	874	37.8	2.8	1.4	0.1
16.	Protein Foods	Poultry	957	35.9	3.0	1.4	0.1
17.	Mixed Dishes	Mixed Dishes – M/P/F	429	35.9	3.7	1.4	0.1
18.	Snacks and Sweets	Sweet Bakery Products	1257	35.3	1.9	1.3	0.1
19.	Mixed Dishes	Mixed Dishes – Soups	337	34.0	3.3	1.3	0.1
20.	Snacks and Sweets	Other Desserts	608	29.0	2.8	1.1	0.1
21.	Protein Foods	Meats	625	24.5	1.8	0.9	0.1
22.	Grains	Cooked Grains	463	21.9	1.7	0.8	0.1
23.	Condiments and Sauces	Condiments and Sauces	1282	20.7	1.8	0.8	0.1
24.	Snacks and Sweets	Savoury Snacks	1379	19.9	1.1	0.8	0.0
25.	Protein Foods	Cured Meats/Poultry	874	19.6	1.5	0.7	0.1
26.	Mixed Dishes	Mixed Dishes – Asian	238	19.2	2.8	0.7	0.1
27.	Grains	Quick Breads and Bread Products	475	17.0	1.5	0.6	0.1
28.	Protein Foods	Eggs	473	16.6	1.4	0.6	0.1
29.	Grains	Ready-to-Eat Cereals	879	14.9	0.9	0.6	0.0
33.	Milk and Dairy	Cheese	1017	13.8	1.0	0.5	0.0
31.	Milk and Dairy	Dairy Drinks and Substitutes	121	12.6	1.7	0.5	0.1
32.	Protein Foods	Plant-based Protein Foods	520	12.2	1.1	0.5	0.0
33.	Water	Flavoured or Enhanced Water	73	10.9	1.9	0.4	0.1
34.	Fats and Oils	Fats and Oils	1074	10.8	0.9	0.4	0.0
35.	Snacks and Sweets	Candy	914	10.4	1.0	0.4	0.0
36.	Sugars	Sugars	688	8.1	1.1	0.3	0.0
37.	Protein Foods	Seafood	210	6.5	1.2	0.2	0.0
38.	Milk and Dairy	Yoghurt	126	6.1	0.9	0.2	0.0
39.	Grains	Cooked Cereals	86	5.2	1.2	0.2	0.0
40.	Snacks and Sweets	Crackers	353	5.0	0.6	0.2	0.0
41.	Snacks and Sweets	Snack/Meal Bars	181	3.6	0.5	0.1	0.0

Cons, number of consumers; PCT, percentage contribution; M/P/F, meat/poultry/fish. *All forty-one weighted subgroups of foods' contribution to daily total gram intake.

Table 4 Food sources* of sodium (mg), mean contribution and as a percentage of total sodium intake, among US adolescents aged 10–19 years (*n* 3156), National Health and Nutrition Examination Survey 2011–2014

Rank	Main group	Subgroup	Cons	Mean	SE	PCT	SE
1.	Mixed Dishes	Mixed Dishes – Pizza	705	300.5	25.5	8.7	0.7
2.	Mixed Dishes	Mixed Dishes – Mexican	495	231.4	21.8	6.7	0.6
3.	Protein Foods	Cured Meats/Poultry	874	228.8	17.0	6.6	0.4
4.	Mixed Dishes	Mixed Dishes – Sandwiches	553	222.8	22.5	6.5	0.6
5.	Grains	Breads, Rolls, Tortillas	1659	217.7	7.4	6.3	0.2
6.	Mixed Dishes	Mixed Dishes – Grain-based	715	209.1	10.0	6.1	0.3
7.	Protein Foods	Poultry	957	189.6	16.6	5.5	0.5
8.	Condiments and Sauces	Condiments and Sauces	1282	141.9	11.4	4.1	0.3
9.	Mixed Dishes	Mixed Dishes – M/P/F	429	134.4	15.6	3.9	0.5
10.	Milk and Dairy	Cheese	1017	124.8	10.1	3.6	0.3
11.	Snacks and Sweets	Savoury Snacks	1379	118.0	6.9	3.4	0.2
12.	Snacks and Sweets	Sweet Bakery Products	1257	113.6	6.7	3.3	0.2
13.	Vegetables	White Potatoes	874	105.8	8.3	3.1	0.2
14.	Protein Foods	Meats	625	104.2	7.5	3.0	0.2
15.	Mixed Dishes	Mixed Dishes – Soups	337	100.3	9.7	2.9	0.3
16.	Grains	Quick Breads and Bread Products	475	92.4	8.6	2.7	0.2
17.	Milk and Dairy	Milk	1433	85.8	3.9	2.5	0.1
18.	Mixed Dishes	Mixed Dishes – Asian	238	81.2	13.8	2.4	0.4
19.	Grains	Ready-to-Eat Cereals	879	75.0	4.3	2.2	0.1
20.	Protein Foods	Eggs	473	73.2	6.5	2.1	0.2
21.	Fats and Oils	Fats and Oils	1074	68.0	6.4	2.0	0.2
22.	Beverages, Non-alcoholic	Sweetened Beverages	2087	63.3	5.0	1.8	0.1
23.	Vegetables	Vegetables, excluding Potatoes	1181	58.8	5.4	1.7	0.2
24.	Grains	Cooked Grains	463	51.5	4.0	1.5	0.1
25.	Snacks and Sweets	Crackers	353	41.0	5.1	1.2	0.1
26.	Protein Foods	Plant-based Protein Foods	520	37.2	2.7	1.1	0.1
27.	Protein Foods	Seafood	210	32.5	6.7	0.9	0.2
28.	Water	Plain Water	2447	27.8	1.3	0.8	0.0
29.	Milk and Dairy	Flavoured Milk	382	24.9	2.5	0.7	0.1
30.	Snacks and Sweets	Other Desserts	608	24.4	2.8	0.7	0.1
31.	Snacks and Sweets	Candy	914	14.3	1.3	0.4	0.0
32.	Snacks and Sweets	Snack/Meal Bars	181	11.1	1.7	0.3	0.0
33.	Milk and Dairy	Dairy Drinks and Substitutes	121	8.6	1.2	0.2	0.0
34.	Grains	Cooked Cereals	86	8.1	2.0	0.2	0.1
35.	Beverages, Non-alcoholic	Coffee and Tea	704	7.4	0.5	0.2	0.0
36.	Beverages, Non-alcoholic	Diet Beverages	234	5.1	0.7	0.1	0.0
37.	Sugars	Sugars	688	4.7	0.6	0.1	0.0
38.	Beverages, Non-alcoholic	100% Juice	727	3.9	0.8	0.1	0.0
39.	Milk and Dairy	Yoghurt	126	3.4	0.5	0.1	0.0
40.	Fruit	Fruits	1251	1.4	0.1	0.0	0.0
41.	Water	Flavoured or Enhanced Water	73	1.2	0.3	0.0	0.0

Cons, number of consumers; PCT, percentage contribution; M/P/F, meat/poultry/fish.

*All forty-one weighted subgroups of foods' contribution of daily intake of Na.

Contribution of foods to total added sugars consumed

The added sugar food subgroups (and categories) are presented in Table 6 and the online supplementary material, Supplemental Table 6. The top ten subgroups contributed 89.1% of total added sugar intake. The top food sources were: 42.1% from SSB (25.6% from soft drinks); 12.1% from sweet bakery products (5.0% from cookies and brownies); 7.6% from coffee and tea (6.9% from tea); 6.1% from candy (3.5% from candy not containing chocolate); 5.5% from other desserts (4.3% from ice cream and frozen dairy desserts); 4.9% from sugars; 4.9% from ready-to-eat cereals (4.3% from ready-to-eat cereal, higher in sugar); 2.1% from flavoured milk (0.6% from flavoured milk, reduced fat); 1.9% from breads, rolls and tortillas (1.0% from yeast breads); and 1.8% from quick breads (1.1% from biscuits, muffins, quick breads).

Discussion

Identification of food sources for intakes of energy, total grams consumed and nutrients to limit may guide public health efforts to align adolescents' diets more closely with current dietary recommendations. The present study provides the food sources of energy, nutrients to limit and total amount of grams consumed by a nationally representative sample of US adolescents; to our knowledge, this is the first time that data for this age group have been reported. While some food categories contributed a high percentage of total energy and total amount of grams consumed, such as milk and water, less desirable food sources, including SSB and sweetened bakery products, were also identified.

The present findings add to the literature that identifies intakes of SSB and sweetened bakery products as being

Table 5 Food sources* of SFA (g), mean contribution and as a percentage of total SFA intake, among US adolescents aged 10–19 years (*n* 3156), National Health and Nutrition Examination Survey 2011–2014

Rank	Main group	Subgroup	Cons	Mean	SE	PCT	SE
1.	Mixed Dishes	Mixed Dishes – Pizza	705	2.4	0.2	9.1	0.7
2.	Snacks and Sweets	Sweet Bakery Products	1257	2.2	0.1	8.3	0.5
3.	Mixed Dishes	Mixed Dishes – Mexican	495	2.1	0.2	7.9	0.7
4.	Milk and Dairy	Milk	1433	2.0	0.1	7.6	0.4
5.	Milk and Dairy	Cheese	1017	1.8	0.1	6.9	0.4
6.	Mixed Dishes	Mixed Dishes – Sandwiches	553	1.7	0.2	6.3	0.6
7.	Mixed Dishes	Mixed Dishes – Grain-based	715	1.4	0.1	5.4	0.4
8.	Snacks and Sweets	Other Desserts	608	1.3	0.1	4.8	0.5
9.	Fats and Oils	Fats and Oils	1074	1.1	0.1	4.2	0.3
10.	Protein Foods	Meats	625	1.0	0.1	3.9	0.3
11.	Protein Foods	Poultry	957	1.0	0.1	3.6	0.3
12.	Protein Foods	Cured Meats/Poultry	874	0.9	0.1	3.4	0.3
13.	Snacks and Sweets	Savoury Snacks	1379	0.9	0.1	3.4	0.3
14.	Protein Foods	Eggs	473	0.7	0.1	2.7	0.2
15.	Mixed Dishes	Mixed Dishes – M/P/F	429	0.7	0.1	2.5	0.2
16.	Snacks and Sweets	Candy	914	0.7	0.1	2.5	0.2
17.	Vegetables	White Potatoes	874	0.6	0.1	2.4	0.2
18.	Grains	Breads, Rolls, Tortillas	1659	0.5	0.0	1.9	0.1
19.	Protein Foods	Plant-based Protein Foods	520	0.5	0.0	1.7	0.1
20.	Grains	Quick Breads and Bread Products	475	0.5	0.1	1.7	0.2
21.	Milk and Dairy	Flavoured Milk	382	0.4	0.0	1.4	0.2
22.	Milk and Dairy	Dairy Drinks and Substitutes	121	0.3	0.1	1.2	0.2
23.	Mixed Dishes	Mixed Dishes – Soups	337	0.3	0.0	1.0	0.1
24.	Mixed Dishes	Mixed Dishes – Asian	238	0.2	0.0	0.9	0.2
25.	Snacks and Sweets	Crackers	353	0.2	0.0	0.8	0.1
26.	Condiments and Sauces	Condiments and Sauces	1282	0.2	0.0	0.7	0.1
27.	Grains	Ready-to-Eat Cereals	879	0.2	0.0	0.7	0.1
28.	Vegetables	Vegetables, excluding Potatoes	1181	0.1	0.0	0.5	0.0
29.	Beverages, Non-alcoholic	Coffee and Tea	704	0.1	0.0	0.4	0.1
30.	Snacks and Sweets	Snack/Meal Bars	181	0.1	0.0	0.4	0.1
31.	Protein Foods	Seafood	210	0.1	0.0	0.4	0.1
32.	Beverages, Non-alcoholic	Sweetened Beverages	2087	0.1	0.0	0.3	0.1
33.	Grains	Cooked Grains	463	0.1	0.0	0.2	0.0
34.	Milk and Dairy	Yoghurt	126	0.1	0.0	0.2	0.0
35.	Sugars	Sugars	688	0.1	0.0	0.2	0.1
36.	Grains	Cooked Cereals	86	0.0	0.0	0.2	0.0
37.	Fruit	Fruits	1251	0.0	0.0	0.1	0.0
38.	Beverages, Non-alcoholic	100% Juice	727	0.0	0.0	0.0	0.0
39.	Beverages, Non-alcoholic	Diet Beverages	234	0.0	0.0	0.0	0.0
40.	Water	Plain Water	2447	0.0	0.0	0.0	0.0
41.	Water	Flavoured or Enhanced Water	73	0.0	0.0	0.0	0.0

Cons, number of consumers; PCT, percentage contribution; M/P/F, meat/poultry/fish.

*All forty-one weighted subgroups of foods' contribution of daily intake of SFA.

major contributors of added sugars and SFA. However, the question that has not been addressed in the research field is whether there is an independent role of nutrients to limit and food sources, or if nutrients to limit and food sources simply add excessive energy to the diet leading to adverse health effects⁽³⁶⁾. For example, 100% fruit juice contributes positively to nutrient intakes, but should be consumed in adequate portion sizes in order not to overconsume excess energy. On the other hand, flavoured teas and coffees contribute to higher amount of added sugars. A previous study⁽³⁶⁾ suggests that the role of SSB is probably larger than has been reported because the SSB category did not include sugar-sweetened tea and coffee.

Corroborating with a representative study using 2009–2012 data from NHANES⁽³⁶⁾ showed that the major food source of added sugars was sweet bakery products (i.e. cookies and brownies). The total intake of added sugars

was 12% in the adolescent population. Moreover, sweetened bakery products contributed to the intake of SFA in the diet of the US population⁽³⁷⁾. Therefore, practitioners, researchers and policy makers should continuously be working together to reduce intakes of added sugars and SFA from the food sources commonly consumed by adolescents, in accordance with the recommendations of the Dietary Guidelines for Americans⁽⁵⁾.

In the current study, adolescents reported consuming an average of 8774 kJ (2097 kcal)⁽⁵⁾, which is within current estimated daily energy needs⁽³⁸⁾. However, approximately 37 and 20% of adolescents were overweight or obese, respectively⁽³⁹⁾. By inference, many must be consuming more energy than they require. Moreover, studies have repeatedly shown under-reporting of energy intake based on self-reported data, specifically among overweight and obese individuals^(40–42).

Table 6 Food sources* of added sugar (teaspoons), mean contribution and as a percentage of total added sugar intake, among US adolescents aged 10–19 years (*n* 3156), National Health and Nutrition Examination Survey 2011–2014

Rank	Main group	Subgroup	Cons	Mean	SE	PCT	SE
1.	Beverages, Non-alcoholic	Sweetened Beverages	2087	8.6	0.3	42.1	1.3
2.	Snacks and Sweets	Sweet Bakery Products	1257	2.5	0.2	12.1	0.7
3.	Beverages, Non-alcoholic	Coffee and Tea	704	1.6	0.2	7.6	1.1
4.	Snacks and Sweets	Candy	914	1.3	0.1	6.1	0.6
5.	Snacks and Sweets	Other Desserts	608	1.1	0.1	5.5	0.5
6.	Sugars	Sugars	688	1.0	0.1	4.9	0.6
7.	Grains	Ready-to-Eat Cereals	879	1.0	0.1	4.9	0.4
8.	Milk and Dairy	Flavoured Milk	382	0.4	0.0	2.1	0.2
9.	Grains	Breads, Rolls, Tortillas	1659	0.4	0.0	1.9	0.1
10.	Grains	Quick Breads and Bread Products	475	0.4	0.0	1.8	0.2
11.	Condiments and Sauces	Condiments and Sauces	1282	0.3	0.0	1.2	0.2
12.	Snacks and Sweets	Snack/Meal Bars	181	0.2	0.0	1.1	0.1
13.	Mixed Dishes	Mixed Dishes – Sandwiches	553	0.2	0.0	1.1	0.1
14.	Milk and Dairy	Dairy Drinks and Substitutes	121	0.2	0.0	1.1	0.2
15.	Mixed Dishes	Mixed Dishes – Asian	238	0.1	0.0	0.7	0.2
16.	Fruit	Fruits	1251	0.1	0.0	0.6	0.1
17.	Fats and Oils	Fats and Oils	1074	0.1	0.0	0.6	0.1
18.	Milk and Dairy	Yoghurt	126	0.1	0.0	0.6	0.1
19.	Mixed Dishes	Mixed Dishes – Pizza	705	0.1	0.0	0.5	0.1
20.	Mixed Dishes	Mixed Dishes – M/P/F	429	0.1	0.0	0.5	0.2
21.	Water	Flavoured or Enhanced Water	73	0.1	0.0	0.5	0.1
22.	Mixed Dishes	Mixed Dishes – Grain-based	715	0.1	0.0	0.4	0.1
23.	Snacks and Sweets	Crackers	353	0.1	0.0	0.3	0.0
24.	Snacks and Sweets	Savoury Snacks	1379	0.0	0.0	0.2	0.1
25.	Protein Foods	Plant-based Protein Foods	520	0.0	0.0	0.2	0.0
26.	Protein Foods	Cured Meats/Poultry	874	0.0	0.0	0.2	0.0
27.	Protein Foods	Poultry	957	0.0	0.0	0.2	0.0
28.	Mixed Dishes	Mixed Dishes – Mexican	495	0.0	0.0	0.1	0.0
29.	Vegetables	Vegetables, excluding Potatoes	1181	0.0	0.0	0.1	0.0
30.	Vegetables	White Potatoes	874	0.0	0.0	0.1	0.0
31.	Grains	Cooked Cereals	86	0.0	0.0	0.0	0.0
32.	Beverages, Non-alcoholic	Diet Beverages	234	0.0	0.0	0.0	0.0
33.	Protein Foods	Meats	625	0.0	0.0	0.0	0.0
34.	Protein Foods	Seafood	210	0.0	0.0	0.0	0.0
35.	Mixed Dishes	Mixed Dishes – Soups	337	0.0	0.0	0.0	0.0
36.	Beverages, Non-alcoholic	100 % Juice	727	0.0	0.0	0.0	0.0
37.	Grains	Cooked Grains	463	0.0	0.0	0.0	0.0
38.	Milk and Dairy	Cheese	1017	0.0	0.0	0.0	0.0
39.	Protein Foods	Eggs	473	0.0	0.0	0.0	0.0
40.	Milk and Dairy	Milk	1433	0.0	0.0	0.0	0.0
41.	Water	Plain Water	2447	0.0	0.0	0.0	0.0

Cons, number of consumers; PCT, percentage contribution; M/P/F, meat/poultry/fish.

*All forty-one weighted subgroups of foods' contribution of daily intake of added sugar.

Although previous studies with NHANES data did not evaluate adolescents specifically, consistent findings were found for children aged 6–18 years⁽¹²⁾ and ≥ 2 years^(14,36,43) in that the highest-ranking food sources of Na were pizza, mixed dishes – Mexican, mixed dishes – sandwiches, cheese, milk and poultry. For SFA, major food sources were beef, milk and cheese; and for added sugars major food sources were desserts, snacks, and SSB. Meeting nutrient intake recommendations while staying within energy needs has proven to be challenging for many adolescents^(12,14,17), potentially contributing to the high prevalence of overweight and obesity⁽³⁹⁾, premature risk for CVD and type 2 diabetes⁽⁴⁴⁾ and a high likelihood of remaining with these adverse health conditions into adult life⁽⁴⁵⁾. Average Na intake among US adolescents is much higher than in younger children and adults⁽³²⁾. Corroborating with a previous NHANES analysis⁽¹²⁾ the

top food sources of Na were mixed dishes (i.e. pizza and Mexican), cured meats, bread rolls and tortilla, and savoury snacks, but with variation in the ranking of the top food sources' contributions by different social demographic characteristics. A previous study⁽⁴⁶⁾ of consumption trends showed that individuals aged 4–19 years significantly reduced their consumption of solid fats, added sugars and Na in the last decade because grocery stores, fast-food restaurants and full-service restaurants have been making an effort to reduce those nutrients to limit. To help US adolescents improve dietary habits and reduce intakes of Na, SFA and added sugars with better food choices, identifying food sources contributing to energy, nutrients to limit and total gram amount consumed is essential and needs continued monitoring.

Strengths of the present study are the use of a large, nationally representative database to examine food

sources of selected nutrients. The limitations include self-reported measurements that may over- or under-report dietary intake and physical activity⁽³¹⁾. Results need to be interpreted with caution because adolescents might be over-reporting their intakes of healthier foods and under-reporting their intakes of food sources of nutrients to limit in the diet, particularly when using a one 24 h dietary recall⁽⁴⁷⁾. Further, under-reporting is greater in those who are overweight or obese compared with those in the healthy weight range^(42,48) and findings might need to be interpreted with caution. To reduce the impact of mis-reporting, data were expressed as percentage contributions of food sources to energy, grams and nutrients to limit⁽⁴⁹⁾. A single day's intake may not be representative of an individual's usual intake but given large sample sizes does adequately represent mean intakes. Also, the identification of food sources of nutrient intakes is a limitation because this depends on a food grouping system that may not be universally used. For example, other evidence using the NOVA classification system⁽⁴⁹⁾ and the Food Pyramid Groups⁽⁵⁰⁾ have identified some foods that were in the top intake sources of adolescents, while in the present analysis those food sources were not among the top major contributors. Finally, the study used cross-sectional data from which casual relationships cannot be drawn.

Conclusion

Given adolescence is an important period of transition from childhood to adulthood with increased freedom of food choices, understanding dietary intake during this period is important⁽⁵⁰⁾. The present study provides detailed information on the food sources contributing to total energy, total grams, Na, SFA and added sugars consumed by a representative sample of US adolescents aged 10–19 years. A large proportion of total energy consumed was from energy-dense food groups (e.g. SSB and sweet bakery products), but also from some major food sources contributing important vitamins and minerals (e.g. beef, cheese and milk)⁽¹⁴⁾. Awareness of food sources may be useful to create or refine dietary strategies within public health initiatives to improve the diets of adolescents.

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President of Nutrition Impact, LLC, V.F. performs data analyses of large government databases like NHANES for numerous members of the food, beverage and dietary supplement industry. T.N. has received numerous grants from the food and beverage industry and federal agencies throughout her career. *Authorship:* All authors contributed to the development of this study. A.C.L. contributed to interpretation of data, drafting the manuscript and critical revision of the manuscript for scientific content. T.B. contributed to critical revision of the manuscript for scientific content. D.T. contributed to critical revision of the manuscript for scientific content. S.T. contributed to critical revision of the manuscript for scientific content. C.O.N. contributed to critical revision of the manuscript for scientific content. V.F. contributed to statistical analysis and critical revision of the manuscript for scientific content. T.N., the senior researcher of this project, participated in study concept and design, acquisition of data, interpretation of data and critical revision of the manuscript for important scientific content. *Ethics of human subject participation:* As it was a secondary analysis which lacked personal identifiers, this study did not require institutional review beyond the approval from the Centers for Disease Control and Prevention, National Center for Health Statistics Research Ethics Review Board (<https://www.cdc.gov/nchs/nhanes/irba98.htm>, accessed 6 April 2018).

Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S1368980018002884>

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